DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1978/70

Operating Manual for the
GABHYD Model

by

G.E. SEIDEL

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CONTENTS

SUMMARY

A brief introduction is given to the GABHYD model of the Great Artesian Basin. Detailed instructions are provided on how to run the model and how to analyse and present the results using interactive console programs on the CSIRONET system run by the Division of Computing Research of CSIRO and based on their CDC CYBER76 computer in Canberra. These interactive programs are suitable for most applications of the GABHYD model. Some specialized applications might require a more detailed knowledge of the model and the computer system on which it is run. For these cases the user is referred to the model description. Listings of the interactive programs and naming conventions for data files are provided in the Appendix.

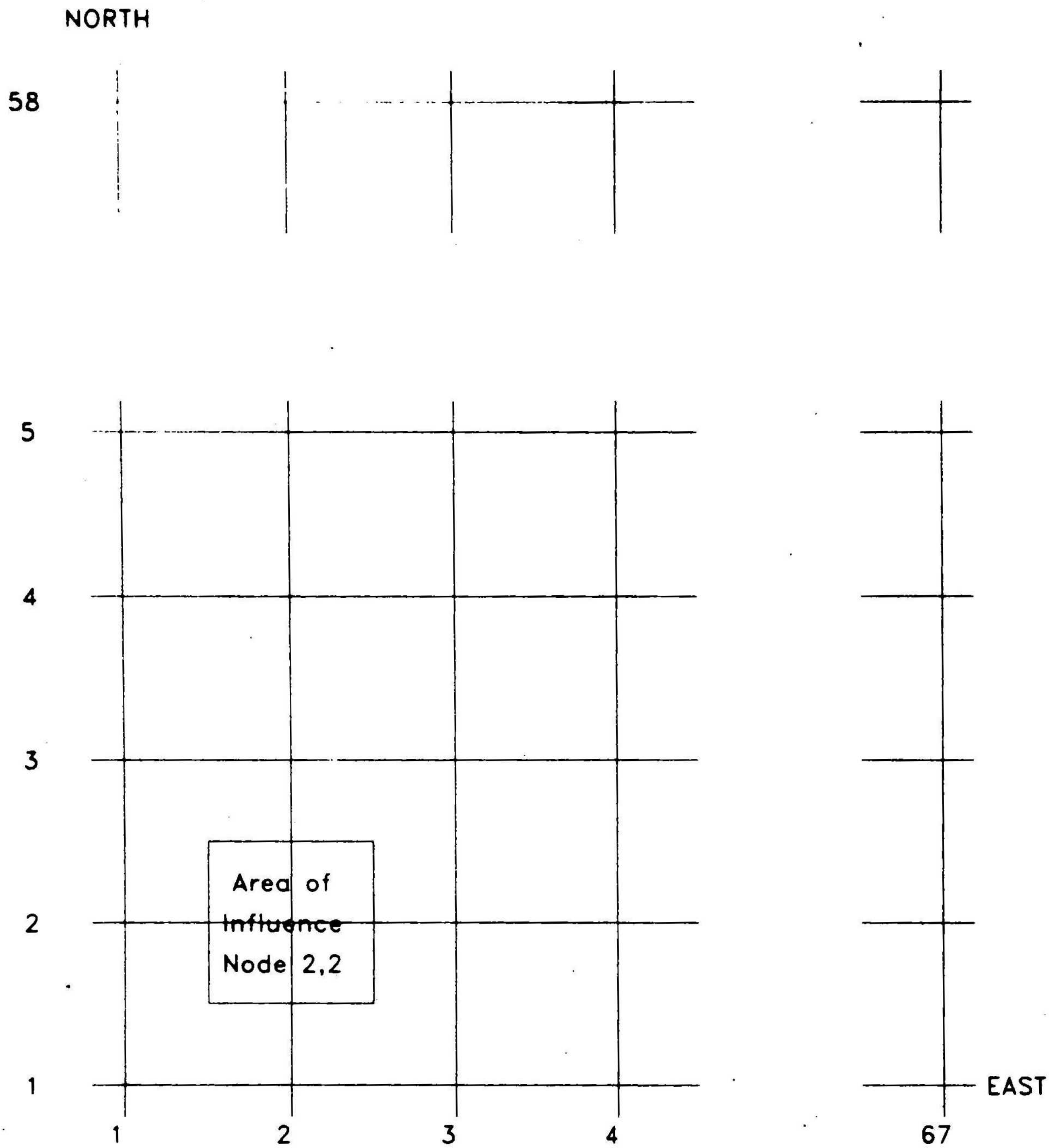
1. BRIEF DESCRIPTION OF THE MODEL AND ITS CALIBRATION

The GABHYD model was designed as a regional groundwater management tool. Its purpose is to provide a basinwide assessment of the artesian groundwater resources of the Great Artesian Basin and of their response to various alternative management programs. The requirements to consider the entire basin simultaneously and to keep the model within reasonable limits of complexity led to a regional type of model which is not suitable for consideration of individual bores or small detailed areas, but rather of areas at least 25 km square and preferably larger.

From among the alternative types a finite difference numerical model to be run on a large scale digital computer was chosen as the best compromise. For solution by the finite difference method all data have to be defined on regularly spaced gridpoints. For the GABHYD model a square grid was adopted with a separation of 25 km between the gridlines. The Great Artesian Basin fits into a rectangle containing 67 such gridlines counted from west to east and 58 gridlines counted from south to north (Fig. 1). Each intersection of gridlines is called a node and represents an area of 25 km by 25 km of which it is the centre.

Discretization in the vertical dimension is by aquifer group (Fig. 2). The first aquifer is the watertable and is given the number 0 in the model. It is considered constant, i.e. the model does not attempt to recalculate it. The second aquifer is given the number 1 as the first confined aquifer. In reality it represents a group of aquifers, which are considered as one hydrologic unit and broadly correspond to the aquifers composed of Cretaceous rocks. Only a few data are available for this aquifer and although it had to be included in the model for continuity no detailed calibration could be attempted and the model results for this aquifer should not be used. Aquifer number 2 in the model broadly corresponds to the aquifers of the Jurassic age and again includes a number of geologically different units, which are however considered one hydrologic unit (Audibert, 1976). Results from the calibration of the model indicate that this assumption is not always entirely valid (Seidel, 1978). Aquifer no. 2 is the main aquifer of the model.

For each of the two confined aquifers and on each gridnode the model prototype defines the hydraulic parameters (horizontal transmissivities, vertical leakage factors, storativities) and the state variables (potentials, discharges). For the watertable the potentials only are required.



Point 1,1 Longitude 133.30 N-S Gridlines parallel to Longitude 144.
Latitude 32.

