LP 91-08

Management Evaluation Model for the Edwards Aquifer

Texas Water Commission

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by

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INTRODUCTION

Purpose and Scope of Investigation

The purpose of this report is to document the development of the Management Evaluation Model for the Edwards aquifer and provide users of the model with the necessary information to simulate a variety of management scenarios.

The management of the Edwards aquifer has been discussed on an ongoing basis for many years and continues to be a topic of discussion in the San Antonio region, as well as other areas. The Texas Water Commission became involved in late 1989 as a mediator/ negotiator in discussions with the regional interest groups.

The water level in the J-17 index well, located at Fort Sam Houston in San Antonio, declined to 622.7 ft above Mean Sea Level (MSL) during the summer of 1990, which was the lowest level recorded in the well since the "drought of record" in 1957. The J-17 index well, an observation well, has been used to monitor water levels in the Edwards aquifer since the early 1960's. The CY-26 observation well, which was located near J-17, was used as the index well from 1933 until 1963.

The low water levels enlivened the discussions and emphasized the need for a comprehensive plan to manage aquifer development and use. As a result of the these discussions, many different management concepts were suggested by different concerned parties but no means were available to compare them. This created the need for a tool capable of evaluating any proposed management plans. The model was developed to meet this need and to provide a means for evaluating the relative impact of different management scenarios on the aquifer.

Physiographic and Hydrologic Setting

The Edwards aquifer in the San Antonio region lies within two physiographic provinces, the Edwards Plateau and the Gulf Coastal Plain. The catchment area for most of the recharge lies within the Edwards Plateau, where recharge takes place to the Edwards-Trinity aquifer. Ground water in the Edwards Plateau moves southeastward and, unless withdrawn, discharges as springflow near the southern end of the plateau. The resulting streams flow southeastward across the eroded surface of the Glen Rose Formation, until reaching the updip outcrop of the Edwards (Balcones fault zone) aquifer, where recharge into the aquifer takes place. The water then flows downdip toward the confined portion of the aquifer, where water movement is principally to the east and northeast. Major discharge points are located in the eastern areas of the aquifer at Comal Springs and San Marcos Springs.

The aquifer extends for approximately 180 miles and varies in width from 5 to 40 miles (Figure 1). It's eastern and western boundaries are marked by ground-water divides in Hays County and Kinney County, respectively. The northern boundary occurs along

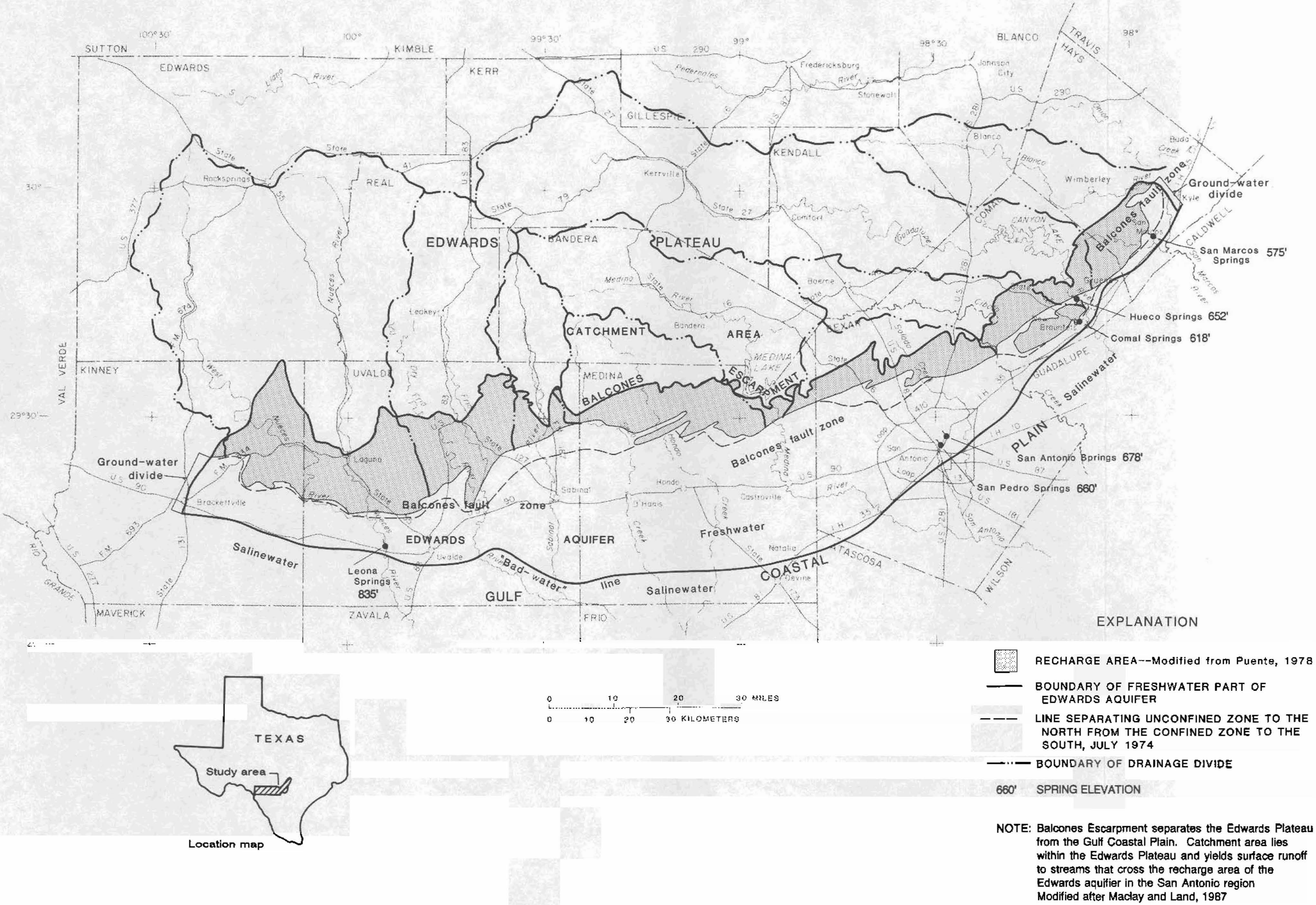


Figure 1.–Location of the San Antonio Region, Edwards Aquifer, Physiographic Regions, and Drainage Basins that Contribute Recharge

the faulted outcrop of the aquifer and generally coincides with the Balcones Escarpment. The aquifer extends south to the "bad-water" line, an arbitrary boundary represented by a total dissolved solids (TDS) concentration of 1,000 milligrams per liter (mg/l). South of the "bad-water" line, TDS values increase rapidly as transmissivity values decrease.

Acknowledgements

Acknowledgement is extended to Mr. John E. Birdwell, Commissioner, Texas Water Commission and Mr. James Kowis, Assistant Division Director, Water Rights and Uses Division, Texas Water Commission for their interest and support in the development of a ground-water management tool for the San Antonio region of the Edwards aquifer.

The model is based on the BASIC version of PLASM (Prickett-Lonnquist Aquifer Simulation Model).

Appreciation is also extended to the Texas Water Development Board for providing access to computer data files containing hydrologic information for the Edwards aquifer. The Edwards Underground Water District was instrumental in providing historic data for the Edwards aquifer.

HYDROGEOLOGY

Stratigraphy

In the San Antonio region, the Edwards aquifer consists of Lower Cretaceous reefal, shallow marine, and lagoonal deposits. The Edwards aquifer is underlain by the Glen Rose Formation, which is a limestone, in part shaley with minor amounts of dolomite. The upper confining unit is the Del Rio Clay. The stratigraphic nomenclature for the area was first developed by R.T. Hill (1891) and was later modified by Rose (1972). Rose (1972) elevated the Edwards Limestone to group status and subdivided it into two formations; the lower formation was designated the Kainer Formation, and the upper was named the Person Formation.

Within the San Antonio region are three distinct depositional provinces; the Maverick Basin, the Devils River Trend, and the San Marcos Platform. The Kainer, Person, and Georgetown Formations are found on the San Marcos Platform and are stratigraphically equivalent to the Devils River Limestone, found in the Devils River Trend. The West Nueces, McKnight, and Salmon Peak, Formations in the Maverick Basin are also stratigraphic equivalents to the

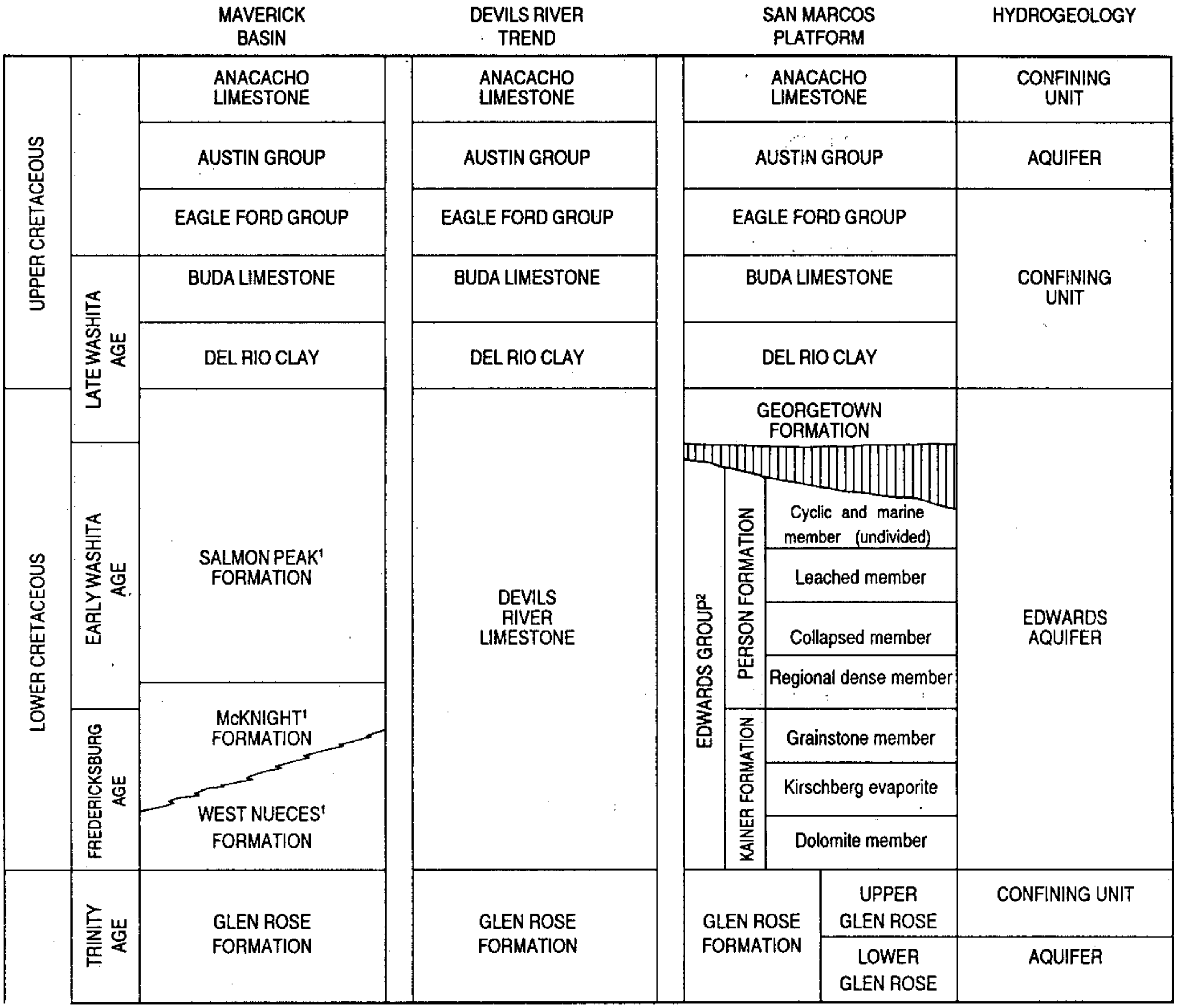
Kainer, Person, and Georgetown Formations. Figure 2 provides a correlation of stratigraphic units within each of the three depositional provinces as described by Rose (1972).

Structure

The geologic structure of the Edwards Group and Associated Limestones of the Edwards aquifer is characterized by a series of parallel trending normal faults, which separate distinct fault blocks. The faults trend predominantly in a east-northeasterly direction and are downthrown to the south and southeast. Associated fractures trend in both northeasterly and northwesterly directions. Maximum fault displacement is reported to be 600 feet at the Comal Springs fault, with fault displacement averaging 200 feet to the west in Medina and Uvalde Counties (Klemt and others, 1979).

Hydrology

The Edwards aquifer is bounded on the north by the northern edge of the Balcones fault zone and the southern boundary is marked by the downdip limit of the occurrence of fresh water, known as the "bad-water" line. This arbitrary southern boundary is usually represented by a isoconcentration line of 1,000 mg/l total dissolved solids and commonly coincides with a reduction in transmissivity south of the boundary. The eastern extent of the Edwards aquifer in the San Antonio region is represented by a ground-water divide north of Kyle in Hays County. A similar



[1] Of Lozo and Smith (1964).

[2] The Edwards Limestone was raised to a stratigraphic group by Rose (1972) and includes Kainer and Persons Formations in the subsurface.

Figure 2.–Correlation of Cretaceous Stratigraphic Units

boundary occurs in the west, near Brackettville in Kinney County.

Both confined and unconfined conditions exist within the Edwards aquifer. The unconfined portion is located in the northern area of the aquifer, where the Edwards Group and/or the Georgetown Formation or stratigraphically equivalent rocks are exposed at the surface. The majority of the recharge to the aquifer takes place in this area, with insignificant amounts of underflow from the Glen Rose Formation. Within the "recharge zone" or unconfined portion of the aquifer, approximately 80% of the total recharge is estimated to occur along major drainage systems which cross the area (Maclay and Small, 1986). The remaining recharge from this area is the result of direct infiltration on interstream areas. For the period of record, 1934 - 1988, the annual recharge has averaged 635,500 acre-feet. The confined portion of the aquifer occurs downdip of the recharge zone and extends southward to the "bad-water" line. Most of the discharge occurs within the confined portion of the aquifer as pumpage and spring flow. Discharge includes all water which leaves the aquifer, such as spring flow, artesian well flow, withdrawal (pumpage), and interaquifer leakage. The main pumpage centers are located at municipalities such as San Antonio, New Braunfels, San Marcos, and Uvalde, and in western areas where pumpage for irrigation takes place on a less localized basis. The main springs are Leona Springs in Uvalde County, San Pedro and San Antonio Springs in Bexar County, Comal and Hueco Springs in Comal County, and San Marcos Springs in Hays County. The locations and spill elevations for the springs are shown in

Figure 1.

Water recharging the aquifer in the north flows principally southward until reaching the confined portion of the aquifer, where it then flows in a easterly direction. Closer inspection of water levels indicates that in local areas, faults act to redirect ground water and restrict flow from the recharge area to the confined portion of the aquifer. The structural complexity affects water movement more in the unconfined portion of the aquifer than in the confined areas, where hydraulic gradients are relatively flat and transmissivities are very large. The aquifer can be divided into three distinct areas or "pools," based on water levels (Figure 3).

Transmissivity values for the Edwards aquifer are difficult to quantify due the nature of the limestone aquifer. Each of the different members which comprise the Edwards Group display different porosity and permeability characteristics. An estimate of transmissivities was suggested by Maclay and Small (1986) to range from 200,000 square feet per day to 2,000,000 square feet per day.

Specific yields and storage coefficients have also been estimated from previous work on the Edwards aquifer. Maclay and Small (1986) estimated the storage coefficient to range from about .0001 to .00001 and the specific yield to be 3 percent. Prior studies by Klemt and others (1979) suggested storage coefficients ranging from .0004 to .0008, and they used specific yields of 6 percent for model applications.