100 km

Figure 1 Definition of Grid

Record 1978/70

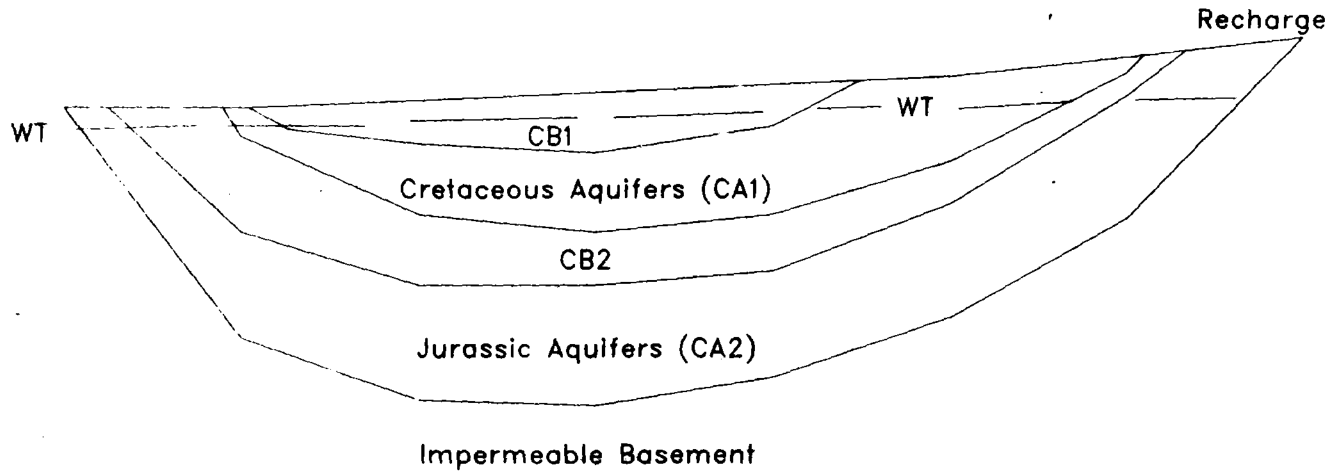


Figure 2 Vertical Crossection of Model Prototype

The model determines in turn for each node of each confined aquifer the complete waterbalance. Outflows, including well discharges, are subtracted from inflows and the balance is made up from storage. Through the storativity of the aquifer at a particular node the storage there relates directly to a corresponding pressure head or potential. The flows between adjoining nodes are calculated according to Darcy's Law from the difference in potentials and a conductance factor. This conductance corresponds to the transmissivity for horizontals flow and the vertical leakage factor for vertical flows. A special case of vertical flow is well discharge. Here the potential difference is between the aquifer pressure head and the elevation of the well head (usually close to ground elevation). The conductance here is a coefficient determined from the records of net pressure at the well head and of the corresponding discharge.

Water balances are thus determined in sequence row by row and column by column throughout the grid and for each aquifer. Each complete traverse of rows, columns, and aquifers is called an iteration. The model progresses through time in small steps. For each step a number of iterations is executed to define a new set of potentials. For the duration of each step it is assumed that all the flow rates remain constant. In this particular model the flow rates are calculated at the end of the time step ('implicit' formulation). An exception is the calculation of the discharge which is performed between iterations rather than during them. The discharge calculation is in effect 'explicit' which is important when considering the maximum length of time-steps used by the model. If the time-steps are too large computational instability through the discharge calculation may result.

The horizontal boundaries of the model are defined either as impermeable barriers by zero transmissivities, or as permeable boundaries defined by prescribed constant potentials. Vertical boundaries consist of an impermeable basement beneath aquifer 2 and a constant prescribed potential in the watertable above aquifer 1 (or above aquifer 2 where 1 does not exist).

The definition of the appropriate boundary conditions was the major problem during the calibration of the model. Calibration was by a direct method where interior transmissivities were determined from the potentials available as recorded data and from boundary conditions. The boundary conditions in this context are one conductance value or one flow rate value on each distinguishable separate flow path. Because the flow paths starting in the recharge areas branch into multiple discharge boundary paths, vertical leakage paths and well discharge paths one separate conductance value or flow rate was needed for each. Ignoring well discharge the required boundary conditions would be the transmissivities along the discharge boundaries and all vertical leakage factors. Very little information is available on these and the calibration would have been rather unreliable if it relied on these data only. However the situation is improved considerably by including well discharge values. In recent times, artificial discharge has become the major outflow from the basin overall and the dominating flow rate in the developed portions of the basin where it hence forms a dominant boundary condition for calibration. Well discharges are recorded data and hence the calibration of the model is quite good for the developed portions. However care must be taken when using model results for areas which are distant from areas with recorded discharges and potentials. Results for those areas depend on the assumption that hydraulic parameters can be extrapolated over that distance and on the variable quality of geological information on the sequence and thickness of formations.

The sequence of information processing by the model is illustrated in Fig. 3.

In the job preparation step a manipulation file is coded which defines year by year and for each node how the well discharge is specified. It is through this manipulation file that the various management alternatives are implemented on the model.

The second step is the running of the model. The model reads the geometry and parameter data as determined by calibration. It then reads from the model manipulation file the model control parameters including the time range over which the model is to run. The starting potentials are obtained by searching the potentials data file for data for the first year of the specified time range. For the time range specified the model advances by a major time step in years and a minor time step determined dynamically from model control parameters. Discharge specifications are read from the manipulation file for each major time step and remain valid for that time step.