The structural grain of the aquifer has contributed to the

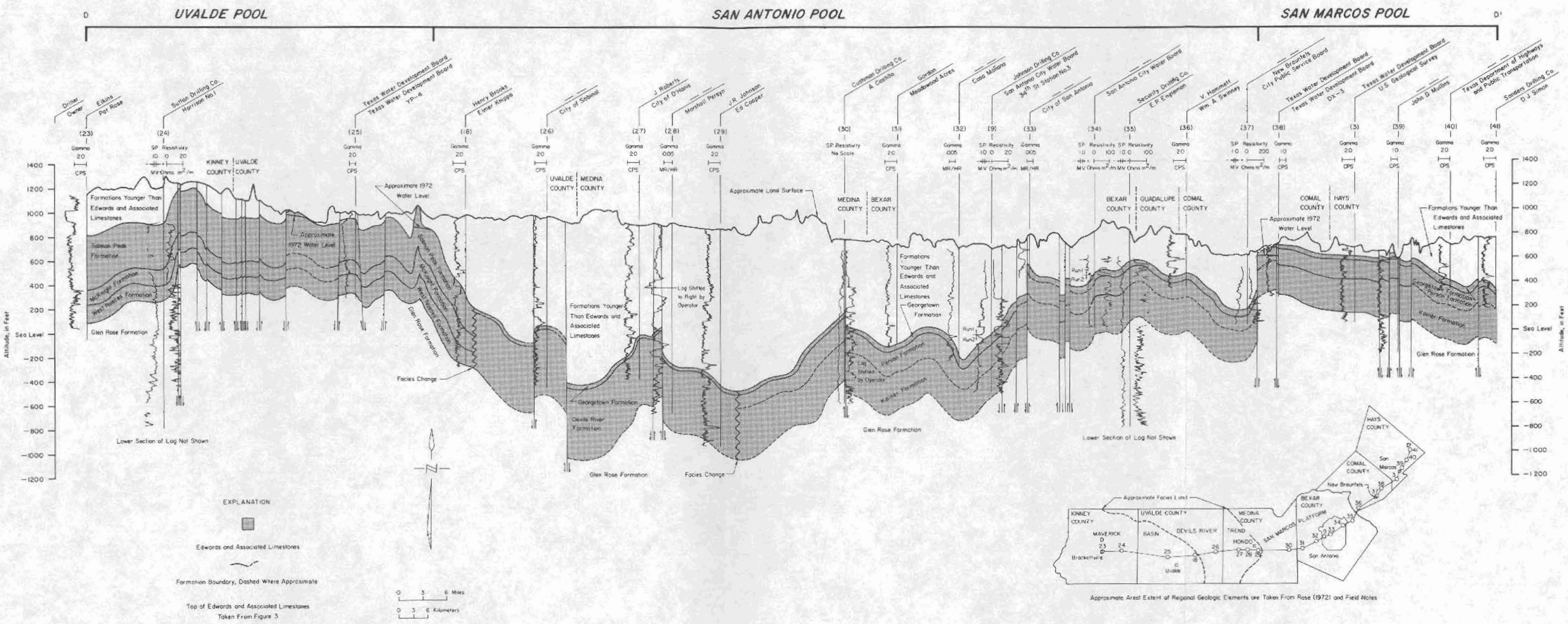


Figure 3.–Geohydrologic Section of the Edwards Aquifer

development of a pronounced anisotropy, which is characterized by larger transmissivities in a east-northeasterly direction. These large transmissivities are probably the result of solution enlargement along fractures and faults which trend in a east-northeasterly direction.

Heterogeneity in the aquifer occurs as the result of the varying porosity and permeability in the different stratigraphic members and the displacement of individual members along faults. This is the primary cause of abrupt water level changes across faults in the unconfined portion of the aquifer.

MATHEMATICAL BASIS FOR COMPUTER MODEL

The starting point for the development of the Management Evaluation Model for the Edwards aquifer was an existing ground-water model called PLASM (Prickett-Lonnquist Aquifer Simulation Model). PLASM is a finite difference model which simulates two dimensional nonsteady-state ground-water flow in a nonhomogeneous anisotropic aquifer. The partial differential equation which describes this flow is as follows:

$$\frac{\partial}{\partial x}\left[T\frac{\partial h}{\partial x}\right] + \frac{\partial}{\partial y}\left[\frac{\partial h}{\partial y}\right] = S\frac{\partial h}{\partial t} + Q$$

where

Q = net ground-water withdrawal rate per unit area
T = transmissivity
S = storage coefficient
h = head
t = time
x,y = rectangular coordinates (Prickett, Lonnquist, 1971)

Since no general solution exists for this equation, a numerical technique must be used. The modeled area of the aquifer is represented by a rectangular grid, each cell of which is assigned the characteristics (transmissivity, storage coefficient, thickness, etc.) which describe the portion of the aquifer that it represents. The computer code of the PLASM model applies a finite difference implicit numerical representation of the above partial differential equation for each cell of the grid. An iterative modified alternating direction procedure is used to solve the resultant array of simultaneous equations.

The version of PLASM, which was the starting point for the model development, was written by Thomas A. Prickett & Associates in February of 1988. It is an interactive version designed especially to be used on a microcomputer. The model is distributed with its BASIC source code, to allow customization. Some other features of the model include the ability to simulate either confined or unconfined conditions, to take into account variable pumpage rates and leakage, and to represent no-flow and constant head boundaries.

PLASM has over the years become a widely used and accepted ground-water model. Its combination of simplicity and elegance makes it suitable for a wide variety of problem solving applications.

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS AQUIFER

Modifications to PLASM Program

It was necessary to modify the PLASM code due to the unique characteristics of the Edwards aquifer and in order to allow the simulation of a variety of ground-water management plans. The first modification to the original PLASM code was to allow the simultaneous simulation of both unconfined and confined conditions. To simulate the Edwards aquifer, it was also necessary to incorporate the ability to simulate spring discharge. Further modifications included the replacement of the original user friendly interface with a fixed model data base and a new interface which allows the simultaneous simulation of several different management options.

The Edwards aquifer is subject to large seasonal fluctuations which necessitate the ability to use seasonal data so as to simulate these fluctuations. It was decided that it was most practical to handle the historical data on a quarterly basis. Most of the data is reported annually, but can be distributed seasonally and thus is best represented on a quarterly basis. Some historical data is available on a monthly basis, but to simulate on a monthly basis would exceed the limitations of most of the available data.

The original user friendly interface which allowed entry of basic data was eliminated since the model has data files which are unique to it and rarely need to be changed. PLASM utilizes one data file, but in the Management Evaluation Model this file was split into two separate files, one which describes the hydrologic nature of the aquifer and another which contains the historical data (i.e., recharge and pumpage).

The program was adapted further by adding the capability to model the flows of Comal Springs and San Marcos Springs. This was accomplished by incorporating equations which calculate spring discharge for the cells in which the springs are located. The equations are based on the historical relationship between the head in a well near each spring and spring discharge.

The original PLASM code, which is able to simulate either confined or unconfined conditions, was altered to handle both confined and unconfined conditions simultaneously. This was necessary due to the hydrology of the aquifer, which is characterized by an unconfined recharge zone and a downdip confined zone.

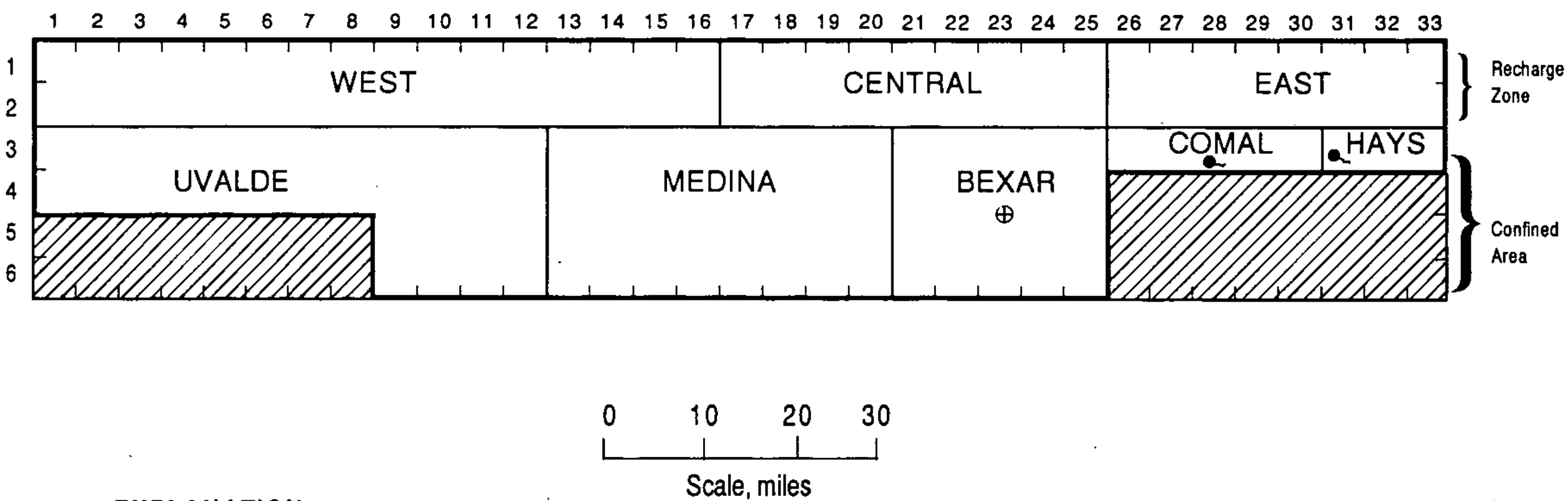
Fundamental to the Management Evaluation Model, are the modifications which allow simulations of a variety of management scenarios. The management plans commonly suggested included some combination of (1) drought management, (2) conservation reduction, and (3) aquifer storage and recovery (ASR). The various discussed drought management plans call for reductions in usage as aquifer water levels decline to predetermined levels. The model has the capability of reducing withdrawal rates as a function of predetermined water levels at the index well, thus simulating a drought management plan (DMP). Conservation reduction refers to reduction of long-term ground water use. The model simulates conservation reduction through reducing maximum allowable pumpage linearly over a specified number of years to a set limit. An ASR program provides for withdrawal of water from the aquifer during high recharge years for storage in a nearby aquifer and later recovery during low recharge years. The model allows this additional pumpage when the water level in the J-17 index well exceeds a specified trigger level. This option also provides the ability to increase pumpage over the historical pumpage which is specified in the historical data file. The historical data file contains withdrawals for the years 1981 - 1986 repeated, thus estimating current pumpage demands. In order to increase pumpage demands, without altering the historical data file, choose a trigger water level at a sufficiently low level as to allow the ASR option to operate during the entire simulation. This allows the user to increase the stress on the aquifer by a fixed amount of pumpage beyond the historical value. During periods when both a drought management plan and conservation reduction plan are in effect, the model chooses the lowest maximum pumpage from the two plans. Historical withdrawal could be less than either of the two maximums from the management plans, in which case the model uses the historical pumpage.

A new user friendly interface was created to allow for ease in selecting management options and inputting the parameters which define the scenario. A data file called MANAGE.DAT is created to save the selected options for future simulations with the same or similar scenarios. The MANAGE.DAT file is automatically called into memory when the program is initialized and may be altered if desired through the user friendly interface. This reduces duplication of effort by avoiding reentry of unaltered data. A detailed explanation of the data entry procedure is provided in Appendix A and a complete listing of the computer code is shown in Appendix B.

Model Development

The model was developed to run on IBM compatible machines with a 286 microprocessor and 287 math coprocessor in a reasonable run time. However, it would be better to have a computer with a 386 microprocessor, 387 math coprocessor, and 20 megabyte hard disk storage. This configuration is capable of providing model run times of 1.5 hours with 55 years of data (1934 - 1988).

The model grid consist of 6 rows and 33 columns, each cell thus formed representing an area of 25 square miles (Figure 4). The number of grid cells was purposely kept to a minimum so as to avoid excessively long run times. In order to minimize the number of grid cells, the Edwards aquifer was projected as a rectangular area. This also aligned the trend of the major faults and hydrologic conduits along an axis of the model grid, which facilitated the representation of an anisotropic aquifer. All



EXPLANATION

Spring

⊕ J-17 Observation Well

— No Flow Boundary

Figure 4.–Model Grid for the Management Evaluation Model for the Edwards Aquifer

model boundaries are considered to be no-flow boundaries, as insignificant inflow or outflow is believed to take place across these boundaries.

A separate data file, EDWARDS.PLA, was created to contain all of the hydrologic data required by the program. Initial values for transmissivity, hydraulic conductivity, storage coefficients, water levels, and the elevation of the bottom of the aquifer were adapted from the Texas Department of Water Resources Report 239. The necessary modifications were made through model calibration.

Historical Data

In the model, the historical data is contained in a separate file called HISTORY.DAT. This data set consists of recharge values for the Edwards aquifer from 1934 to 1988. For a detailed discussion on the structure and contents of the HISTORY.DAT file see Appendix C.

Recharge values were obtained from historical data, which consist of annual recharge figures for the drainage basins that transect the recharge zone. The recharge zone in the model is divided into 3 separate areas; west, central, and east. The western area consists of the Nueces-West Nueces River Basin, Frio-Dry Frio River Basin, Sabinal River Basin, and the area between the Sabinal River and the Medina River Basin. The central area consist of Medina Lake and the area between Cibolo Creek and Medina River Basin. The eastern area is represented by the Cibolo-Dry Comal Creek Basin and the Blanco River Basin. Annual recharge was divided quarterly according to the annual distribution of precipitation in each of the three areas, as measured in 1953 - 1971. The percentages used for the quarterly recharge values are displayed in Table I.

TABLE I

Recharge Distribution

Area	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
West	15%	31%	31%	23%
Central	19%	29%	29%	23%
East	22%	32%	22%	24%

The HISTORY.DAT file contains pumpage data for the years 1981 - 1986, repeated. This allows the model to evaluate the effect of different management scenarios given current pumpage demands and a repeat of the "drought of record."

Pumpage data is reported annually for each county and requires assumptions to be made in order to arrive at quarterly values. For the western counties, Uvalde and Medina, irrigation is the predominant use and occurs mainly during the two summer quarters, April through September. It was estimated that 70% of the annual withdrawal occurs during this time period (35% per quarter), thus 30% of the withdrawal was assumed to take place during the two winter quarters (15% per quarter). For the central and eastern counties (Bexar, Comal and Hays) a more even annual distribution was estimated, with 60% of the annual withdrawal assigned to the two summer quarters (30% per quarter) and 40% for the two winter quarters (20% per quarter).

Calibration and Verification

The model was calibrated for steady state conditions, which were approximated by averaging recharge, pumpage and spring flows for the years 1934 through 1988. Adjustments were made to transmissivity and storage coefficient values in the model to obtain the closest possible agreement between simulated and historical average values for spring flows and the head level at the index well.

Verification was performed for the years 1963 through 1988. The hydrologic data for this period was determined to be the most reliable of the available data. Results of the verification runs were compared against the historical values for spring flows and for the water level at the index well. The average simulated head for the index well was determined to be within 1 foot of the average historical head. While variations between the simulated and historical heads were often greater than 1 foot, the difference was considered to be well within acceptable limits for the purposes for which this model was designed.

Model Output

The model output includes quarterly values for the simulated water level at the index well and quarterly pumpage rates as selected by the model to simulate the given management plan. The pumpage data was included in the output to provide a check of model operation and as input data for graphical displays. The drought management level and the actual management option as selected by the model are also displayed in the output. The PLOT.OUT file contains all this output data and can be readily printed to provide a more convenient method of studying the simulation results. An example of the model output is shown as Appendix D. A second output file called PRINT.OUT is used to diagnose problems if the program does not run properly.

MODEL APPLICATION

The utility of the model is demonstrated through an example application, which evaluates the effect of two different management concepts on the water level in the index well. The results of the model simulations for each concept are provided in graphical form for ease of interpretation. The data from the PLOT.OUT file is easily read into graphics software for manipulation and display.

Both management concepts are evaluated for the period 1934 - 1988, in which withdrawal and recharge from the historical data file were used. This file contains pumpage for the years 1981 - 1986, repeated, and recharge for the period of record, 1934 - 1988. Management Concept A calls for only a drought management plan and contains no provision for conservation reduction or aquifer storage and recovery. This DMP calls for a reduction in withdrawal as the water level in the index well in Bexar County falls below specified levels. The maximum allowable pumpage is based on a reduction of 15%, 25%, and 30% of the 1984 usage (529,800 ac-ft/yr) at water levels of 644, 628, and 612 feet above MSL in the Bexar County index well, respectively. The simulated water level for the index well is displayed in Figure 5.