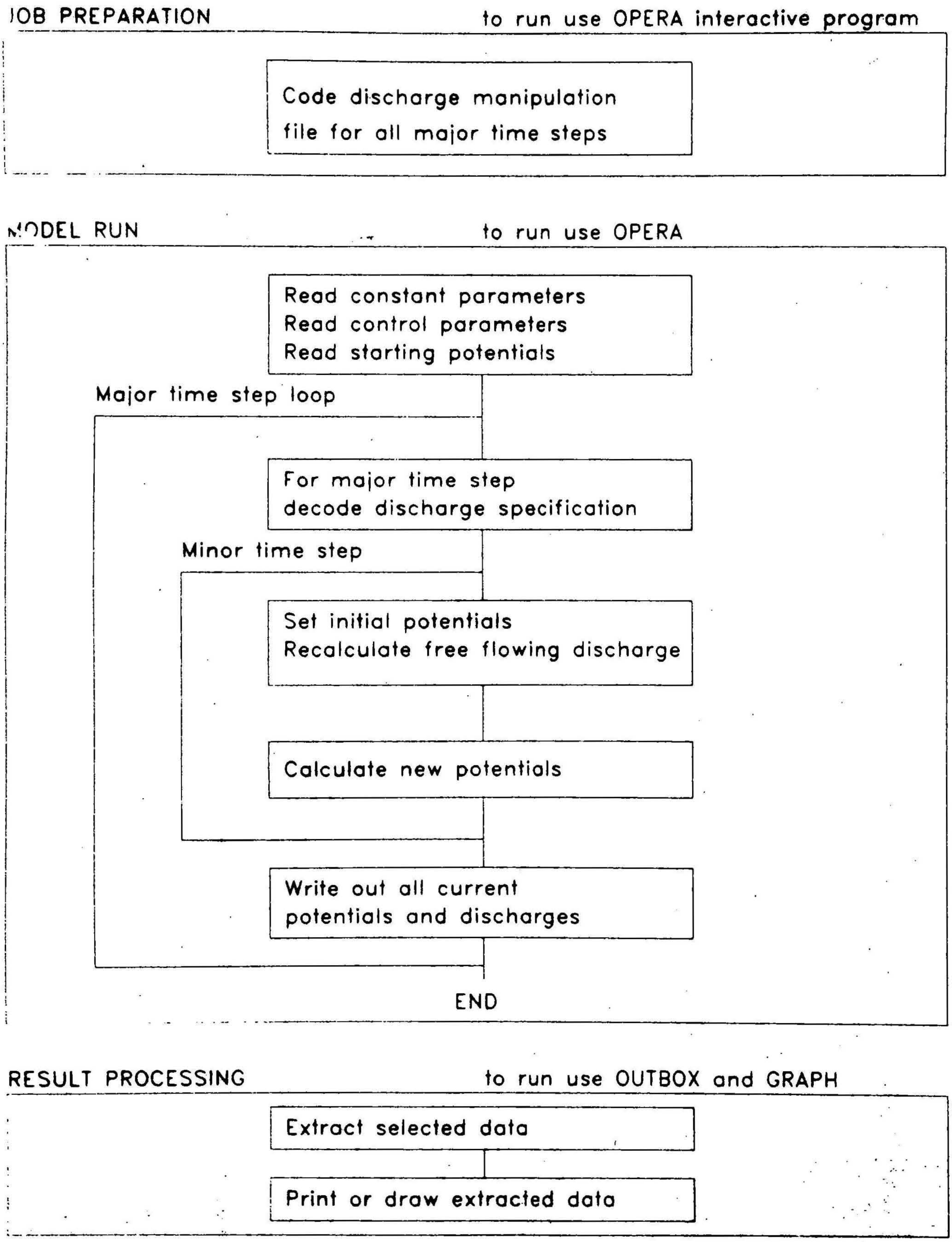


Figure 3 Model Processing Sequence

Free flowing discharge is recalculated for each minor time step from the specifications valid for the major time step (e.g. discharge coefficient) and the potentials current for the minor time step. At the end of each major time step the model writes out the potentials and discharges for each gridnode and aquifer.

The third step is the processing of the model results. The original output from the model is complete and very voluminous. The function of the result processing step is to produce selective results corresponding to the need of the user. As long as the files containing the original model output are retained results can be re-presented in different forms in response to changing requirements.

The model and its calibration are described in greater detail in two separate records (Seidel, 1978). It is recommended that the user refers to them for a more thorough understanding of the capabilities and limitations of the model. The instructions on how to use the model on the CSIRONET system based on the CDC CYBER 76 computer in Canberra are presented in the following chapters.

2. PREPARING A PROBLEM FOR SOLUTION

To prepare a problem for solution it must first be defined in rigorous terms and then be coded. Definition of the problem includes:

- Examination of whether a new model run is required or whether results from previous runs may be used;
- Determination of whether the model is suitable in terms of applicability, scale and accuracy;
- A statement of the model operating requirements in terms of time range, required discharge management, and background data.

The next step then is the coding of instructions for the model run. A special coding language was developed for this purpose. Although it requires some time for a user to familiarize himself with this coding language the saving it offers in time and effort as against direct coding of the model are considerable.

2.1 Defining the Problem

The major considerations in determining the suitability of a problem for solution by the GABHYD model are -

Firstly, the problem must be one of predicting discharges and potentials. Water chemistry and temperatures are not calculated by the model.

Secondly, the aquifer under consideration must be included in the Jurassic sequence. Older (deeper) aquifers are not included in the model and for younger ones (e.g. Cretaceous) not enough data were available for an adequate calibration.

Thirdly, the accuracy required of the results must be within the capabilities of the model. The model is not designed to predict short term events of less than one year duration. Its geometrical grid is based on a spacing of 25 km. There is no point in attempting to distinguish between bores less than 25 km apart. The smallest area which is recommended for separate treatment and predictions is 50 km square.

Fourthly, conditions simulated by the model should be not too different from the ones used for calibrating the model. This applies to time and space. The further the area under consideration is from recorded data for the calibration the less reliable the result. As far as time is concerned the model may be used for long term predictions as long as the events experienced during the prediction period are not too far out of the range of events experienced during the calibration period. Figure 4 shows on a printed map the location of gridnodes where data were available for calibration.

After examining the suitability of the problem for solution by the model the following steps are required to prepare for coding the problem.

1. Specify the time range for the model run. Starting conditions must be available for the starting year of the time range. Select suitable starting conditions from the model data catalogue (catalogue of historical data files and of previous model runs). If necessary expand model run time range backwards to connect with suitable starting conditions.

2. Specify a suitable discharge background. The discharge background consists of the discharge specification for those areas with which the model run is not specifically concerned. If the objective of the run is to study what would have happened during the historical period up to 1970 but assuming different discharge controls then the recorded discharge figures provide a suitable background for the remaining areas. If the model extrapolates into the future however some extra thought has to be given to the background specification. A file of extrapolated discharges assuming no management changes from 1970 to 1999 exists but may not always be suitable as background.

3. Plot the position of the proposed new discharges on a map with the model grid superimposed. Tabulate the proposed discharges per gridpoint (node) and year. If the new discharge is directly

controlled (pumped) no further specifications are required.

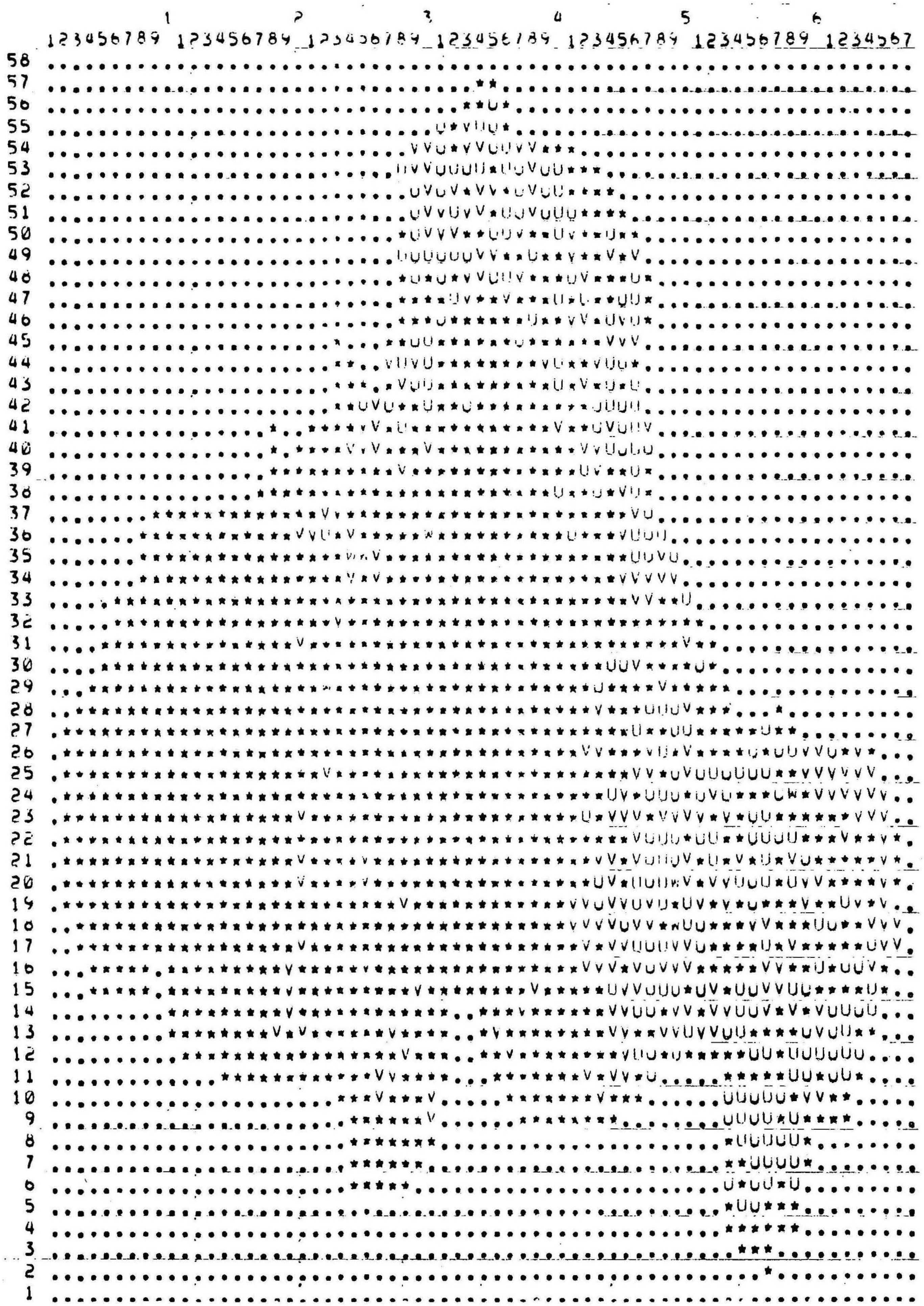
4. If the discharges are free flowing, i.e. they depend on the potentials, then supplementary data are required for each grid point where free flowing discharge is specified. These are a groundelevation/temperature correction and a discharge coefficient. Where discharges were recorded groundelevation/temperature corrections are determined and will be automatically assigned unless the user specifies them explicitly. Discharge coefficients are available for the same nodes for specific years of the historical period and can be used as guides. Where none is available use table 1 to calculate the groundelevation/temperature correction and determine a discharge coefficient from the target discharge and net pressure, or as a first approximation specify controlled instead of free flowing discharge.

TABLE 1 Groundelevation/Temperature Corrections (metres)

Bore Depth(m)	Water Temperature (^{o}C)								
	20	30	40	50	60	70	80	90	100
100	.2	.4	.8	1.2	1.7	2.2	2.8	3.5	4.2
200	.4	.9	1.5	2.4	3.4	4.4	5.6	6.9	8.3
300	.5	1.3	2.3	3.6	5.0	6.7	8.5	10.4	12.5
400	.7	1.8	3.1	4.8	6.7	8.9	11.3	13.9	16.7
500	.9	2.2	3.9	6.0	8.4	11.1	14.1	17.4	20.9
600	1.1	2.6	4.6	7.2	10.1	13.3	16.9	20.8	25.0
700	1.3	3.1	5.4	8.4	11.8	15.5	19.7	24.3	29.2
800	1.4	3.5	6.2	9.6	13.4	17.7	22.6	27.8	33.4
900	1.6	4.0	6.9	10.8	15.1	20.0	25.4	31.2	37.5
1000	1.8	4.4	7.7	12.0	16.8	22.2	28.2	34.7	41.7
2000	3.6	8.8	15.4	24.0	33.6	44.4	56.4	69.4	83.4

Correction = Groundelevation-Temperature correction (m)

Net Pressure = Potential - Correction (m)



U,V,W: recorded data *: no recorded data .: point outside basin

Figure 4 Distribution of Data Used for Calibration

2.2 Coding the Problem

The model requires comprehensive and explicit specifications of discharge for each gridnode and each major time step. To ease the task of preparing these complex discharge manipulation instructions a special translating program was developed which prepares a data file of coded discharge instructions from relatively simple commands.

The available commands are subdivided into

- Major Option Keywords for specifying general operating conditions e.g. model control parameters, discharge background etc.
- Discharge Option Keywords for specifying details of discharge manipulations, e.g. free flow.
- Range Keywords grouping discharge options into consecutive time ranges.

Most keywords are followed directly by a data list. The form which was adopted for the data specification is what is known in the FORTRAN language as 'Namelist'. The data items which can be legally specified for a particular keyword are contained in a list which is referenced by a 'Namelist-name'. The applicable FORTRAN Format is

$Namelist-name   Dataname 1 = Datavalue 1, Dataname N = ...$

The first $ sign must be in column 2 of the input line followed immediately by the Namelist-name, then in arbitrary order any data specifications separated by commas and then to terminate the input line another $ sign. An arbitrary number of data specifications may be included. Extreme cases are either to define every data item legal for the Name List or none at all. The latter has the effect of satisfying the requirement that a data specification line has to be provided yet without altering in any way the data values assigned by the program as default.

The syntax of the coding language for manipulating discharge is presented in tables 2, 3, 4 and 5 and in figure 5.