Management Concept B includes a drought management plan and conservation reduction. The DMP is more restrictive than concept A and calls for reductions in the maximum allowable pumpage of 15%, 30%, and 40%, from the 1984 pumpage level, at water levels of 644, 628, and 612 in the index well, respectively. The overall conservation reduction has as a target, maximum allowable pumpage of 450,000 ac-ft/yr to be reached in 20 years. The model simulates this by reducing linearly from an initial maximum allowable pumpage of 600,000 ac-ft/yr to a maximum allowable rate of 450,000 ac-ft/yr over the first 20 years of the run. Figure 6 shows the effect of Management Concept B on the water level in the index well.

By comparing Figures 5 and 6, the relative impact of each management concept on aquifer water levels can be ascertained. This basis for comparison of the two concepts, which the model provides, allows a quick and direct method to evaluate ground-water management concepts. Printouts of the actual PLOT.OUT files for both simulations are located in Appendix D.

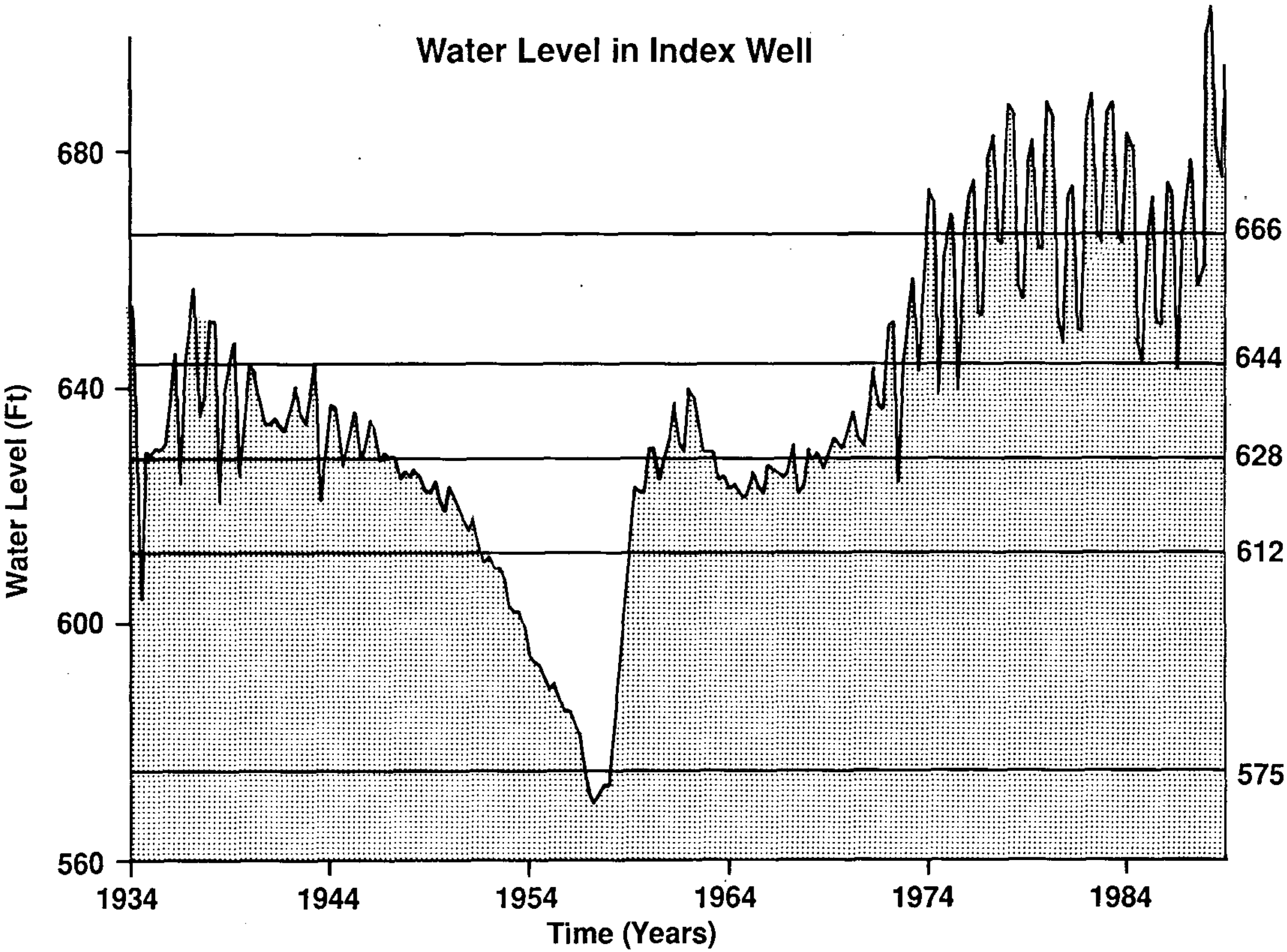


Figure 5.–Plot of the Water Level for the Index Well from Management Concept A

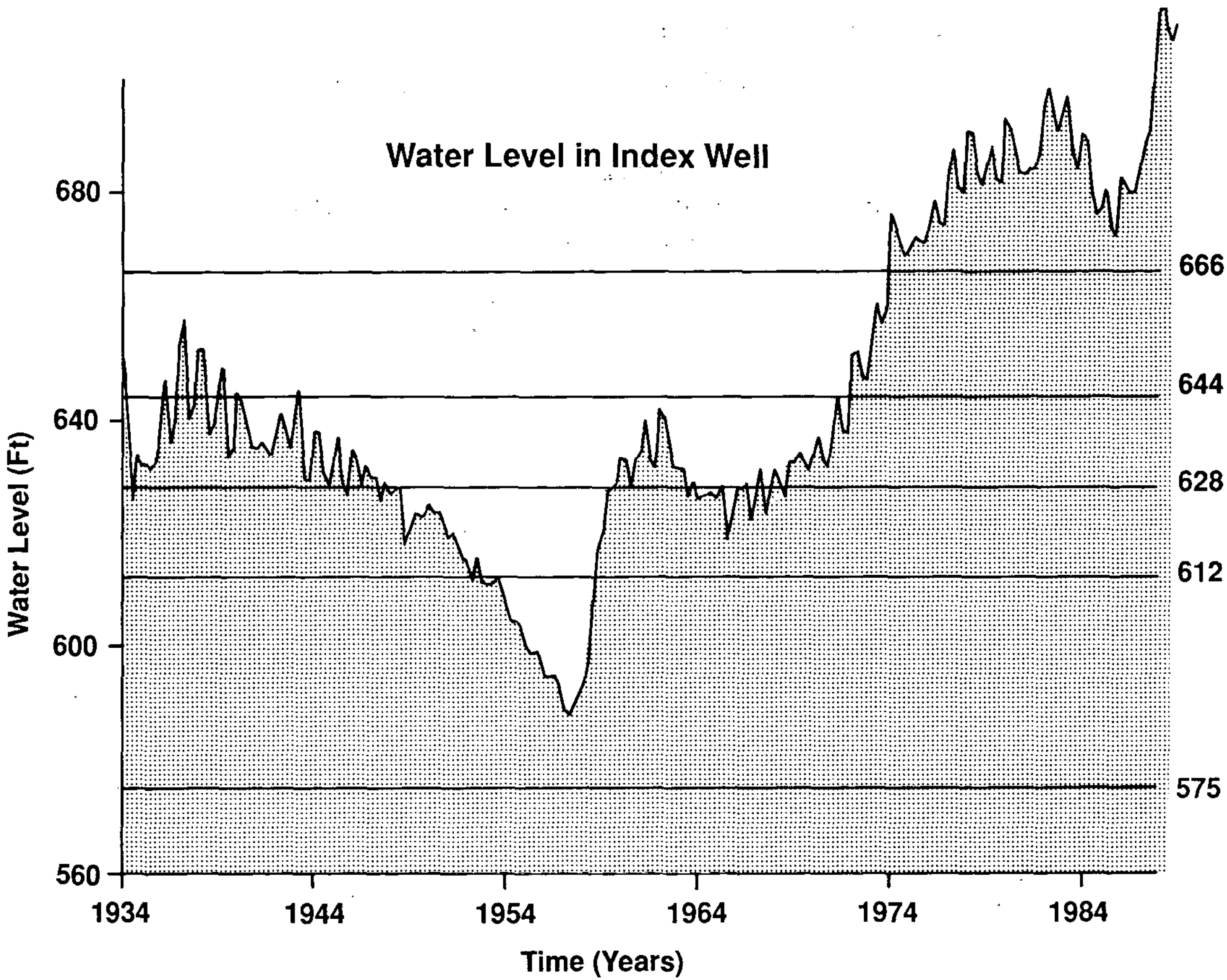


Figure 6.–Plot of the Water Level for the Index Well from Management Concept B

LIMITATIONS AND RECOMMENDATIONS

The Management Evaluation Model for the Edwards aquifer was developed specifically as a ground-water management tool. To minimize the computer time and memory necessary to perform a simulation, the number of grid cells used in the model was chosen judiciously. As the number of grid cells decreases, each cell and the hydraulic properties used for each cell must then represent a larger area. The larger cell size necessitates that the predicted head for a cell represents more of an average and less of a point value. This limits the ability to accurately predict the head at a given point, such as the water level at the index well. The accuracy and detail of available hydrologic data limit the accuracy of the model and may have a greater effect than the number of cells used to represent the aquifer. The model grid is believed to represent the best compromise between required computer time and memory, and full utilization of available hydrologic data.

The model is designed to calculate aquifer water levels at the index well in Bexar County for a given recharge and selected withdrawal. The model uses historic patterns for the geographic distribution of recharge, but since future geographic distributions cannot be accurately predicted, the model is limited in its ability to predict future aquifer water levels at the index well. The ability to predict future aquifer water levels at the index well is also affected by the inability to accurately predict future seasonal distributions of recharge. These limitations restrict the use of the model to predict future aquifer water levels and associated spring flows. However, the model is capable of evaluating management concepts for the period of record (1934 - 1988), which is provided in the historical input file.

The Management Evaluation Model for the Edwards aquifer was developed to evaluate a variety of management scenarios as to their relative effectiveness in preventing or minimizing water level declines in the Edwards aquifer. It is recommended that the model be used to perform evaluations by comparing the relative effect of management plans and not to determine the unqualified effect of a single plan.

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APPENDIX A

Data Entry Procedure

When the model is first activated, by typing EDWARDS at the DOS prompt and pressing Enter, the question "Do you have a color monitor (Y-yes or N-no)?" is displayed. After the user gives the appropriate response the program moves to the part of the interface which is used to input the various management parameters. Three different management activities can be simulated in any combination; aquifer storage and recovery (ASR), conservation reduction, and drought management (DMP).

If there is no existing MANAGE.DAT file, the first screen of the interface presents the question, "WILL ASR BE IN EFFECT (Y-yes or N-no)?" as shown in FIG-1. If the question is answered affirmatively then two more questions will come up, one at a time (FIG-2). These require the user to input the ASR pumping rate and the index well elevation above which ASR goes into effect. The interface next queries the user whether or not conservation reduction is to be simulated and at the same time it displays all data entered, thus far, at the top of the interface box, as shown in FIG-3. If conservation reduction is to be modeled three more data inputs are required to describe it; the starting pumpage limit, the target pumping limit, and the number of years in which the target limit is to be achieved. After the inputs for conservation reduction are completed the user is asked whether he wants to simulate drought management. A positive response will lead first of all to queries which establish the number of drought management levels and the pumpage rate which will be the basis of the stepped reduction of the maximum allowed pumpage rate (FIG-4). Next is the input of the data which defines each level. The first level is the elevation above which the pumpage will be historical. This elevation is 644 feet in our example, as shown in FIG-5. For the remainder of the management levels the user is prompted to input the aquifer elevation above which that level is in effect and the percent of the basis of stepped reduction, which will be the maximum allowable pumpage for that level. FIG-6 shows the inputs for level two of our example. It indicates that above 628 feet (but below 644 feet, which is the level 1 elevation) the maximum pumpage will be restricted to 85% of 529,800 acre-ft/year. After all levels are input the interface displays all the entered data and gives the user a chance to go back and change any that was incorrectly entered. If all the data is correct then G can be pressed to indicate to the program to "go" with the inputted data and proceed with the simulation. If the user does not want to continue at this point, E can be pressed to escape the program, in which case the entered data will not be lost but will be saved in the MANAGE.DAT file. Any time the program is started again, the data from the MANAGE.DAT file is reloaded, and the interface goes directly to the screen shown in FIG-7, with the same options of changing the data, going on with the simulation or, exiting the program. Another feature of the interface that needs to be mentioned is that at any stage of input, the F1 key can be pressed to move the user to a previous stage of input to correct any errors which may have been made.

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

```
WILL ASR BE IN EFFECT (Y-yes or N-no)?
```

(FIG-1)

PRESS F1 TO MOVE UP

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

```
WILL ASR BE IN EFFECT (Y-yes or N-no)? y

      WHAT WILL BE THE ASR AMOUNT? - (ACRE-FT/YEAR) - ? 20000
      WHAT WILL BE THE ASR INDEX WELL WATER LEVEL? - (FT) - ? 666
```

(FIG-2)

PRESS F1 TO MOVE UP

```
MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

1  THE ASR PUMPAGE WILL BE 20000 ACRE-FT/YEAR
   WHEN THE INDEX WELL LEVEL IS ABOVE 666 FT.



   IS CONSERVATION REDUCTION TO BE SIMULATED ? y

         STARTING LIMIT IN ACRE-FT/YEAR---? 529800
         TARGET LIMIT IN ACRE-FT/YEAR-----? 450000
         NUMBER OF YEARS TO REACH TARGET--? 20

PRESS F1 TO MOVE UP
```

(FIG-3)

```
MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

1  THE ASR PUMPAGE WILL BE 20000 ACRE-FT/YEAR
   WHEN THE INDEX WELL LEVEL IS ABOVE 666 FT.
2  CONSERVATION REDUCTION WILL BE SIMULATED.
      THE STARTING LIMIT WILL BE 529800 ACRE-FT/YEAR.
      THE TARGET LIMIT WILL BE 450000 ACRE-FT/YEAR.
      CONSERVATION REDUCTION WILL BE IMPLEMENTED IN 20 YEARS.



   WILL THERE BE A DMP SIMULATED IN THIS RUN? ? y

         NUMBER OF MANAGEMENT LEVELS - ? 4
         MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR - ? 529800

PRESS F1 TO MOVE UP
```

(FIG-4)

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

```
1  THE ASR PUMPAGE WILL BE 20000 ACRE-FT/YEAR
   WHEN THE INDEX WELL LEVEL IS ABOVE 666 FT.
2  CONSERVATION REDUCTION WILL BE SIMULATED.
      THE STARTING LIMIT WILL BE 529800 ACRE-FT/YEAR.
      THE TARGET LIMIT WILL BE 450000 ACRE-FT/YEAR.
      CONSERVATION REDUCTION WILL BE IMPLEMENTED IN 20 YEARS.


   WILL THERE BE A DMP SIMULATED IN THIS RUN? ? y

         NUMBER OF MANAGEMENT LEVELS - ? 4
         MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR - ? 529800

         THE LEVEL # 1 ELEVATION IS 644 ABOVE WHICH THE
         PUMPAGE WILL BE HISTORICAL.
```

PRESS F1 TO MOVE UP

(FIG-5)

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

```
1  THE ASR PUMPAGE WILL BE 20000 ACRE-FT/YEAR
   WHEN THE INDEX WELL LEVEL IS ABOVE 666 FT.
2  CONSERVATION REDUCTION WILL BE SIMULATED.
      THE STARTING LIMIT WILL BE 529800 ACRE-FT/YEAR.
      THE TARGET LIMIT WILL BE 450000 ACRE-FT/YEAR.
      CONSERVATION REDUCTION WILL BE IMPLEMENTED IN 20 YEARS.
3  DMP WILL BE SIMULATED WITH 4 LEVELS.
      LVL. 1 IS 644 ABOVE WHICH THE PUMPAGE WILL BE THE HISTORICAL.


         NUMBER OF MANAGEMENT LEVELS -  4
         MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR -  529800

         THE LEVEL # 2 ELEVATION IS 628 ABOVE WHICH THE
         PUMPAGE IS TO BE 85  % OF  529800 .
```

PRESS F1 TO MOVE UP

(FIG-6)

MANAGEMENT EVALUATION MODEL FOR THE EDWARDS

```
1  THE ASR PUMPAGE WILL BE 20000 ACRE-FT/YEAR
   WHEN THE INDEX WELL LEVEL IS ABOVE 666 FT.
2  CONSERVATION REDUCTION WILL BE SIMULATED.
      THE STARTING LIMIT WILL BE 529800 ACRE-FT/YEAR.
      THE TARGET LIMIT WILL BE 450000 ACRE-FT/YEAR.
      CONSERVATION REDUCTION WILL BE IMPLEMENTED IN 20 YEARS.
3  DMP WILL BE SIMULATED WITH 4 LEVELS.
      LVL. 1 IS 644 ABOVE WHICH THE PUMPAGE WILL BE THE HISTORICAL.
      LVL. 2 IS 628 ABOVE WHICH MAX. PUMPAGE IS      85% OF 529800.
      LVL. 3 IS 612 ABOVE WHICH MAX. PUMPAGE IS      70% OF 529800.
      LVL. 4 IS 400 ABOVE WHICH MAX. PUMPAGE IS      60% OF 529800.



   DO YOU WANT TO ALTER ONE OF THE ABOVE?
   HIT THE DESIRED NUMBER OR G TO GO OR E TO EXIT.
```

(FIG-7)