Table 2 is a listing of the Major Option Keywords and of their functions. All Major Option Keywords are followed directly by a line of data specifications except for keywords CONTROLLED and END. END does not require any data, CONTROLLED is followed first by the Range Keyword NEW TIME and then a data line specifying the time range which applies to the discharge specifications to follow.

Table 3 lists the Discharge Option Keywords and the type of discharge manipulation specified by them. Each Discharge Option Keyword is preceeded by the keyword NEW CODE. The Discharge Option Keyword is followed by one CODE Namelist data specification line and then by one or more COORDI Namelist data specification lines.

Table 4 lists the various Namelists, their functions, and where they may occur. Namelist TIME may occur in different options. For each Namelist there is a list of legal data names.

Table 5 lists names, the names of data items legal within that Namelist, definition of the corresponding data item and an automatic default values are usually safe but not always useful.

The structure of a typical instruction set is illustrated in figure 5. Major options, e.g. to set model control parameters, are invoked first followed then by the CONTROLLED option. This defines the discharge for a number of consecutive time ranges (two in fig. 5). It may then be followed by another Major Option Keyword, e.g. to redefine free flow well discharge coefficients or to copy a section of previously used discharge specifications, and then another CONTROLLED option for the following period etc.

The detailed definitions of the Major Option Keywords are:

MODELCON This option produces a header to the discharge manipulation file containing control parameters for the model. Namelist MODEL is to be used for data specification. Of the parameters which can be defined through MODEL several may be left at their default values. These are TMF, MAXI, ORFI, CON, NCAR. The default values for these have been arrived at by experience. STEP should be left defined as 1 (year) unless there is a

TABLE 2 Major Option Keywords

Keyword	Option Invoked	Namelist
MODELCON	Specify model control parameters	MODEL
FREECOEF	Calculate free flow discharge coefficients	FLOW
HISTORIC	Compile discharge file from recorded data	TIME
COPY OLD	Copy old discharge (manipulation) file onto new	TIME
CONTROLLED	Discharge manipulation instructions follow	n.a.
END	No further instructions	n.a.

TABLE 3 Discharge Option Keywords

Keyword	Option invoked
CONTROLLED	Discharge is prescribed unconditionally
CONTTHRES	as above but subject to threshold pressure exceeded
FREE FLOW	Free flowing discharge unconditionally
FREE THRES	as above but subject to threshold pressure exceeded
ELEVATED	Free flowing modified by raising outflow level
MAXIMUM	Free flowing restrained to maximum
MINIMUM	Free flowing but maintained at minimum

TABLE 4 Namelist Names

Name	Data specified	Occurs in
MODEL	Model run control parameters	MODELCON
FLOW	Year for which discharge coefficients are calculated	FREECOEF
TIME	Time range and file type specification	(HISTORIC, COPY (OLD NEW TIME
CODE	Discharge control data	any discharge option
COORDI	Range of grid nodes (coordinates)	any discharge option

TABLE 5 Namelist data items and default values

Namelist Name	Data Name	Definition	Default
	FROM	starting year for model run	1880
	TO	final year for model run	1881
	STEP	model (major) time step (years)	1
	TMF	minor time step incremental factor	1.5
MODEL	YMIN	1/YMIN = minimum minor time step (years)	365
	YMAS	1/YMAS = maximum minor time step	1.0
	MAXF	maximum number of iterations in minor step	20
	ORFI	overrelaxation factor (not used this version)	1.0
	CON	convergence limit in metres	0.01
	NCAR	flag to call CARRE overrelaxation (not used)	0
FLOW	AT	year for which discharge coefficients are determined	1970
	FROM	first year of time range	1880
TIME	TO	last year of time range	1881
	STEP	time step in years	1
	FILE	(refer to text for details)	1
	DISCH	discharge in m^3/s	0.
	THRES	threshold pressure head in metres	0.
CODE	RISPIP	extra elevation of outflow (m)	0.
	MAXDIS	maximum discharge (m^3/s)	1.
	MINDIS	minimum discharge (m^3/s)	0.
	FLOWCO	free flow discharge coefficient (m^2/s)	0.
	GELEV	groundelevation/temperature correction (m)	0.
	WESTFR	gridnode range western limit	1
	EASTTO	gridnode range eastern limit	1
	SOUTFR	gridnode range southern limit	1
	NORTTO	gridnode range northern limit	1
COORDI	EAST	east-west gridnode index } interchangeable	1
	WEST	east-west gridnode index } interchangeable	1
	NORTH	north-south gridnode index } interchangeable	
	SOUTH	north-south gridnode index } interchangeable	1
	AQUIFR	aquifer number	2
	CONTI	continuation code	0