PRESS F1 TO MOVE UP

APPENDIX B

Computer Code Listing

```
REM name: Management Evaluation Model for the Edwards
REM
REM purpose: To evaluate various management schemes
REM          for the Edwards Aquifer.
REM
REM adapted by:
REM                Joseph L. Peters & Scott Crouch
REM                Texas Water Commission
REM                Austin, Texas
REM
REM adapted from: PLASM (Interactive Microcomputer Version)
REM
REM purpose: To simulate one- or two- dimensional, nonsteady ground water
REM          flow in an artesian or water table/heterogeneous, isotropic/
REM          anisotropic aquifer system.  A finite difference approach is
REM          used to formulate the equations of ground water flow.  A
REM          modified alternating direction implicit method is used to
REM          solve the set of resulting finite difference equations.
REM
REM written by:
REM                Thomas A. Prickett & Associates
REM                Urbana, Illinois 61801
REM                Phone: 217/384-0615 or 344-2277
REM
REM date: 02/21/1988
REM
REM definitions: NS= Number of time steps
REM                DE= Time increments
REM                ER= Convergence error on head
REM                NC= Number of columns
REM                NR= Number of rows
REM                TT= Default transmissivity
REM                HH= Default head
REM                QQ= Default withdrawal rate
REM                 I= Column number
REM                 J= Row number
REM          TI(I,J)= Transmissivity in i-direction at node (i,j)
REM          TJ(I,J)= Transmissivity in j-direction at node (i,j)
REM          SF(I,J)= Storage factor at node (i,j)
REM          HO(I,J)= Head at node (i,j) at start of a time step
REM       PERMI(I,J)= Permeability in i-direction at node (i,j)
REM       PERMJ(I,J)= Permeability in j-direction at node (i,j)
REM         BOT(I,J)= Elevation of bottom of aquifer
REM           H(I,J)= Head at node (i,j) at end of the time step
REM           R(I,J)= Leakage factor at node (i,j)
REM          RH(I,J)= Source bed head at node (i,j)
REM          RD(I,J)= Confining bed head at node (I,J)
REM      AA,BB,CC,DD= Coefficients in water balance equations
REM

DECLARE SUB XBOX ()
DECLARE SUB SSSUB1 (YNASR$, Q1ASR!, H1ASR!)
DECLARE SUB SSSUB3 (MQCON!, QQCON!, TIMCON!, AACON$)
DECLARE SUB SSSUB4 (AADMP$, NUMMUL%, PUMPMAX!, REFH!(), XREDUC!(), DNUMMUL%)
DIM G(50), B(50), DL(50, 10), H(50, 10), HO(50, 10), TI(50, 10)
DIM TJ(50, 10), SF(50, 10), Q(50, 10), R(50, 10), RH(50, 10)
DIM RD(50, 10), DELX(51), DELY(51), BOT(50, 10), PERMI(50, 10)
DIM PERMJ(50, 10), IP(12), JP(12), P(12, 24)
DIM XQ(50, 10), XR(50, 10), XTI(50, 10), XTJ(50, 10), XSF(50, 10)
DIM QXQ(50, 10), RXR(50, 10), REFH!(9), MULTI!(9), XREDUC!(9)

CLS
LOCATE 12, 15
70 INPUT "Do you have a color monitor (Y-yes, N-no)? ", XX$
IF XX$ <> "Y" AND XX$ <> "y" AND XX$ <> "N" AND XX$ <> "n" THEN
PRINT "(Y-yes, N-no)"
GOTO 70
END IF
IF XX$ = "Y" OR XX$ = "y" THEN COLOR 14, 1, 1: CLS  ELSE CLS

MAXP = 12
MAXRT = 24

ON ERROR GOTO HANDLER
START: OPEN "I", #10, "MANAGE.DAT"

GOTO ENDHANDLER
HANDLER:
XNUMBER = ERR
XERL = ERL
IF XNUMBER = 53 THEN
     OPEN "O", 10, "MANAGE.DAT"
     CLOSE 10
     RESUME START
ELSE
     PRINT "ERROR # "; XNUMBER; " ON LINE "; XERL
     ERROR XNUMBER
```

```
            ON ERROR GOTO 0
        END IF
ENDHANDLER:

        ON ERROR GOTO 0
        LLLL% = LOF(10)

        IF LLLL% > 25 THEN
            INPUT #10, YNASR$
            YNASR$ = LEFT$(YNASR$, 3)
            INPUT #10, Q1ASR!
            INPUT #10, H1ASR!
            INPUT #10, AAACON$
            IF LEFT$(AAACON$, 3) = "CON" THEN
               AACON$ = "Y"
            ELSE
               AACON$ = "N"
            END IF
            INPUT #10, MQCON!
            INPUT #10, QQCON!
            INPUT #10, TIMCON!
            INPUT #10, AAADMP$
            IF LEFT$(AAADMP$, 3) = "DMP" THEN
               AADMP$ = "Y"
            ELSE
               AADMP$ = "N"
            END IF
            INPUT #10, NUMMUL%
            INPUT #10, PUMPMAX!
            FOR IJXY = 1 TO NUMMUL%
               INPUT #10, REFH!(IJXY), XREDUC!(IJXY)
            NEXT
        CLOSE 10
        OPEN "O", #10, "MANAGE.DAT"
        KEY 1, "UP" + CHR$(13)
        GOTO LBLB

        ELSE

        CLOSE 10
        OPEN "O", #10, "MANAGE.DAT"

        KEY 1, "UP" + CHR$(13)
        CH$ = "0"
        DO
LBL00:  IF CH$ = "0" OR CH$ = "1" THEN
LBL0:   CLS
        CALL XBOX

        DO
            LOCATE 16, 10
            INPUT "WILL ASR BE IN EFFECT (Y-yes or N-no)"; AA$
            IF RIGHT$(AA$, 2) = "UP" THEN GOTO LBL00
        LOOP WHILE (AA$ <> "Y" AND AA$ <> "y" AND AA$ <> "N" AND AA$ <> "n")

        IF AA$ = "Y" OR AA$ = "y" THEN
LBL1:   DO
            LOCATE 18, 2
            INPUT "            WHAT WILL BE THE ASR AMOUNT? - (ACRE-FT/YEAR) - "; XQ1ASR$
            IF RIGHT$(XQ1ASR$, 2) = "UP" THEN GOTO LBL0
            Q1ASR! = VAL(XQ1ASR$)
        LOOP WHILE (Q1ASR! <= 0!)
        DO
            LOCATE 19, 2
            INPUT "            WHAT WILL BE THE ASR INDEX WELL WATER LEVEL? - (FT) - "; XH1ASR$
            IF RIGHT$(XH1ASR$, 2) = "UP" THEN
            LOCATE 19, 5
            PRINT "                                          " +
                  "                                          "
            GOTO LBL1
            END IF
            H1ASR! = VAL(XH1ASR$)
        LOOP WHILE (H1ASR! <= 0!)
            YNASR$ = "ASR"
        ELSE
            YNASR$ = "NOASR"
            Q1ASR! = 0!
            H1ASR! = 1000!
        END IF

        END IF
        IF CH$ = "0" OR CH$ = "2" THEN

LBL3:   CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)

        DO
            LOCATE 16, 10
            INPUT "IS CONSERVATION REDUCTION TO BE SIMULATED "; AA$
```

```
          IF RIGHT$(AA$, 2) = "UP" THEN
          CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
          GOTO LBL0
          END IF
     LOOP WHILE (AA$ <> "Y" AND AA$ <> "y" AND AA$ <> "N" AND AA$ <> "n")
     AACON$ = AA$

     IF AA$ = "Y" OR AA$ = "y" THEN

LBL4:     DO
          LOCATE 18, 2
          INPUT "              STARTING LIMIT IN ACRE-FT/YEAR----"; XBB$
          IF RIGHT$(XBB$, 2) = "UP" THEN
          CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
          GOTO LBL3
          END IF
          BB! = VAL(XBB$)
          LOOP WHILE BB! <= 0!
LBL5:     DO
          LOCATE 19, 2
          INPUT "              TARGET LIMIT IN ACRE-FT/YEAR------"; XCC$
          IF RIGHT$(XCC$, 2) = "UP" THEN
          CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
          LOCATE 16, 10
          PRINT "IS CONSERVATION REDUCTION TO BE SIMULATED "; AACON$
          GOTO LBL4
          END IF
          CC! = VAL(XCC$)
          LOOP WHILE CC! > BB!
          DO
          LOCATE 20, 2
          INPUT "              NUMBER OF YEARS TO REACH TARGET--"; XDD$
          IF RIGHT$(XDD$, 2) = "UP" THEN
          LOCATE 20, 5
          PRINT "                                                            "
          GOTO LBL5
          END IF
          DD! = VAL(XDD$)
          LOOP WHILE DD! <= 0!
     ELSE
          BB! = 30000000#
          CC! = 30000000#
          DD! = 30000000#
     END IF

     MQCON! = BB!
     QQCON! = CC!
     TIMCON! = DD!

     END IF
     IF CH$ = "0" OR CH$ = "3" THEN

     CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
     CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)

LBL6:     DO
     LOCATE 16, 10
     PRINT "WILL THERE BE A DMP SIMULATED IN THIS RUN? ";
     INPUT AA$
     IF RIGHT$(AA$, 2) = "UP" THEN
     LOCATE 16, 10
     CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
     CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
     GOTO LBL3
     END IF
     LOOP WHILE (AA$ <> "Y" AND AA$ <> "y" AND AA$ <> "N" AND AA$ <> "n")

     AADMP$ = AA$

     IF AA$ = "Y" OR AA$ = "y" THEN

LBL7:     DO
     LOCATE 18, 2
     INPUT "              NUMBER OF MANAGEMENT LEVELS - "; XNUMMAN$
     IF RIGHT$(XNUMMAN$, 2) = "UP" THEN
     CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
     CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
     GOTO LBL6
     END IF
     NUMMUL% = VAL(XNUMMAN$)
     LOOP WHILE (NUMMUL% > 6 OR NUMMUL% < 1)
LBL8:     DO
     LOCATE 19, 2
     INPUT "              MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR - "; XPUMPMAX$
     IF RIGHT$(XPUMPMAX$, 2) = "UP" THEN
     CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
     CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
     LOCATE 16, 10
```

```
        PRINT "WILL THERE BE A DMP SIMULATED IN THIS RUN? "; AADMP$
        GOTO LBL7
        END IF
        PUMPMAX! = VAL(XPUMPMAX$)
        LOOP WHILE (PUMPMAX! <= 0!)

        JJK% = 0
LBL9:   JJK% = JJK% + 1
        LOCATE 21, 16

        IF JJK% = 1 THEN
           PRINT "THE LEVEL #"; JJK%; "ELEVATION IS      ABOVE WHICH THE"
           PRINT "|                    PUMPAGE WILL BE HISTORICAL."
        ELSE
           PRINT "THE LEVEL #"; JJK%; "ELEVATION IS      ABOVE WHICH THE"
           PRINT "|                    PUMPAGE IS TO BE      % OF "; PUMPMAX!; "."
        END IF
        XREDUC(1) = 100!
        DO
        LOCATE 21, 43
        INPUT "", XXELEV$
        IF RIGHT$(XXELEV$, 2) = "UP" THEN
        JJK% = JJK% - 2
        IF JJK% < 0 THEN
        CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
        CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
        LOCATE 16, 10
        PRINT "WILL THERE BE A DMP SIMULATED IN THIS RUN? "; AADMP$
        LOCATE 18
        PRINT "|                 NUMBER OF MANAGEMENT LEVELS - "; NUMMUL%
        GOTO LBL8
        END IF
        XXTEST! = REFH!(JJK%)
        GOTO LBLA
        END IF
        REFH!(JJK%) = VAL(XXELEV$)
        IF JJK% > 1 THEN
        XXTEST! = REFH!(JJK% - 1)
        ELSE
        XXTEST! = 1000!
        END IF
        LOOP WHILE (REFH!(JJK%) >= XXTEST!)

        IF JJK% <> 1 THEN

        DO
        LOCATE 22, 33
        INPUT "", XXREDUC$
        IF RIGHT$(XXREDUC$, 2) = "UP" THEN
        JJK% = JJK% - 1
        GOTO LBL9
        END IF
        XREDUC!(JJK%) = VAL(XXREDUC$)
        IF JJK% > 1 THEN
        XXTEST! = XREDUC!(JJK% - 1)
        ELSE
        XXTEST! = 100!
        END IF
        LOOP WHILE (XREDUC!(JJK%) > XXTEST!)
        END IF

LBLA:   CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
        CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
        CALL SSSUB4(AADMP$, JJK%, PUMPMAX!, REFH!(), XREDUC!(), NUMMUL%)
        IF JJK% < NUMMUL% THEN
        LOCATE 18, 1
        PRINT "|                 NUMBER OF MANAGEMENT LEVELS - "; NUMMUL%
        PRINT "|                 MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR - "; PUMPMAX!
        GOTO LBL9
        END IF

        ELSE

                NUMMUL% = 1
                PUMPMAX! = 30000000#
                REFH!(1) = 450!
                XREDUC!(1) = 100!

        END IF

        END IF


LBLB:   CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
        CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
        CALL SSSUB4(AADMP$, NUMMUL%, PUMPMAX!, REFH!(), XREDUC!(), NUMMUL%)

        LOCATE 20, 10
```

```
PRINT "DO YOU WANT TO ALTER ONE OF THE ABOVE?"
LOCATE 21, 10
PRINT "HIT THE DESIRED NUMBER OR G TO GO OR E TO EXIT."

DO
CH$ = INKEY$
LOOP WHILE (CH$ < "1" OR CH$ > "3" AND (CH$ <> "G" AND CH$ <> "g"_
AND CH$ <> "E" AND CH$ <> "e" AND CH$ <> "^[" AND CH$ <> "U"))

IF CH$ = "U" THEN

REM DRAIN THE KEYBOARD BUFFER TO AVOID SIDE EFFECTS
XXXY$ = INKEY$
XXXZ$ = INKEY$
REM

JJK% = NUMMUL% - 1
CALL SSSUB1(YNASR$, Q1ASR!, H1ASR!)
CALL SSSUB3(MQCON!, QQCON!, TIMCON!, AACON$)
CALL SSSUB4(AADMP$, JJK%, PUMPMAX!, REFH!(), XREDUC!(), NUMMUL%)
LOCATE 18, 2
PRINT "                 NUMBER OF MANAGEMENT LEVELS - "; NUMMUL%
LOCATE 19, 2
PRINT "                 MAXIMUM TOTAL PUMPAGE IN ACRE-FT/YEAR - "; PUMPMAX!
GOTO LBL9

END IF

LOOP WHILE (CH$ <= "3")

END IF

        PRINT #10, YNASR$
        PRINT #10, Q1ASR!
        PRINT #10, H1ASR!
        IF AACON$ = "Y" OR AACON$ = "y" THEN
        PRINT #10, "CON"
        ELSE
        PRINT #10, "NOCON"
        END IF
        PRINT #10, MQCON!
        PRINT #10, QQCON!
        PRINT #10, TIMCON!
        IF AADMP$ = "Y" OR AADMP$ = "y" THEN
        PRINT #10, "DMP"
        ELSE
        PRINT #10, "NODMP"
        END IF
        PRINT #10, NUMMUL%
        PRINT #10, PUMPMAX!
        FOR IJXY = 1 TO NUMMUL%
           PRINT #10, REFH!(IJXY), XREDUC!(IJXY)
           MULTI!(IJXY) = XREDUC!(IJXY) / 100!
        NEXT
CLOSE 10
IF CH$ = "E" OR CH$ = "e" OR CH$ = "^[" THEN
CLS
END
END IF
QBASES = PUMPMAX!

OPEN "O", 2, "PRINT.OUT"
OPEN "I", 3, "HISTORY.DAT"
OPEN "O", 4, "PLOT.OUT"
REM OPEN "O", 6, "PLOT2.OUT"
QQCON = QQCON * 892.8767123#
MQCON = MQCON * 892.8727123#
QBASES = QBASES * 892.8767123#
KOUNT = 0
FLAG = 0
Q283T = 0!
Q313T = 0!
LLLL = -1!
XMFLAG = 0
XTPUMP = 0
XTRECH = 0
ASR$ = "   "
XASR$ = "   "

TXTIME = 0!
QCON = 0!: REM AC-FT/YR  PROPORTIONAL MAX.

XQBASE = 0!: REM THE SMALLER OF EITHER MQCON OR QQCON
MTYPE$ = "   ": REM SHOWS EITHER CON OR DMP, WHICHEVER IS IN EFFECT
XMTYPE$ = "   ": REM HOLDS VALUE OVER TILL NEXT QUARTER
KKOUNT = 0: REM YEAR COUNTER
TXTPUMP = 0!: REM YEARLY TOTAL AND THEN YEARLY AVERAGE
TTTPUMP = 0!: REM OVERALL TOTAL
```

```
                Q1ASR = Q1ASR / .001119975#
                Q1ASR = Q1ASR / 20!

100             CLS

600             GOSUB 6520


780             REM
790             REM ********************************************
800             REM *       VARIABLE GRID EQUATIONS            *
810             REM ********************************************
820             REM

840             FOR I = 1 TO NC
850                 FOR J = 1 TO NR
                       XSF(I, J) = SF(I, J)
860                    SF(I, J) = SF(I, J) * (DELX(I) + DELX(I + 1)) * (DELY(J) + DELY(J + 1)) / 4 * KS
                       XQ(I, J) = Q(I, J)
870                    Q(I, J) = Q(I, J) * (DELX(I) + DELX(I + 1)) * (DELY(J) + DELY(J + 1)) / 4
                       XR(I, J) = R(I, J)
880                    R(I, J) = R(I, J) * (DELX(I) + DELX(I + 1)) * (DELY(J) + DELY(J + 1)) / 4

890                    REM  IF CONFINED$ = "C" OR CONFINED$ = "c" THEN GOTO 920
                       IF J > 2 THEN GOTO 920

900                    IF I < NC THEN TI(I, J) = PERMI(I, J) * SQR((H(I, J) -_
                           BOT(I, J)) * (H(I + 1, J) - BOT(I + 1, J)))
910                    IF J < NR THEN TJ(I, J) = PERMJ(I, J) * SQR((H(I, J) -_
                           BOT(I, J)) * (H(I, J + 1) - BOT(I, J + 1)))
920                    XTI(I, J) = TI(I, J)
                       TI(I, J) = TI(I, J) * (DELY(J) + DELY(J + 1)) / DELX(I + 1) / 2
                       XTJ(I, J) = TJ(I, J)
930                    TJ(I, J) = TJ(I, J) * (DELX(I) + DELX(I + 1)) / DELY(J + 1) / 2
940                 NEXT J
950             NEXT I
                TOLD = -91.25
                TQOLD = -91.25
                QX313 = Q(31, 3)
                QX283 = Q(28, 3)

1000            REM ***START OF SIMULATION***
1010            REM
1020            CLS
                       INPUT #3, IYEAR
                       INPUT #3, NUMYEARS%
                       NS = NUMYEARS% * 73
                       YEAR = IYEAR
1030            TIME = 0!
1040            PKC = 1!
1050            PDEL = DE
1060            FOR XYZ = 1 TO NS + 1
                IF XYZ = NS + 1 THEN
                XFLAG = 1
                GOTO 1695
                END IF

                IF (XYZ MOD 10) = 0 THEN
                   PRINT #2, "TIME = "; TIME; "  Q(21, 3) = "; Q(21, 3); " TPUMP = "; TPUMP
                END IF

1070            REM
1080            REM     *** CALCULATE PREDICTOR ***
1090            REM
1100            IF PREDICTOR$ = "N" OR PREDICTOR$ = "n" THEN GOTO 1330
1110            FOR I = 1 TO NC
1120                FOR J = 1 TO NR
1130                   D = H(I, J) - HO(I, J)
1140                   HO(I, J) = H(I, J)
1150                   F = 1
1160                   IF DL(I, J) = 0 THEN 1200
1170                   IF XYZ > 2 THEN F = D / DL(I, J)
1180                   IF F > 5 THEN F = 5
1190                   IF F < 0 THEN F = 0
1200                   DL(I, J) = D
1210                   H(I, J) = H(I, J) + D * F
                       IF J <= 3 AND H(I, J) <= BOT(I, J) THEN
                       H(I, J) = BOT(I, J) + .01
                       PRINT #2, "Node ("; I; ","; J; ") went dry."
                       END IF
1230                NEXT J
1240            NEXT I
1250            GOTO 1380
1260            REM
1270            REM ***END CALCULATE PREDICTOR***
1280            REM
1290            REM
1300            REM
```

```
1310    REM *** SET PREVIOUS HEADS IF THE PREDICTOR ISN'T IN EFFECT ***
1320    REM
1330    FOR I = 1 TO NC
1340            FOR J = 1 TO NR
                   IF J <= 3 AND H(I, J) <= BOT(I, J) THEN
                   H(I, J) = BOT(I, J) + .01
                   PRINT #2, "Node ("; I; ","; J; ") went dry."
                   END IF
1350               HO(I, J) = H(I, J)
1360            NEXT J
        NEXT I
1370    REM
1380    REM
1390    REM
1400    REM ***TRANSMISSIVITY CONTROL CALCULATIONS***
1410    REM

1420    REM  IF CONFINED$ = "C" OR CONFINED$ = "c" THEN GOTO 1520

1430    FOR I = 1 TO NC
1440            FOR J = 1 TO 2
1450               IF I < NC THEN
                      TI(I, J) = PERMI(I, J) * SQR((H(I, J) -
                         BOT(I, J)) * (H(I + 1, J) - BOT(I + 1, J)))
                   END IF
1460               IF J < NR THEN
                      TJ(I, J) = PERMJ(I, J) * SQR((H(I, J) -
                         BOT(I, J)) * (H(I, J + 1) - BOT(I, J + 1)))
                END IF

1470               TI(I, J) = TI(I, J) * (DELY(J) + DELY(J + 1)) / DELX(I + 1) / 2
1480               TJ(I, J) = TJ(I, J) * (DELX(I) + DELX(I + 1)) / DELY(J + 1) / 2
1490            NEXT J
1500    NEXT I
1510    REM
1520    REM ***END TRANSMISSIVITY CONTROL CALCULATIONS***
1530    REM
1540    REM
1550    REM ***VARIABLE PUMPAGE***
1560    REM
1570    IF NSP = 0 THEN GOTO 1680
1580    Z = INT((XYZ - 1) / NSP) + 1
1590    IF (Z - PKC) <> 0 THEN GOTO 1680

1600    FOR K = 1 TO NP
1610            III = IP(K)
1620            JJJ = JP(K)
1630            Q(III, JJJ) = P(K, PKC)
1640    NEXT K

1650    DE = PDEL
1660    PKC = PKC + 1
1670    REM
1680    REM *** END VARIABLE PUMPAGE ***
1690    REM

        REM IF TIME > 2920 AND TIME < 4380 THEN PRINT #5, TIME; HO(23, 4)

        XFLAG = 0

        IF (TIME - TQOLD) >= 91.25 THEN
                TQOLD = TQOLD + 91.25
                XFLAG = 1
        END IF

        IF (TIME - TOLD) >= 91.25 THEN

                TOLD = TOLD + 91.25
                FLAG = 1
                INPUT #3, BLOCKS

                IF BLOCKS <> 0 THEN
                           FOR IIJJ = 1 TO BLOCKS

                              INPUT #3, IXX, JYY, IXXX, JYYY
                              INPUT #3, XYRECH
                              INPUT #3, XYPUMP
                              INPUT #3, NNN

                              XYRECH = (XYRECH / NNN) * 892.8767123#
                              XYPUMP = (XYPUMP / NNN) * 892.8767123#

                              REM  *****  THE ABOVE CONVERTS AC-FT/YR TO GAL/DAY

                              REM  *****  THE FOLLOWING IS AN ADJUSTMENT FOR
                                      REM          RECHARGE AND PUMPAGE

                              XYRECH = XYRECH * 4
```

```
                              XYPUMP = XYPUMP * 4

                              REM  *****  END OF ADJUSTMENT CARDS

                              FOR II = IXX TO IXXX
                                    FOR JJ = JYY TO JYYY

                                    QXQ(II, JJ) = XYPUMP
                                    RXR(II, JJ) = XYRECH


                                    NEXT JJ
                              NEXT II

                        NEXT IIJJ

                        TXTIME = INT(TIME / 365!)

                        IF TXTIME <= TIMCON THEN

                        QCON = MQCON - (TXTIME / TIMCON) * (MQCON - QQCON)

                        ELSE

                        QCON = QQCON

                        END IF

                  END IF

            END IF

1695        REM

            IF XFLAG = 1 THEN

            FLAG = 1

            MFLAG = NUMMUL%

            FOR IN = NUMMUL% TO 1 STEP -1
                  IF HO(23, 4) >= REFH(IN) THEN MFLAG = IN
            NEXT IN

                        TRECH = 0!
                        TPUMP = 0!
                        TQPMP = 0!

                        FOR I = 1 TO NC
                           FOR J = 1 TO NR
                           TQPMP = TQPMP + QXQ(I, J)
                           NEXT J
                        NEXT I

                  IF MFLAG = 1 THEN

                        IF TQPMP < QCON THEN

                        XQBASE = TQPMP
                        MTYPE$ = "HIS"
                        XRATIO = 1!

                        ELSE

                        XQBASE = QCON
                        MTYPE$ = "CON"
                        XRATIO = XQBASE / TQPMP

                        END IF

                  ELSE

                        QBMULT = QBASES * MULTI(MFLAG)

                        IF QBMULT < QCON THEN

                        XQBASE = QBMULT
                        MTYPE$ = "DMP"
                        XRATIO = XQBASE / TQPMP

                        ELSE

                        XQBASE = QCON
                        MTYPE$ = "CON"
                        XRATIO = XQBASE / TQPMP
```

```
            END IF

            IF TQPMP <= XQBASE THEN
            XRATIO = 1!
            MTYPE$ = "HIS"
            END IF

      END IF

            FOR I = 1 TO NC
               FOR J = 1 TO NR
               AAAA = QXQ(I, J) * XRATIO
               Q(I, J) = AAAA + RXR(I, J)
               TPUMP = TPUMP + AAAA
               TRECH = TRECH + RXR(I, J)
               NEXT J
            NEXT I

            REM THE INDEX WELL IS CHECKED ONCE EACH QUARTER

            IF YNASR$ = "ASR" THEN

            IF HO(23, 4) > H1ASR! THEN
               ASR$ = "ASR"

               PRINT #2, "Q(21, 3) = "; Q(21, 3); "   TPUMP = "; TPUMP

               FOR I = 21 TO 25
               FOR J = 3 TO 6

               Q(I, J) = Q(I, J) + Q1ASR
               TPUMP = TPUMP + Q1ASR

               NEXT J
               NEXT I

               PRINT #2, "Q(21, 3) = "; Q(21, 3); "  TPUMP = "; TPUMP

            ELSE

               ASR$ = "   "

            END IF

            END IF

            REM
            REM
            REM

            QX313 = Q(31, 3)
            QX283 = Q(28, 3)

END IF

REM
REM  ****************************************************************************
REM
REM    A.     COMAL SPRING  AT NODE [28,3]
REM
REM
REM           FLOW BASED ON GROUND WATER ELEVATION OF WELL AT SAME NODE
REM
REM          DDD1 = 618.0 + 23.85 - HO(28,3)
REM
REM                where  DDD1 = water level depth below ground surface (ft)
REM                        618 = water elevation at which spring flow is zero (ft)
REM                      23.85 = depth below ground surface at which spring flow
REM                              is zero (ft)
REM
REM           Q(28,3) = 1038.73 - 43.54 * DDD1
REM
REM
REM    B.     SAN MARCOS SPRING AT NODE [31,3]
REM
REM           FLOW BASED ON GROUND WATER ELEVATION OF WELL AT SAME NODE
REM
REM          DDD2 = 573.0 + 124.46 - HO(31,3)
REM
REM                where DDD2 = water level depth below ground surface (ft)
REM                        573 = water elevation at which spring flow is zero (ft)
REM                    124.46 = depth below ground surface at which spring flow
REM                             is zero (ft)
REM
REM           Q(31,3) = 3211.0 - 25.8 * DDD2
REM
```

```
REM

Q(28, 3) = 35! * HO(28, 3) - 20415.2: REM SLOPE OF 33.04 CHANGED TO 35.0
Q(31, 3) = 82.1875 * HO(31, 3) - 47477.8
IF KS = 7.48052 THEN
Q(28, 3) = Q(28, 3) * KS * 86400!
Q(31, 3) = Q(31, 3) * KS * 86400!

IF Q(28, 3) < 0! THEN Q(28, 3) = 0!
IF Q(31, 3) < 0! THEN Q(31, 3) = 0!

ELSE

Q(28, 3) = Q(28, 3) * .02832 * 86400!
Q(31, 3) = Q(31, 3) * .02832 * 86400!

IF Q(28, 3) < 0! THEN Q(28, 3) = 0!
IF Q(31, 3) < 0! THEN Q(31, 3) = 0!

END IF

KOUNT = KOUNT + 1
Q283T = Q283T + Q(28, 3)
Q313T = Q313T + Q(31, 3)

IF FLAG = 1 THEN

FLAG = 0
LLLL = LLLL + 1
Q283T = Q283T / KOUNT
Q313T = Q313T / KOUNT
KOUNT = 0
TPUMP = TPUMP * .001119975#
TRECH = TRECH * .001119975#
FLCNVRT2 = .000001547#: REM (THIS IS TO CONVERT GAL/DAY TO CFS)
FLCNVRT = .001119975#
REM (THE ABOVE CONVERTS GAL/DAY TO ACRE-FT/YEAR)
TSPRING = (Q283T + Q313T) * FLCNVRT
XTIME = TIME / 365 + IYEAR

IF TIME <> 0 THEN XTIME = XTIME - .01

IF TIME = 0 THEN
PRINT #4, ""
PRINT #4,"______________________________________________________________________________________"
PRINT #4, "                                           MGT              INDEX                          AVERAGE  "
PRINT #4, "                                   DMP     IN               WELL                           YEARLY   "
PRINT #4, "  YEAR          YEAR              LEVEL   EFFECT    ASR     LEVEL      PUMPAGE             PUMPAGE  "
PRINT #4, "              DECIMAL                                        FT       ACRE-FT/YR         ACRE-FT/YR "
PRINT #4,"______________________________________________________________________________________"
PRINT #4, ""
END IF
PRINT #4, USING "  ####"; YEAR;
PRINT #4, USING "  #########.##"; XTIME;
IF XMTYPE$ = "CON" OR XMTYPE$ = "HIS" THEN
PRINT #4, USING "\       \"; " " + RIGHT$("   (" + LTRIM$(RTRIM$(STR$(XMFLAG))) + ")   ", 7);
ELSE
PRINT #4, USING "\       \"; " " + RIGHT$("    " + LTRIM$(RTRIM$(STR$(XMFLAG))) + "    ", 7);
END IF
PRINT #4, USING "\      \"; " " + XMTYPE$ + " ";
PRINT #4, USING "\      \"; "   " + XASR$;
PRINT #4, USING "  ####.##"; HO(23, 4);
IF (LLLL MOD 4 <> 0) THEN
PRINT #4, USING "  #########.#"; XTPUMP
ELSE
PRINT #4, USING "  #########.#"; XTPUMP;
END IF
        TXTPUMP = TXTPUMP + XTPUMP
XTPUMP = TPUMP
XTRECH = TRECH
XMFLAG = MFLAG
XASR$ = ASR$
XMTYPE$ = MTYPE$
IF (LLLL MOD 4 = 0) THEN
   KKOUNT = KKOUNT + 1
   TXTPUMP = TXTPUMP / 4!
   PRINT #4, USING "  #########.#"; TXTPUMP
   PRINT #4, " "
   TTTPUMP = TTTPUMP + TXTPUMP
   TXTPUMP = 0!
   IF TIME > 0 THEN YEAR = YEAR + 1
END IF

        Q283T = 0!
        Q313T = 0!

END IF
```

```
        Q(28, 3) = Q(28, 3) + QX283
        Q(31, 3) = Q(31, 3) + QX313

        REM
        REM
        REM ****************************************************************************
        REM
        REM

        IF XYZ = NS + 1 THEN GOTO 3730

1700    TIME = TIME + DE
1710    ITER = 0!
1720    E = 0
1730    ITER = ITER + 1
        LOCATE 9, 34: PRINT "TIME ="; TIME
        LOCATE 11, 27: PRINT "Performing iteration #"; ITER;
1750    FOR II = 1 TO NC
1760            I = II
1770            IF (XYZ + ITER) MOD 2 = 1 THEN I = NC - I + 1
1780            FOR J = 1 TO NR
1790                    REM
1800                    REM *** INDUCED INFILTRATION CALCULATION ***
1810                    REM
1820                    IF H(I, J) < RD(I, J) THEN
                                RE = (RH(I, J) - RD(I, J)) * R(I, J)
                                RB = 0!
                                ELSE
                                RE = RH(I, J) * R(I, J)
                                RB = 1!
                    END IF
1830                    BB = SF(I, J) / DE + R(I, J) * RB
1840                    DD = HO(I, J) * SF(I, J) / DE - Q(I, J) + RE
1850                    REM
1860                    REM *** END INDUCED INFILTRATION CALCULATION ***
1870                    REM
1880                    AA = 0
1890                    CC = 0
1900                    IF (J - 1 < 0 OR J - 1 > 0) THEN AA = -TJ(I, J - 1): BB = BB + TJ(I, J - 1)
1910                    IF (J - NR < 0 OR J - NR > 0) THEN CC = -TJ(I, J): BB = BB + TJ(I, J)
1920                    IF (I - 1 < 0 OR I - 1 > 0) THEN
                           BB = BB + TI(I - 1, J): DD = DD + H(I - 1, J) * TI(I - 1, J)
                    END IF
1930                    IF (I - NC < 0 OR I - NC > 0) THEN
                           BB = BB + TI(I, J): DD = DD + H(I + 1, J) * TI(I, J)
                    END IF
1940                    W = BB - AA * B(J - 1)
1950                    B(J) = CC / W
1960                    G(J) = (DD - AA * G(J - 1)) / W
1970            NEXT J
1980            E = E + ABS(H(I, NR) - G(NR))
1990            H(I, NR) = G(NR)
2000            N = NR - 1
2010            HA = G(N) - B(N) * H(I, N + 1)
2020            E = E + ABS(HA - H(I, N))
2030            H(I, N) = HA
2040            N = N - 1
2050            IF NOT (N < 0 OR N = 0) THEN 2010

2060            REM  IF CONFINED$ = "c" OR CONFINED$ = "C" THEN GOTO 2130

2070            FOR N = 1 TO 3
2080                    IF H(I, N) > BOT(I, N) THEN GOTO 2120
2090                    PRINT #2, "Node ("; I; ","; N; ") went dry."
2100                    E = E + BOT(I, N) + .01 - H(I, N)
2110                    H(I, N) = BOT(I, N) + .01
2120            NEXT N
2130    NEXT II
2140    TEMPE = E
2150    REM
2160    REM ***ROW CALCULATIONS***
2170    REM
2180    FOR JJ = 1 TO NR
2190            J = JJ
2200            IF (XYZ + ITER) MOD 2 = 1 THEN J = NR - J + 1
2210            FOR I = 1 TO NC
2220                    REM
2230                    REM *** INDUCED INFILTRATION CALCULATION ***
2240                    REM
2250                    IF H(I, J) < RD(I, J) THEN
                                RE = (RH(I, J) - RD(I, J)) * R(I, J)
                                RB = 0
                                ELSE
                                RE = RH(I, J) * R(I, J)
                                RB = 1
                    END IF
2260                    BB = SF(I, J) / DE + R(I, J) * RB
2270                    DD = HO(I, J) * SF(I, J) / DE - Q(I, J) + RE
```

```
2280                    REM
2290                    REM *** END INDUCED INFILTRATION CALCULATION ***
2300                    REM
2310                    AA = 0
2320                    CC = 0
2330                    IF (J - 1 < 0 OR J - 1 > 0) THEN
                           BB = BB + TJ(I, J - 1)
                           DD = DD + H(I, J - 1) * TJ(I, J - 1)
                        END IF
2340                    IF (J - NR < 0 OR J - NR > 0) THEN
                           DD = DD + H(I, J + 1) * TJ(I, J)
                           BB = BB + TJ(I, J)
                        END IF
2350                    IF (I - 1 < 0 OR I - 1 > 0) THEN BB = BB + TI(I - 1, J): AA = -TI(I - 1, J)
2360                    IF (I - NC < 0 OR I - NC > 0) THEN BB = BB + TI(I, J): CC = -TI(I, J)
2370                    W = BB - AA * B(I - 1)
2380                    B(I) = CC / W
2390                    G(I) = (DD - AA * G(I - 1)) / W
2400                NEXT I
2410                E = E + ABS(H(NC, J) - G(NC))
2420                H(NC, J) = G(NC)
2430                N = NC - 1
2440                HA = G(N) - B(N) * H(N + 1, J)
2450                E = E + ABS(H(N, J) - HA)
2460                H(N, J) = HA
2470                N = N - 1
2480                IF NOT (N < 0 OR N = 0) THEN 2440

2490                REM IF CONFINED$ = "c" OR CONFINED$ = "C" THEN GOTO 2560
                    IF JJ > 3 THEN GOTO 2560

2500                FOR N = 1 TO NC
2510                        IF H(N, J) > BOT(N, J) THEN GOTO 2550
2520                        PRINT #2, "Node ("; N; ","; J; ") went dry."
2530                        E = E + BOT(N, J) + .01 - H(N, J)
2540                        H(N, J) = BOT(N, J) + .01
2550                NEXT N
2560            NEXT JJ
2570            LOCATE 13, 29: PRINT "Total ER = "; E: PRINT
2590            IF E > ER AND ITER > 199 THEN INPUT " EXIT (Y OR N)"; A$
2600            IF E > ER AND ITER > 199 AND A$ = "Y" THEN 3720
2610            IF E > ER THEN 1720

2620            REM
2630            REM *** CALCULATE WATER BALANCE ***
2640            REM
2650            IF WBALANCE$ = "N" OR WBALANCE$ = "n" THEN GOTO 2900
2660            QS = 0!: QF = 0!: WB = 0!: QR = 0!: QH = 0!: TOTIN = 0!: TOTOUT = 0!: CHND = 0
2662            INFIN = 0: INFOUT = 0: QIN = 0: QOUT = 0: QFS = 0: QTS = 0: QCHNIN = 0: QCHNOUT = 0
2670            FOR I = 1 TO NC
2680                FOR J = 1 TO NR
2690                        IF H(I, J) < RD(I, J) THEN GOTO 2720
2700                        QI = R(I, J) * (RH(I, J) - H(I, J))
2710                        GOTO 2730
2720                        QI = R(I, J) * (RH(I, J) - RD(I, J))
2730                        QR = QR + QI: IF QI > 0 THEN TOTIN = TOTIN + QI ELSE TOTOUT = TOTOUT - QI
2732                        IF QI > 0 THEN INFIN = INFIN + QI ELSE INFOUT = INFOUT - QI
2738                        QF = QF + Q(I, J)
                            IF Q(I, J) > 0 THEN TOTOUT = TOTOUT + Q(I, J) ELSE TOTIN = TOTIN - Q(I, J)
2740                        IF Q(I, J) > 0 THEN QOUT = QOUT + Q(I, J) ELSE QIN = QIN - Q(I, J)
2741                        IF SF(I, J) > 1E+21 THEN 2752
2742                        IF SF(I, J) < 1E+21 THEN
                               QSI = ((SF(I, J) / DE) * HO(I, J) - (SF(I, J) / DE) * H(I, J))
                            END IF
2744                        IF QSI > 0 THEN TOTIN = TOTIN + QSI ELSE TOTOUT = TOTOUT - QSI
2745                        IF QSI > 0 THEN QFS = QFS + QSI ELSE QTS = QTS - QSI
2751                        GOTO 2768
2752                        QIP1 = 0
                                    IF SF(I + 1, J) < 1E+21 AND I < NC THEN
                                    QIP1 = (H(I + 1, J) - H(I, J)) * TI(I, J)
                                    END IF
                                    IF QIP1 < 0 THEN
                                    TOTIN = TOTIN - QIP1
                                    ELSE
                                    TOTOUT = TOTOUT + QIP1
                                    END IF
2754                        QJP1 = 0
                                    IF SF(I, J + 1) < 1E+21 AND J < NR THEN
                                    QJP1 = (H(I, J + 1) - H(I, J)) * TJ(I, J)
                                    END IF
                                    IF QJP1 < 0 THEN
                                    TOTIN = TOTIN - QJP1
                                    ELSE
                                    TOTOUT = TOTOUT + QJP1
                                    END IF
2756                        QJM1 = 0
                                    IF SF(I, J - 1) < 1E+21 AND J > 1 THEN
                                    QJM1 = (H(I, J - 1) - H(I, J)) * TJ(I, J - 1)
```

```
                                        END IF
                                        IF QJM1 < 0 THEN
                                        TOTIN = TOTIN - QJM1
                                        ELSE
                                        TOTOUT = TOTOUT + QJM1
                                        END IF
2758                            QIM1 = 0
                                        IF SF(I - 1, J) < 1E+21 AND I > 1 THEN
                                        QIM1 = (H(I - 1, J) - H(I, J)) * TI(I - 1, J)
                                        END IF
                                        IF QIM1 < 0 THEN
                                        TOTIN = TOTIN - QIM1
                                        ELSE
                                        TOTOUT = TOTOUT + QIM1
                                        END IF
2760                            IF QIP1 < 0 THEN QCHNIN = QCHNIN - QIP1 ELSE QCHNOUT = QCHNOUT + QIP1
2762                            IF QJP1 < 0 THEN QCHNIN = QCHNIN - QJP1 ELSE QCHNOUT = QCHNOUT + QJP1
2763                            IF QJM1 < 0 THEN QCHNIN = QCHNIN - QJM1 ELSE QCHNOUT = QCHNOUT + QJM1
2765                            IF QIM1 < 0 THEN QCHNIN = QCHNIN - QIM1 ELSE QCHNOUT = QCHNOUT + QIM1
2768                    NEXT J
2770            NEXT I

2810            WB = 100 * (1 - ABS(TOTIN / TOTOUT))
2820            REM PRINT "Total Flow IN ="; TOTIN; "   Total Flow OUT ="; TOTOUT
2840            REM PRINT "Percent unaccounted water ="; WB: PRINT
2841            REM PRINT "Flow from storage ="; QFS; "  Flow into storage ="; QTS
2842            REM PRINT "Flow in from leakance ="; INFIN; "  Flow out via leakance ="; INFOUT
2843            REM PRINT "Flow in from withdrawal ="; QIN; "  Flow out via withdrawal = "; QOUT
2844            REM PRINT "Flow from constant heads ="; QCHNIN; "  Flow out to constant heads ="; QCHNOUT

2871            EE$ = ""
2872            IF ITER > 199 THEN INPUT "Continue?  Enter Y-Yes or S to print results"; EE$
2874            IF EE$ <> "Y" OR EE$ <> "y" THEN 2880 ELSE 3720
2880            IF ABS(WB) > WBB THEN GOTO 1720
2890            REM
2900            REM *** END WATER BALANCE CALCULATION ***
2910            REM

3720            CLS
3730            NEXT XYZ

                PRINT #4, USING "\         \"; SPC(68); "__________"
                PRINT #4, USING "  #########.#"; SPC(64); TTTPUMP / KKOUNT

                CLOSE 2
                CLOSE 3
                CLOSE 4
                REM CLOSE 6

                IF XOK$ = "Y" OR XOK$ = "y" THEN

                FILE$ = XFILE$
                OPEN "O", 1, FILE$
                PRINT #1, "name:"; FILE$; ", EXTERNAL FILE FOR PLASM PROGRAM"
                PRINT #1, CONFINED$
                PRINT #1, PREDICTOR$
                PRINT #1, WBALANCE$
                PRINT #1, WBB
                PRINT #1, DISK$
                PRINT #1, RATETYPE$
                PRINT #1, FORM$
                PRINT #1, NS; DE; ER; KS; DAYS
                PRINT #1, NC; NR; NP; NSP; NRT
                FOR I = 1 TO NC
                        FOR J = 1 TO NR
                                PRINT #1, I; J; XTI(I, J); XTJ(I, J); XSF(I, J); H(I, J);_
                                XQ(I, J); XR(I, J); RH(I, J); RD(I, J); BOT(I, J);_
                                PERMI(I, J); PERMJ(I, J)
                        NEXT J
                NEXT I
                FOR I = 1 TO NC + 1
                        PRINT #1, DELX(I)
                NEXT I
                FOR J = 1 TO NR + 1
                        PRINT #1, DELY(J)
                NEXT J
                FOR I = 1 TO NP
                        PRINT #1, IP(I), JP(I)
                        FOR N = 1 TO NRT
                                PRINT #1, P(I, N)
                        NEXT N
                NEXT I
                CLOSE 1

                END IF

3740            PRINT "Your job is over!@#": END
```

```
6520    REM name: PCONT
6530    REM purpose: To read the data stored in an external file EDWARDS.PLA
6540    REM called by PMAIN
6720    OPEN "I", #1, "EDWARDS.PLA"
6730    LINE INPUT #1, A$
6740    INPUT #1, CONFINED$
6750    INPUT #1, PREDICTOR$
6760    INPUT #1, WBALANCE$
6770    INPUT #1, WBB
6780    INPUT #1, DISK$
6790    INPUT #1, RATETYPE$
6800    INPUT #1, FORM$
6810    INPUT #1, NS, DE, ER, KS, DAYS
6820    INPUT #1, NC, NR, NP, NSP, NRT
6830    FOR I = 1 TO NC
6840            FOR J = 1 TO NR
6850                    INPUT #1, I, J, TI(I, J), TJ(I, J), SF(I, J), H(I, J),_
                        Q(I, J), R(I, J), RH(I, J), RD(I, J), BOT(I, J),_
                        PERMI(I, J), PERMJ(I, J)
6860                    HO(I, J) = H(I, J)
6870            NEXT J
6880    NEXT I
6890    FOR I = 1 TO NC + 1
6900            INPUT #1, DELX(I)
6910    NEXT I
6920    FOR J = 1 TO NR + 1
6930            INPUT #1, DELY(J)
6940    NEXT J
6950    FOR I = 1 TO NP
6960            INPUT #1, IP(I), JP(I)
6970            FOR N = 1 TO NRT
6980                    INPUT #1, P(I, N)
6990            NEXT N
7000    NEXT I
7010    CLOSE 1
7020    RETURN

        REM
        REM SUBROUTINES FOLLOW
        REM

        SUB SSSUB1 (YNASR$, Q1ASR!, H1ASR!)
        CLS
        CALL XBOX
        LOCATE 4, 7
        IF YNASR$ = "ASR" THEN
                PRINT "1  THE ASR PUMPAGE WILL BE" + STR$(Q1ASR!) + " ACRE-FT/YEAR"
                PRINT "|         WHEN THE INDEX WELL LEVEL IS ABOVE" + STR$(H1ASR!) + " FT."
        ELSE
                PRINT "1  ASR IS NOT IN EFFECT."
        END IF
        END SUB

        SUB SSSUB3 (MQCON!, QQCON!, TIMCON!, AACON$)
                IF AACON$ = "N" OR AACON$ = "n" THEN
                PRINT "|      2  CONSERVATION REDUCTION WILL NOT BE SIMULATED."
                ELSE
                PRINT "|      2  CONSERVATION REDUCTION WILL BE SIMULATED."
                PRINT "|            THE STARTING LIMIT WILL BE" + STR$(MQCON!) + " ACRE-FT/YEAR."
                PRINT "|            THE TARGET LIMIT WILL BE" + STR$(QQCON!) + " ACRE-FT/YEAR."
                PRINT "|            CONSERVATION REDUCTION WILL BE IMPLEMENTED IN" +_
                        STR$(TIMCON!) + " YEARS."
                END IF
        END SUB

        SUB SSSUB4 (AADMP$, NUMMUL%, PUMPMAX!, REFH!(), XREDUC!(), NUMMAX%)
                IF AADMP$ = "N" OR AAADMP$ = "n" THEN
                PRINT "|      3  DMP WILL NOT BE SIMULATED."
                ELSE
                PRINT "|      3  DMP WILL BE SIMULATED WITH" + STR$(NUMMAX%) + " LEVELS."
                FOR JJK% = 1 TO NUMMUL%
                        IF JJK% = 1 THEN
                        PRINT "|              LVL." + STR$(JJK%) + " IS" +_
                        STR$(REFH!(JJK%)) +_
                        " ABOVE WHICH THE PUMPAGE WILL BE THE HISTORICAL."
                        ELSE
                        PRINT "|              LVL." + STR$(JJK%) + " IS" +_
                        STR$(REFH!(JJK%)) +_
                        " ABOVE WHICH MAX. PUMPAGE IS " +_
                        RIGHT$("       " + STR$(XREDUC!(JJK%)), 7) +_
                        "% OF" + STR$(PUMPMAX!) + "."
                        END IF
                NEXT
                END IF
        END SUB

        SUB XBOX
                LOCATE 25, 10
```

```
        PRINT "PRESS F1 TO MOVE UP"
        LOCATE 2, 23
        PRINT "MANAGEMENT EVALUATION MODEL FOR THE EDWARDS"
        LOCATE 3
        PRINT CHR$(218) + STRING$(78, 196) + CHR$(191)
        FOR I = 4 TO 22
                LOCATE I, 1
                PRINT CHR$(179)
                LOCATE I, 80
                PRINT CHR$(179)
        NEXT
        LOCATE 23
        PRINT CHR$(192) + STRING$(78, 196) + CHR$(217)
END SUB
```