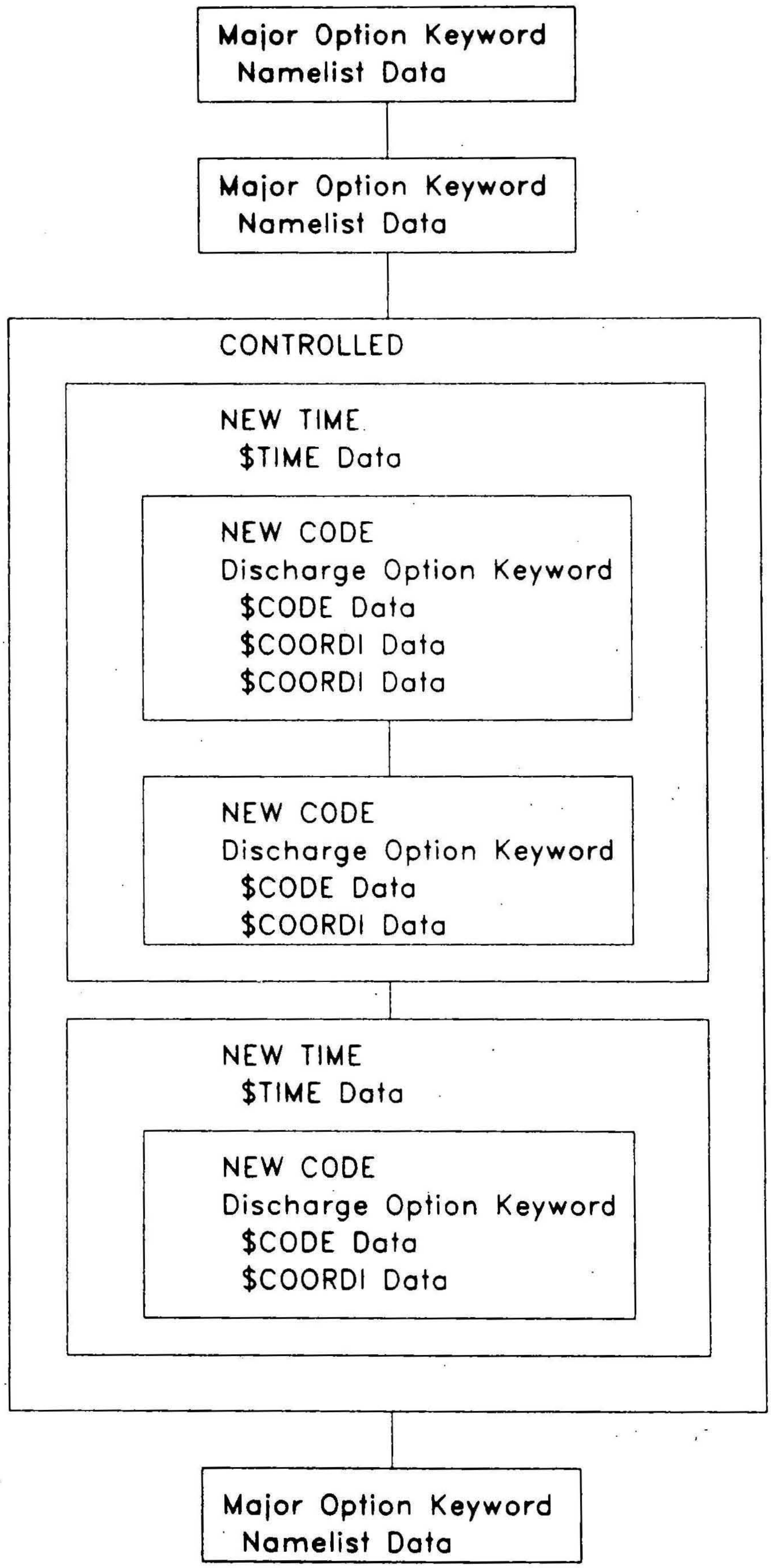


Figure 5 Nesting of Instructions

specific reason for wanting a less frequent specification of discharge and less frequent output from the model. It refers to the major time step as defined in the model description. YMIN defines the minimum minor time step and YMAX the maximum (as number of subdivisions applied to each year). Both may be left at their default values except when significant changes in free flowing well discharge might occur in this case a value of 4.0 was found more suitable for YMAX. The values for FROM and TO need to be specified to determine the operating time range for the model run. MODELCON should be invoked only once and at the beginning of the sequence.

FREECOEF This option specified that free flow discharge coefficients are to be calculated from the recorded data at a particular year. The recorded data are obtained from the data files RUNDIS for discharge, RUNPOT for potentials, and CORLEV for groundelevation/temperature corrections. Whenever free flow is specified as a discharge option and no separate discharge co-efficients are provided then the coefficients calculated by invoking FREECOEF will be used. FREECOEF may be invoked at any time between other major options. The Namelist associated with FREECOEF is FLOW and has only one legal data item called AT, which is the year for which data are to be extracted from RUNDIS and RUNPOT for calculating the co-efficients.

HISTORIC This option specifies the compilation of a separate discharge file from actually recorded data. Two types of discharge file can be produced, the historic type, identical in format to RUNDIS and model output discharge files or the manipulation type used as model input. The Namelist associated with this option is TIME. The meaning of data items FROM, TO, STEP is as defined in table 4. FILE = 1 specifies that a historic type, FILE = 2 that a manipulation type discharge file is to be produced.

COPY OLD This option serves to copy part or all of a previously produced discharge file of either type onto the new manipulation file. Its main purpose is to avoid duplicate coding when only a minor modification is to be made to a previous manipulation file, e.g. if a different set of control parameters is to be used with the same discharge specifications. The associated Namelist is TIME. FROM, TO, and STEP are defined as above but FILE = 1 specifies the input file from which the copying is done as of the historic type, FILE = 2 as of the manipulation type.

<u>CONTROLLED</u> This is the major discharge manipulation option. This keyword must be followed by the Range Keyword NEW TIME and then the time range specification through Namelist TIME which applies to all the discharge options to follow until a new Range Keyword NEW TIME or another Major Option Keyword is encountered. FROM, TO and STEP are as above. It should be noted that STEP should agree with the corresponding specification under the MODELCON option. FILE may be specified as 0, 1, 2 and serves to define the discharge background to be applied. Discharges are first set to this background and then modified by the specific instructions through discharge options. FILE = 0 specified that all discharges are to be set to zero first. FILE = 1 causes the discharge background to be copied from the historic discharge file RUNDIS. If FILE = 2 a manipulation type file is used as background. A small change has to be made in this case to the control cards heading program MANMOD (see model description, Seidel 1978) to make the appropriate file accessible.

The Discharge Option Keywords may occur only within the CONTROLLED major option and must be preceeded by a time range specification through NEW TIME. The format for the discharge option specifications is (see Fig. 5)

NEW CODE

Discharge Option Keyword

$CODE ....data $

$COORDI ....data $

CODE allows the specification of supplementary data for the discharge option selected. Usually only one or two of the data items legal within the CODE Namelist will be required.

The gridnodes (coordinates) to which the discharge option is to be applied are defined through the COORDI Namelist. Grid coordinates may be set as single coordinates e.g. EAST = 15 or as a range of coordinates, e.g. WESTFR = 10, EASTTO = 20 or as any combination thereof, e.g. EAST = 15, SOUTFR = 30, NORTTO = 40. Several such coordinate specifications may be supplied for each discharge option. In this case all but the last of the coordinate specification lines must include the item CONTI = 1 to indicate that the specification continues.

The detailed definitions of the Discharge Option Keywords are:

CONTROLLED (not to be confused with the Major Option Keyword of the same name). The discharge is prescribed unconditionally for the time range specified above and for the grid nodes specified through COORDI. The discharge value itself is assigned through CODE by data item DISCH = value.

CONTHRES The discharge is still prescribed but no longer unconditionally. The condition is that the net pressure at the well head exceeds the threshold pressure defined as THRES = value through CODE. Both THRES and DISCH have to be defined. GELEV the groundelevation correction is required for calculating the net pressure from the potential and unless specified separately through CODE a value taken from data file CORLEV will be used. If no value is available from CORLEV the default value is used instead.

FREE FLOW The discharge is free flowing unconditionally. The data specifications through CODE may be for FLOWCO the discharge coefficient, and GELEV the groundelevation/temperature correction. If any of them is not specified substitutes will be taken from the last call to FREECOEF for FLOWCO or from CORLEV for GELEV. If neither is available the default values are used.

FREE THRES The discharge is free flowing but subject to the net pressure exceeding a threshold pressure. Data specification through CODE is as for FREE FLOW but with the additional item THRES to be defined.

ELEVATED As for FREE FLOW but the outflow level (well head) is artificially raised, e.g. by installing a riser pipe, by an amount specified by RISPIP through CODE.