APPENDIX C

Explanation of the HISTORY.DAT File

The HISTORY.DAT file supplied with the program will simulate a relatively harsh drought-usage scenario. It combines the severe 1950's drought with the heavy usage of the present day. If the user of the program wants to test various management scenarios against a different backdrop, say a synthetic record statistically derived to represent a 100-year drought occurrence; then the HISTORY.DAT file would need to be changed. What will be needed is a text editor and a knowledge of the structure of the file.

A portion of the HISTORY.DAT file is shown in FIG-1. The first line is the year that simulation is to begin, in this case 1934, and the second line is the number of years to be simulated, 55. The rest of the file is quarterly pumpage and recharge data for the various subareas of the aquifer for the 55 year period. The 9 that appears on the third line of FIG-8 indicates the number of subareas into which the aquifer is divided for the purposes of modeling. Following are 9 sets of 4 lines. The first of the 4 lines describes the exact location on the model's grid on which the subarea lies. In our example the first area inhabits grid cells 1,1 to 16,2 (The whole aquifer is divided into a 33 by 6 grid.). For the first area, the -10831 is the first quarter recharge (pumpage is positive and recharge negative), in units of acre-ft/year and the 0 on the next line is the pumpage, also in acre- ft/year. The 32 on the fourth line is the number of cells over which the -10831 recharge and 0 pumpage is divided. The program uses this to calculate recharge and pumpage for each individual cell. The data set continues in this manner so that, for each year to be modeled, there are 4 groups (one per quarter) of 9 sets (in our example) of the four lines that describe the grid area, recharge, pumpage, and number of cells, respectively.

```
1934
55
9
1,1 16,2
-10831
0
32
17,1 25,2
-14492
0
18
26,1 33,2
-11983
0
16
1,3 12,4
0
22635
32
13,3 20,6
0
7035
32
21,3 25,6
0
61940
20
26,3 30,3
0
3560
5
31,3 33,3
0
2700
3
9,5 12,6
0
22635
32
9
1,1 16,2
-22384
0
32
```

(FIG-1)

APPENDIX D

Output for Example Applications

MANAGEMENT PLAN A

YEAR	YEAR DECIMAL	DMP LEVEL	MGT IN EFFECT	ASR	INDEX WELL LEVEL FT	PUMPAGE ACRE-FT/YR	AVERAGE YEARLY PUMPAGE ACRE-FT/YR
1934	1934.00	0			655.71	0.0	0.0
1934	1934.25	(1)	HIS		645.97	391480.0	
1934	1934.50	(1)	HIS		608.84	686119.3	
1934	1934.74	4	DMP		634.48	370859.8	
1934	1934.99	(2)	HIS		633.48	391480.0	459984.8
1935	1935.25	(2)	HIS		634.71	388219.8	
1935	1935.50	2	DMP		634.09	450329.8	
1935	1935.74	2	DMP		635.69	450329.8	
1935	1935.99	(2)	HIS		643.50	388219.8	419274.8
1936	1936.25	(2)	HIS		650.04	350899.7	
1936	1936.50	(1)	HIS		628.27	601499.6	
1936	1936.74	2	DMP		640.59	450329.9	
1936	1936.99	(2)	HIS		654.23	350899.7	438407.2
1937	1937.25	(1)	HIS		659.89	322079.8	
1937	1937.50	(1)	HIS		638.15	548119.5	
1937	1937.74	2	DMP		642.41	450330.1	
1937	1937.99	(2)	HIS		654.76	322079.8	410652.3
1938	1938.25	(1)	HIS		654.15	363200.1	
1938	1938.50	(1)	HIS		624.41	625999.8	
1938	1938.74	3	DMP		642.23	397349.8	
1938	1938.99	(2)	HIS		646.27	363200.1	437437.5
1939	1939.25	(1)	HIS		651.16	326479.9	
1939	1939.50	(1)	HIS		628.49	558319.5	
1939	1939.74	2	DMP		633.38	450330.1	
1939	1939.99	(2)	HIS		646.28	326479.9	415402.3
1940	1940.25	(1)	HIS		644.20	391480.0	
1940	1940.50	(1)	HIS		608.89	686119.3	
1940	1940.74	4	DMP		635.96	370859.8	
1940	1940.99	(2)	HIS		635.34	391480.0	459984.8
1941	1941.25	(2)	HIS		636.74	388219.8	
1941	1941.50	2	DMP		635.08	450329.8	
1941	1941.74	2	DMP		634.55	450329.8	
1941	1941.99	(2)	HIS		637.90	388219.8	419274.8
1942	1942.25	(2)	HIS		642.29	350899.7	
1942	1942.50	2	DMP		637.28	450329.9	
1942	1942.74	2	DMP		635.44	450329.9	
1942	1942.99	(2)	HIS		641.91	350899.7	400614.8
1943	1943.25	(2)	HIS		646.16	322079.8	
1943	1943.50	(1)	HIS		622.76	548119.5	
1943	1943.74	3	DMP		631.73	397350.0	
1943	1943.99	(2)	HIS		639.21	322079.8	397407.3
1944	1944.25	(2)	HIS		638.20	363200.1	
1944	1944.50	2	DMP		631.21	450329.6	
1944	1944.74	2	DMP		628.80	450329.6	
1944	1944.99	(2)	HIS		632.69	363200.1	406764.9
1945	1945.25	(2)	HIS		637.87	326479.9	

1945	1945.50	2	DMP	629.51	450330.1	
1945	1945.74	2	DMP	627.02	450330.1	
1945	1945.99	(3)	HIS	635.71	326479.9	388405.0
1946	1946.25	(2)	HIS	633.44	391480.0	
1946	1946.50	2	DMP	628.97	450329.7	
1946	1946.74	2	DMP	626.81	450329.7	
1946	1946.99	(3)	HIS	627.65	391480.0	420904.9
1947	1947.25	(3)	HIS	629.03	388219.8	
1947	1947.50	2	DMP	625.81	450329.8	
1947	1947.74	3	DMP	627.71	397349.6	
1947	1947.99	(3)	HIS	626.20	388219.8	406029.7
1948	1948.25	(3)	HIS	627.71	350899.7	
1948	1948.50	3	DMP	625.93	397350.2	
1948	1948.74	3	DMP	623.67	397350.2	
1948	1948.99	(3)	HIS	623.46	350899.7	374124.9
1949	1949.25	(3)	HIS	625.54	322079.8	
1949	1949.50	3	DMP	621.42	397350.0	
1949	1949.74	3	DMP	619.93	397350.0	
1949	1949.99	(3)	HIS	624.67	322079.8	359714.9
1950	1950.25	(3)	HIS	623.26	363200.1	
1950	1950.50	3	DMP	620.95	397349.8	
1950	1950.74	3	DMP	618.51	397349.8	
1950	1950.99	(3)	HIS	616.89	363200.1	380275.0
1951	1951.25	(3)	HIS	619.20	326479.9	
1951	1951.50	3	DMP	614.14	397350.1	
1951	1951.74	3	DMP	611.16	397350.1	
1951	1951.99	(4)	HIS	612.70	326479.9	361915.0
1952	1952.25	(3)	HIS	607.63	391480.0	
1952	1952.50	4	DMP	609.22	370859.8	
1952	1952.74	4	DMP	607.94	370859.8	
1952	1952.99	4	DMP	604.02	370859.6	376014.8
1953	1953.25	4	DMP	602.59	370860.0	
1953	1953.50	4	DMP	602.91	370859.8	
1953	1953.74	4	DMP	600.89	370859.8	
1953	1953.99	4	DMP	596.25	370860.0	370859.9
1954	1954.25	(4)	HIS	594.28	350899.7	
1954	1954.50	4	DMP	593.38	370859.7	
1954	1954.74	4	DMP	591.35	370859.7	
1954	1954.99	(4)	HIS	589.18	350899.7	360879.7
1955	1955.25	(4)	HIS	590.49	326479.9	
1955	1955.50	4	DMP	588.25	370860.1	
1955	1955.74	4	DMP	586.03	370860.1	
1955	1955.99	(4)	HIS	586.12	326479.9	348670.0
1956	1956.25	4	DMP	583.30	370859.6	
1956	1956.50	4	DMP	582.47	370859.8	
1956	1956.74	4	DMP	579.42	370859.8	
1956	1956.99	4	DMP	573.38	370859.6	370859.7
1957	1957.25	4	DMP	571.37	370860.0	
1957	1957.50	4	DMP	574.01	370859.8	
1957	1957.74	4	DMP	576.94	370859.8	
1957	1957.99	4	DMP	578.72	370860.0	370859.9
1958	1958.25	(4)	HIS	585.26	350899.7	
1958	1958.50	4	DMP	592.86	370859.7	
1958	1958.74	4	DMP	602.99	370859.7	
1958	1958.99	(4)	HIS	613.01	350899.7	360879.7

1959	1959.25	(3)	HIS	622.16	322079.8	
1959	1959.50	3	DMP	620.76	397350.0	
1959	1959.74	3	DMP	620.84	397350.0	
1959	1959.99	(3)	HIS	628.15	322079.8	359714.9
1960	1960.25	(2)	HIS	628.01	363200.1	
1960	1960.50	2	DMP	623.25	450329.6	
1960	1960.74	3	DMP	626.55	397349.8	
1960	1960.99	(3)	HIS	630.13	363200.1	393519.9
1961	1961.25	(2)	HIS	636.47	326479.9	
1961	1961.50	2	DMP	629.67	450330.1	
1961	1961.74	2	DMP	628.06	450330.1	
1961	1961.99	(2)	HIS	639.13	326479.9	388405.0
1962	1962.25	(2)	HIS	637.06	391480.0	
1962	1962.50	2	DMP	631.89	450329.7	
1962	1962.74	2	DMP	628.94	450329.7	
1962	1962.99	(2)	HIS	628.73	391480.0	420904.9
1963	1963.25	(2)	HIS	629.16	388219.8	
1963	1963.50	2	DMP	624.25	450329.8	
1963	1963.74	3	DMP	625.37	397349.6	
1963	1963.99	(3)	HIS	622.83	388219.8	406029.7
1964	1964.25	(3)	HIS	623.71	350899.7	
1964	1964.50	3	DMP	622.42	397350.2	
1964	1964.74	3	DMP	621.17	397350.2	
1964	1964.99	(3)	HIS	622.34	350899.7	374124.9
1965	1965.25	(3)	HIS	625.71	322079.8	
1965	1965.50	3	DMP	622.78	397350.0	
1965	1965.74	3	DMP	621.69	397350.0	
1965	1965.99	(3)	HIS	626.74	322079.8	359714.9
1966	1966.25	(3)	HIS	625.79	363200.1	
1966	1966.50	3	DMP	625.11	397349.8	
1966	1966.74	3	DMP	624.62	397349.8	
1966	1966.99	(3)	HIS	625.52	363200.1	380275.0
1967	1967.25	(3)	HIS	630.33	326479.9	
1967	1967.50	2	DMP	621.93	450330.1	
1967	1967.74	3	DMP	623.83	397350.1	
1967	1967.99	(3)	HIS	629.54	326479.9	375160.0
1968	1968.25	(2)	HIS	627.31	391480.0	
1968	1968.50	3	DMP	629.21	397350.2	
1968	1968.74	2	DMP	626.28	450329.7	
1968	1968.99	(3)	HIS	629.11	391480.0	407660.0
1969	1969.25	(2)	HIS	631.99	388219.8	
1969	1969.50	2	DMP	630.66	450329.8	
1969	1969.74	2	DMP	629.61	450329.8	
1969	1969.99	(2)	HIS	631.94	388219.8	419274.8
1970	1970.25	(2)	HIS	636.00	350899.7	
1970	1970.50	2	DMP	631.28	450329.9	
1970	1970.74	2	DMP	629.88	450329.9	
1970	1970.99	(2)	HIS	637.43	350899.7	400614.8
1971	1971.25	(2)	HIS	642.94	322079.8	
1971	1971.50	2	DMP	636.27	450330.1	
1971	1971.74	2	DMP	635.73	450330.1	
1971	1971.99	(2)	HIS	650.13	322079.8	386205.0
1972	1972.25	(1)	HIS	650.68	363200.1	
1972	1972.50	(1)	HIS	624.15	625999.8	
1972	1972.74	3	DMP	644.78	397349.8	
1972	1972.99	(1)	HIS	650.55	363200.1	437437.5

1973	1973.25	(1)	HIS	658.42	326479.9	
1973	1973.50	(1)	HIS	642.43	558319.5	
1973	1973.74	2	DMP	654.07	450330.1	
1973	1973.99	(1)	HIS	673.31	326479.9	415402.3
1974	1974.25	(1)	HIS	672.83	391480.0	
1974	1974.50	(1)	HIS	642.45	686119.3	
1974	1974.74	2	DMP	661.31	450329.7	
1974	1974.99	(1)	HIS	668.09	391480.0	479852.3
1975	1975.25	(1)	HIS	671.33	388219.8	
1975	1975.50	(1)	HIS	643.49	690179.9	
1975	1975.74	2	DMP	664.08	450329.8	
1975	1975.99	(1)	HIS	672.35	388219.8	479237.3
1976	1976.25	(1)	HIS	677.60	350899.7	
1976	1976.50	(1)	HIS	656.43	601499.6	
1976	1976.74	(1)	HIS	653.64	601499.6	
1976	1976.99	(1)	HIS	679.19	350899.7	476199.6
1977	1977.25	(1)	HIS	686.09	322079.8	
1977	1977.50	(1)	HIS	668.13	548119.5	
1977	1977.74	(1)	HIS	665.77	548119.5	
1977	1977.99	(1)	HIS	688.02	322079.8	435099.7
1978	1978.25	(1)	HIS	688.22	363200.1	
1978	1978.50	(1)	HIS	660.93	625999.8	
1978	1978.74	(1)	HIS	656.14	625999.8	
1978	1978.99	(1)	HIS	678.07	363200.1	494600.0
1979	1979.25	(1)	HIS	685.36	326479.9	
1979	1979.50	(1)	HIS	667.61	558319.5	
1979	1979.74	(1)	HIS	665.61	558319.5	
1979	1979.99	(1)	HIS	689.28	326479.9	442399.7
1980	1980.25	(1)	HIS	688.00	391480.0	
1980	1980.50	(1)	HIS	655.92	686119.3	
1980	1980.74	(1)	HIS	649.37	686119.3	
1980	1980.99	(1)	HIS	673.09	391480.0	538799.7
1981	1981.25	(1)	HIS	677.67	388219.8	
1981	1981.50	(1)	HIS	654.59	690179.9	
1981	1981.74	(1)	HIS	652.88	690179.9	
1981	1981.99	(1)	HIS	686.02	388219.8	539199.8
1982	1982.25	(1)	HIS	693.39	350899.7	
1982	1982.50	(1)	HIS	670.10	601499.6	
1982	1982.74	(1)	HIS	665.65	601499.6	
1982	1982.99	(1)	HIS	686.35	350899.7	476199.6
1983	1983.25	(1)	HIS	691.27	322079.8	
1983	1983.50	(1)	HIS	670.01	548119.5	
1983	1983.74	(1)	HIS	665.87	548119.5	
1983	1983.99	(1)	HIS	684.19	322079.8	435099.7
1984	1984.25	(1)	HIS	683.38	363200.1	
1984	1984.50	(1)	HIS	653.37	625999.8	
1984	1984.74	(1)	HIS	646.37	625999.8	
1984	1984.99	(1)	HIS	666.75	363200.1	494600.0
1985	1985.25	(1)	HIS	673.75	326479.9	
1985	1985.50	(1)	HIS	655.13	558319.5	
1985	1985.74	(1)	HIS	652.78	558319.5	
1985	1985.99	(1)	HIS	676.09	326479.9	442399.7
1986	1986.25	(1)	HIS	675.65	391480.0	
1986	1986.50	(1)	HIS	647.60	686119.3	
1986	1986.74	(1)	HIS	644.58	686119.3	

1986	1986.99	(1)	HIS	674.01	391480.0	538799.7
1987	1987.25	(1)	HIS	681.42	388219.8	
1987	1987.50	(1)	HIS	661.08	690179.9	
1987	1987.74	(1)	HIS	661.98	690179.9	
1987	1987.99	(1)	HIS	699.53	388219.8	539199.8
1988	1988.25	(1)	HIS	707.52	350899.7	
1988	1988.50	(1)	HIS	684.22	601499.6	
1988	1988.74	(1)	HIS	679.42	601499.6	
1988	1988.99	(1)	HIS	698.80	350899.7	476199.6
						412998.8

MANAGEMENT PLAN B

YEAR	YEAR DECIMAL	DMP LEVEL	MGT IN EFFECT	ASR	INDEX WELL LEVEL FT	PUMPAGE ACRE-FT/YR	AVERAGE YEARLY PUMPAGE ACRE-FT/YR
1934	1934.00	0			655.71	0.0	0.0
1934	1934.25	(1)	HIS		645.97	391480.0	
1934	1934.50	(1)	CON		620.24	599997.5	
1934	1934.74	3	DMP		636.50	370859.8	
1934	1934.99	(2)	HIS		634.75	391480.0	438454.3
1935	1935.25	(2)	HIS		635.58	388219.8	
1935	1935.50	2	DMP		634.76	450329.8	
1935	1935.74	2	DMP		636.26	450329.8	
1935	1935.99	(2)	HIS		643.92	388219.8	419274.8
1936	1936.25	(2)	HIS		650.45	350899.7	
1936	1936.50	(1)	CON		630.85	584997.9	
1936	1936.74	2	DMP		641.37	450329.9	
1936	1936.99	(2)	HIS		654.70	350899.7	434281.8
1937	1937.25	(1)	HIS		660.32	322079.8	
1937	1937.50	(1)	HIS		638.55	548119.5	
1937	1937.74	2	DMP		642.81	450330.1	
1937	1937.99	(2)	HIS		655.08	322079.8	410652.3
1938	1938.25	(1)	HIS		654.48	363200.1	
1938	1938.50	(1)	CON		632.16	569997.9	
1938	1938.74	2	DMP		637.93	450329.6	
1938	1938.99	(2)	HIS		645.59	363200.1	436681.9
1939	1939.25	(1)	HIS		651.09	326479.9	
1939	1939.50	(1)	HIS		628.69	558319.5	
1939	1939.74	2	DMP		633.63	450330.1	
1939	1939.99	(2)	HIS		646.55	326479.9	415402.3
1940	1940.25	(1)	HIS		644.46	391480.0	
1940	1940.50	(1)	CON		626.37	554998.1	
1940	1940.74	3	DMP		639.33	370859.8	
1940	1940.99	(2)	HIS		637.55	391480.0	427204.5
1941	1941.25	(2)	HIS		638.34	388219.8	
1941	1941.50	2	DMP		636.25	450329.8	
1941	1941.74	2	DMP		635.62	450329.8	
1941	1941.99	(2)	HIS		638.89	388219.8	419274.8
1942	1942.25	(2)	HIS		643.20	350899.7	
1942	1942.50	2	DMP		638.13	450329.9	
1942	1942.74	2	DMP		636.26	450329.9	
1942	1942.99	(2)	HIS		642.70	350899.7	400614.8
1943	1943.25	(2)	HIS		646.91	322079.8	
1943	1943.50	(1)	CON		625.51	532498.4	
1943	1943.74	3	DMP		636.15	370860.0	
1943	1943.99	(2)	HIS		640.90	322079.8	386879.5
1944	1944.25	(2)	HIS		639.47	363200.1	
1944	1944.50	2	DMP		632.19	450329.6	
1944	1944.74	2	DMP		629.72	450329.6	
1944	1944.99	(2)	HIS		633.56	363200.1	406764.9
1945	1945.25	(2)	HIS		638.69	326479.9	

1945	1945.50	2	DMP	630.30	450330.1	
1945	1945.74	2	DMP	627.80	450330.1	
1945	1945.99	(3)	HIS	636.40	326479.9	388405.0
1946	1946.25	(2)	HIS	634.13	391480.0	
1946	1946.50	2	DMP	629.66	450329.7	
1946	1946.74	2	DMP	627.50	450329.7	
1946	1946.99	3	DMP	630.42	370859.6	415749.8
1947	1947.25	(2)	HIS	630.62	388219.8	
1947	1947.50	2	DMP	626.83	450329.8	
1947	1947.74	3	DMP	630.70	370859.8	
1947	1947.99	(2)	HIS	628.00	388219.8	399407.3
1948	1948.25	(2)	HIS	628.99	350899.7	
1948	1948.50	2	DMP	620.41	450329.9	
1948	1948.74	3	DMP	623.62	370859.7	
1948	1948.99	(3)	HIS	623.45	350899.7	380747.3
1949	1949.25	(3)	HIS	625.76	322079.8	
1949	1949.50	3	DMP	624.49	370860.0	
1949	1949.74	3	DMP	623.87	370860.0	
1949	1949.99	(3)	HIS	626.33	322079.8	346469.9
1950	1950.25	(3)	HIS	624.44	363200.1	
1950	1950.50	3	DMP	624.53	370859.8	
1950	1950.74	3	DMP	622.83	370859.8	
1950	1950.99	(3)	HIS	619.43	363200.1	367030.0
1951	1951.25	(3)	HIS	620.98	326479.9	
1951	1951.50	3	DMP	618.58	370860.1	
1951	1951.74	3	DMP	616.14	370860.1	
1951	1951.99	(3)	HIS	615.70	326479.9	348670.0
1952	1952.25	3	DMP	612.07	370859.6	
1952	1952.50	3	DMP	611.91	370859.8	
1952	1952.74	4	DMP	614.32	317880.1	
1952	1952.99	3	DMP	607.85	370859.6	357614.8
1953	1953.25	4	DMP	610.15	317880.1	
1953	1953.50	4	DMP	611.88	317879.9	
1953	1953.74	4	DMP	610.85	317879.9	
1953	1953.99	4	DMP	607.28	317880.1	317880.0
1954	1954.25	4	DMP	604.21	317880.1	
1954	1954.50	4	DMP	604.50	317880.1	
1954	1954.74	4	DMP	603.11	317880.1	
1954	1954.99	4	DMP	599.89	317880.1	317880.1
1955	1955.25	4	DMP	598.39	317879.9	
1955	1955.50	4	DMP	598.97	317880.1	
1955	1955.74	4	DMP	597.84	317880.1	
1955	1955.99	4	DMP	594.85	317879.9	317880.0
1956	1956.25	4	DMP	594.63	317879.8	
1956	1956.50	4	DMP	595.07	317880.1	
1956	1956.74	4	DMP	593.11	317880.1	
1956	1956.99	4	DMP	588.77	317879.8	317879.9
1957	1957.25	4	DMP	587.65	317880.1	
1957	1957.50	4	DMP	590.25	317879.9	
1957	1957.74	4	DMP	592.70	317879.9	
1957	1957.99	4	DMP	594.37	317880.1	317880.0
1958	1958.25	4	DMP	597.53	317880.1	
1958	1958.50	4	DMP	606.63	317880.1	
1958	1958.74	4	DMP	616.84	317880.1	
1958	1958.99	(3)	HIS	619.77	350899.7	326135.0

1959	1959.25	(3)	HIS	626.69	322079.8	
1959	1959.50	3	DMP	627.28	370860.0	
1959	1959.74	3	DMP	628.12	370860.0	
1959	1959.99	(2)	HIS	632.58	322079.8	346469.9
1960	1960.25	(2)	HIS	631.99	363200.1	
1960	1960.50	(2)	CON	626.85	449999.6	
1960	1960.74	3	DMP	632.79	370859.8	
1960	1960.99	(2)	HIS	634.20	363200.1	386814.9
1961	1961.25	(2)	HIS	639.77	326479.9	
1961	1961.50	(2)	CON	632.77	450000.3	
1961	1961.74	(2)	CON	631.11	450000.3	
1961	1961.99	(2)	HIS	641.93	326479.9	388240.1
1962	1962.25	(2)	HIS	639.78	391480.0	
1962	1962.50	(2)	CON	634.56	450000.0	
1962	1962.74	(2)	CON	631.57	450000.0	
1962	1962.99	(2)	HIS	631.28	391480.0	420740.0
1963	1963.25	(2)	HIS	631.62	388219.8	
1963	1963.50	(2)	CON	626.66	449999.7	
1963	1963.74	3	DMP	629.81	370859.8	
1963	1963.99	(2)	HIS	626.10	388219.8	399324.8
1964	1964.25	(3)	HIS	626.49	350899.7	
1964	1964.50	3	DMP	627.21	370859.7	
1964	1964.74	3	DMP	626.82	370859.7	
1964	1964.99	(3)	HIS	626.18	350899.7	360879.7
1965	1965.25	(3)	HIS	628.80	322079.8	
1965	1965.50	(2)	CON	619.02	449999.9	
1965	1965.74	3	DMP	623.35	370860.0	
1965	1965.99	(3)	HIS	628.42	322079.8	366254.9
1966	1966.25	(2)	HIS	627.56	363200.1	
1966	1966.50	3	DMP	629.16	370859.8	
1966	1966.74	(2)	CON	622.54	449999.6	
1966	1966.99	(3)	HIS	626.05	363200.1	386814.9
1967	1967.25	(3)	HIS	631.53	326479.9	
1967	1967.50	(2)	CON	623.50	450000.3	
1967	1967.74	3	DMP	627.59	370860.1	
1967	1967.99	(3)	HIS	631.57	326479.9	368455.0
1968	1968.25	(2)	HIS	629.09	391480.0	
1968	1968.50	(2)	CON	626.19	450000.0	
1968	1968.74	3	DMP	633.35	370859.8	
1968	1968.99	(2)	HIS	632.42	391480.0	400954.9
1969	1969.25	(2)	HIS	634.40	388219.8	
1969	1969.50	(2)	CON	632.58	449999.7	
1969	1969.74	(2)	CON	631.37	449999.7	
1969	1969.99	(2)	HIS	633.49	388219.8	419109.8
1970	1970.25	(2)	HIS	637.49	350899.7	
1970	1970.50	(2)	CON	632.75	450000.0	
1970	1970.74	(2)	CON	631.34	450000.0	
1970	1970.99	(2)	HIS	638.82	350899.7	400449.8
1971	1971.25	(2)	HIS	644.28	322079.8	
1971	1971.50	(1)	CON	637.61	449999.9	
1971	1971.74	(2)	CON	637.07	449999.9	
1971	1971.99	(2)	HIS	651.38	322079.8	386039.9
1972	1972.25	(1)	HIS	651.89	363200.1	
1972	1972.50	(1)	CON	647.47	449999.6	
1972	1972.74	(1)	CON	646.44	449999.6	
1972	1972.99	(1)	HIS	652.58	363200.1	406599.9

1973	1973.25	(1)	HIS	660.29	326479.9	
1973	1973.50	(1)	CON	656.28	450000.3	
1973	1973.74	(1)	CON	658.60	450000.3	
1973	1973.99	(1)	HIS	675.78	326479.9	388240.1
1974	1974.25	(1)	HIS	675.11	391480.0	
1974	1974.50	(1)	CON	672.70	450000.0	
1974	1974.74	(1)	CON	671.59	450000.0	
1974	1974.99	(1)	HIS	673.35	391480.0	420740.0
1975	1975.25	(1)	HIS	675.52	388219.8	
1975	1975.50	(1)	CON	674.57	449999.7	
1975	1975.74	(1)	CON	674.64	449999.7	
1975	1975.99	(1)	HIS	678.09	388219.8	419109.8
1976	1976.25	(1)	HIS	682.15	350899.7	
1976	1976.50	(1)	CON	678.05	450000.0	
1976	1976.74	(1)	CON	677.62	450000.0	
1976	1976.99	(1)	HIS	686.45	350899.7	400449.8
1977	1977.25	(1)	HIS	691.54	322079.8	
1977	1977.50	(1)	CON	684.55	449999.9	
1977	1977.74	(1)	CON	683.51	449999.9	
1977	1977.99	(1)	HIS	694.72	322079.8	386039.9
1978	1978.25	(1)	HIS	694.03	363200.1	
1978	1978.50	(1)	CON	687.52	449999.6	
1978	1978.74	(1)	CON	685.08	449999.6	
1978	1978.99	(1)	HIS	688.24	363200.1	406599.9
1979	1979.25	(1)	HIS	692.69	326479.9	
1979	1979.50	(1)	CON	686.35	450000.3	
1979	1979.74	(1)	CON	685.86	450000.3	
1979	1979.99	(1)	HIS	697.41	326479.9	388240.1
1980	1980.25	(1)	HIS	695.17	391480.0	
1980	1980.50	(1)	CON	690.49	450000.0	
1980	1980.74	(1)	CON	687.86	450000.0	
1980	1980.99	(1)	HIS	687.65	391480.0	420740.0
1981	1981.25	(1)	HIS	688.80	388219.8	
1981	1981.50	(1)	CON	688.77	449999.7	
1981	1981.74	(1)	CON	691.62	449999.7	
1981	1981.99	(1)	HIS	699.18	388219.8	419109.8
1982	1982.25	(1)	HIS	703.67	350899.7	
1982	1982.50	(1)	CON	697.69	450000.0	
1982	1982.74	(1)	CON	695.09	450000.0	
1982	1982.99	(1)	HIS	699.34	350899.7	400449.8
1983	1983.25	(1)	HIS	702.08	322079.8	
1983	1983.50	(1)	CON	691.72	449999.9	
1983	1983.74	(1)	CON	688.71	449999.9	
1983	1983.99	(1)	HIS	695.84	322079.8	386039.9
1984	1984.25	(1)	HIS	693.77	363200.1	
1984	1984.50	(1)	CON	684.69	449999.6	
1984	1984.74	(1)	CON	680.85	449999.6	
1984	1984.99	(1)	HIS	682.48	363200.1	406599.9
1985	1985.25	(1)	HIS	685.86	326479.9	
1985	1985.50	(1)	CON	678.63	450000.3	
1985	1985.74	(1)	CON	677.65	450000.3	
1985	1985.99	(1)	HIS	688.27	326479.9	388240.1
1986	1986.25	(1)	HIS	686.83	391480.0	
1986	1986.50	(1)	CON	685.14	450000.0	
1986	1986.74	(1)	CON	685.61	450000.0	

1986	1986.99	(1)	HIS	689.72	391480.0	420740.0
1987	1987.25	(1)	HIS	693.83	388219.8	
1987	1987.50	(1)	CON	696.91	449999.7	
1987	1987.74	(1)	CON	704.52	449999.7	
1987	1987.99	(1)	HIS	715.60	388219.8	419109.8
1988	1988.25	(1)	HIS	720.80	350899.7	
1988	1988.50	(1)	CON	714.35	450000.0	
1988	1988.74	(1)	CON	711.36	450000.0	
1988	1988.99	(1)	HIS	714.88	350899.7	400449.8
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