MAXIMUM As for FREE FLOW but the discharge is limited to a maximum discharge specified by MAXDIS.

MINIMUM As for FREE FLOW but the discharge is prevented from falling below a minimum discharge specified by MINDIS.

A typical coding sequence using the above coding language is:

1) Set Model Control Parameters

```
MODELCON
$MODEL FROM = 1960, TO = 1980, YMAX = 4.$
```

2) Calculate free flow discharge coefficients as valid for 1970

```
FREECOEF
$FLOW AT = 1970$
```

3) Apply historic discharge from 1960 to 1970

```
COPY OLD
$TIME FROM = 1960, TO = 1970, FILE 1$
```

4) Manipulate discharge from 1970 to 1980 in two time ranges.

```
CONTROLLED
specify first time range, background from historic file
NEW TIME
$TIME FROM = 1970, TO = 1975, FILE = 1$
specify free flow for node 35, 45 with flow coefficient of 0.05
NEW CODE
FREE FLOW
$CODE FLOWCO = 0.05$
$COORDI WEST = 35, NORTH = 45$
specify second time range 1975 to 1980, same background
NEW TIME
$TIME FROM = 1975, TO = 1980, FILE = 1$
specify free flow for nodes 35,45 34,46 34,47 34,48, each
with discharge coefficient 0.07 and each maintained at minimum
discharge of 0.100 m^3/s (100 l/s)
NEW CODE
MINIMUM
$CODE FLOWCO = 0.07, MINDIS = 0.1$
$COORDI EAST = 35, SOUTH = 45, CONTI = 1$
$COORDI EAST = 34, SOUTFR = 46, NORTTO = 48$
END
```

Major option keyword END could be replaced by any other Major Option Keyword if another Major Option was to follow, or by NEW CODE if another discharge option within the same time range was to follow, or by

NEW TIME if a new time range within the CONTROLLED Major Option was to be defined for further discharge options.

3. RUNNING THE MODEL THROUGH THE INTERACTIVE TERMINAL

The OPERA interactive program was developed to allow persons with little or no experience with the CYBER 76 computer of CSIRONET to use the GABHYD model on this computer. A compromise had to be made between implementing all possible options of the GABHYD model and providing a simple operating system. As stated in chapter 2 some GABHYD options require that some special data files, e.g. a previous model manipulation file be attached. Such operations are best done with the assistance of someone who is familiar with data file management on this computer and for this reason the facility is not included in OPERA. The following data files are used automatically

1) For job preparation (generating manipulation file)
   ARTCAI, SURCAI, ARTCAZ recorded discharge data 1880-1970 RUNDIS
   historic discharge file 1950 to 1970 } for calculating background
   RUNPOT potentials file 1950 to 1970 } discharge coefficients
   CORLEV groundelevation/temperature correction file 1970

2) For running the model
   MODGEO model geometry file
   MODHYD model hydraulic parameter file

It is assumed that the user has completed the coding of the model run as described in 2.1 and 2.2 and that he is either familiar with the operation of interactive terminals on CSIRONET or has read the relevant instructions of Appendix A.

3.1 Model Preparation Step

Function of the model preparation step is to run the translator program which translates the instructions coded in accordance with 2.2 into the model manipulation file. The manipulation file is stored under a name specified by the user and will be used in the next step for running the model.

The required interactive program is called OPERA and if not available on the interactive system because of prolonged inactivity it can be reloaded simply by dropping the card deck program called DISCO into the job stream for batch processing. OPERA should then be available again shortly (typically 1 hour). To start using it log into ED on the interactive terminal (see Appendix A) and then type

[/OPERA/$

the user will then be asked to type in PREP or RUN.

The correct answer for the job preparation step is

PREP

then the user is requested to identify the job with his name, e.g.

JOHN BROWN

the next request is for a name for the manipulation file to be produced, e.g.

MANIPU

then the user is requested to type in the coded instructions as described in 2.2. Following the typing of the last coded instruction, e.g. END, the linefeed key is operated twice in succession. This signals the end of the code entry.

The computer should then reply

'PREPARATION JOB SUBMITTED'.

During typing care must be taken that keywords are spelled correctly and start in column 1 and that Namelist-names start in column 3 preceded by $ in column 2.

A sample dialogue is reproduced in figure 6.

3.2 Model Running Step

After confirming that the preparation job has run correctly log into ED and start sequence by

[/OPERA/$

OPERA will reply as before but this time the user replies with

RUN

OPERA then requests the user to provide his name for identifying the job, e.g.

TOM JONES

then the user is requested to provide the name of the file containing the starting potentials for the model run, e.g.

COMPTO

then the name of the manipulation file to be read, e.g.

```
:
:
:[ /opera /$
CARHYD MODEL OPERATING SYSTEM
FOR RUN PREPARATION ENTER 'PREP'
ELSE ENTER 'RUN' FOR RUNNING THE MODEL
:prep
STATE YOUR NAME PLEASE
:seidel
TYPE IN THE NAME OF THE MANIPULATION FILE TO BE WRITTEN
:man001
TYPE IN RUNNING INSTRUCTIONS AS PER MANUAL
FOLLOWING THE LAST INSTRUCTION (END) DEPRESS LINE FEED KEY TWICE
DISPLAY CODE MODE.
:modelcon
:  $model from=1950, to=1970$
:freecoef
:  $at
   $flow at=1970$
:copy old
:  $time from=1950, to=1970,file=1$
:end
:
PREPARATION JOB SUBMITTED, CHECK RESULTS BEFORE RUNNING MODEL
END
:q
SYSTEM ?
:q
      0.166 S   CPU TIME      $0.208
    107.520 KC FILE  IO       $0.054
      1.610 KC STATN IO       $0.012
      0.219 RU @   $1.25      $0.274
```

Figure 6 Sample Dialogue Job Preparation

MANIPU
then the user is requested to provide file names for the model output first for the potentials e.g.
PSA611
then the discharge file, e.g.
DSA611
these names should be unique to avoid confusion of different model results. Following entry of these names OPERA notifies the user that the run has been submitted for processing. A sample dialogue is reproduced in figure 7.

4. PRESENTING THE RESULTS

The model writes out data files containing all the potentials and discharges for each major time step and each gridnode. This form of output is complete, and rather cumbersome to analyse directly. For example a model run over ten years produces 118000 lines of output, each line containing 6 data items in scientific notation. Such large data quantities are best searched, summarized, and presented using the computer. A frequent user of the GABHYD model might consider to design and write output analysis programs to suit his particular needs. However for the occasional user a set of data extraction and presentation programs has been provided which is expected to meet most requirements. This group of programs is called OUTSYS and is accessible through the OUTBOX and GRAPH interactive programs described in chapter 5 or through batch processing of programs PLOTAR and PROCCO.

4.1 Overview over the Available Options

The major steps in analysing the model results are: extraction and processing of selected data, and presenting the extracted data.

The routines available for data extraction and processing are summarized in table 6 and described in greater detail in 4.2. Broadly the function of the extraction routines is to

- extract a specified set of data, e.g. potentials for a specified year and aquifer (MAP)

- extract two specified sets of data and relate them, e.g. drowndown as difference between two sets of potentials (FUN)

TABLE 6 Summary of Extraction Routines

Interactive Name	Batch Name	Function
MAP	SIMPRI	extract single data set
FUN	TWOFUN	extract two data sets and relate
DIS	TOTALQ	summarise discharge
LEA	LEAKAG	calculate vertical leakage
BOU	BOUNDQ	calculate boundary discharge
TIM	TIMESE	extract data vs. time

- summarise the well discharges for specified areas over specified time periods (DIS)
- calculate from extracted potentials and hydraulic parameters the vertical leakage for a specified year between specified aquifers (LEA)
- calculate from extracted potentials and hydraulic parameters the boundary discharges and recharges for specified year and aquifer (BOU)
- extract specified data for specified area over a specified period, calculate averages for area if more than one gridnode (TIM)

For each of these extraction routines a range of presentation options is available. These presentation options are either based on the line printer and produced in the same job step with the data extraction, or are based on the line plotter. In the latter case the extracted data are temporarily stored on disc and then accessed by a second job step for plotting.

The presentation options are in brief

- a small map produced on the line printer, approximately A4 size, values coded as letters of the alphabet.
- a large map produced on the line printer in sections, values printed in scientific notation with 4 significant digits in the mantissa.

- a simple tabulation vs. time (for TIM extraction only)
- a printer produced and automatically scaled 1 page plot of data vs. time (for TIM extraction only)
- a contour plot of a data array on 25 cm plotter, or 70 cm plotter, or 35 mm film
- a perspective simulated 3D plot on 25 cm, 70 cm plotter or 35 mm film.

The step by step procedure to use OUTSYS is:

1) Tabulate what data are to be presented and in what form.

2) If several output documents are to be produced subdivide the output requirements into groups for processing. The limitations for each processing group are that only four different data files can be accessed at the same time, and only one data set can be sent for line plotting at a time.

3) For each processing group specify four data files (even if less than four are actually needed) and number them as 10, 20, 30, 40 and for each of the extraction routines to be used note down the relevant option parameters (see 4.2), e.g. aquifer number, data type, function code.

4) Use PROCCO for batch processing or OUTBOX (see 5.1) for processing through the interactive terminal. The result will be printed output and optinally an extracted data file for further processing, i.e. plotting.

5) To plot extracted data file use PLOTAR for batch processing or GRAPH (see 5.2) for processing through the interactive terminal. Completion of step 4 is a prerequisite for starting with step 5.

4.2 Description of Individual Options

Details of the individual extraction routines are given first. A specified range of presentation options is available with each of the extraction routines. Details of these options are provided following the description of the extraction routines.

MAP (SIMPRI) This is the most elementary of the data extraction routines. The user specifies a data array by data file number, the data type code (see table 7), the year for which they had been stored, the aquifer number. He also specified whether normal or log spacing is to be used for character coding on a small map (see presentation options), the length of the maptitle in characters, the map title, and a presentation option. Available presentation options are S for small map, L for large map, B for both, D for generating extracted data file for plotting.

FUN (TWOFUN) This routine which extracts two data sets and then relates them was produced initially for producing maps of drawdowns but was then extended to include other simple functions. The user specifies two data sets, each with the same parameters as for MAP, he specifies normal or log spacing for small maps, map title length, the map title and then a function code which relates the two data sets. These codes are

+	sum of data sets
-	subtract second from first
*	multiply
/	divide first by second
A	arithmetic mean
H	harmonic mean
P	percentage positive difference
E	absolute positive difference (error)

TABLE 7 Data Type Codes

E	East-west directional transmissivity
N	North-south directional transmissivity
Z	Vertical leakage factor
S	Sterativity
W	Watertable potential
I	Potential at beginning of time step or previous potential
P	Current potential or potential and end of time step
Q	Well discharge by gridnode
G	Groundelevation/temperature correction
T	Aquifer thickness

When specifying either P or E as function code a standard error for the entire array (either percent or absolute) is calculated and printed in addition. The same presentation options as for MAP (S,L,B,D) are available. Care should be taken that data sets are compatible in particular that both are defined over the same areas.

DIS (TOTALQ) Well discharge totals are calculated for part (region) or all of an aquifer. A region is specified by using code R and providing the bounds of the region as gridnode indices. The user specifies a data file number for extracting discharge data, a starting year, end year, and a time step in years. Calculation proceeds by subdividing the interval between starting and end year into steps of the specified length. For each step an average discharge rate is determined and multiplied by the length of the time interval. The discharge volumes are summed for each step to provide a total volume of well discharge for the specified period.

LEA (LEAKAG) This routine is provided to calculate and present the vertical leakage for a particular aquifer. The user has to specify two data files by their numbers, the first containing the aquifer potentials, the second the hydraulic parameters. For each of these data files the user further specifies the year and the aquifer number. The following directions of vertical leakage may be specified by code.

- U upward leakage to aquifer above
- D downward leakage to aquifer below
- \+ leakage balance (U + D), positive if aquifer receives more than it loses through leakage
- A All options (U, D, & +)

The results may be presented as small map or large map or both (options S, L, B).

BOU (BOUNDQ) This routine calculates the lateral boundary flow on permeable prescribed head boundaries. As for the previous routine the user specifies potentials and hydraulic parameter files. Results may be presented as small map or large map and are positive for recharge and negative for discharge flows.

<u>TIM (TIMESE)</u> This routine extracts data from up to four data files simultaneously for a time range. Each data file is numbered (10, 20, 30, 40) and further specified by data type code (table 7) and aquifer number. For the data extraction the user specifies starting year, end year, time step in years, and the region by gridnode bounds (indices west, east, south, north) over which data are to be averaged. The total number of time steps must not exceed 100. For each time step and each data file separately the routine extracts the data for the specified region and averages them. When the last time step has been executed the average values for the region for each time step and each data file are available in four separate sequential lists. These can be tabulated (T), plotted on the printer (Q) or both (B). Which of the data lists are plotted is specified by a numeric code:

0	all four lists (10, 20, 30, 40) are plotted
1	only the difference between 10 and 20 is plotted
3	only the difference between 30 and 40 is plotted
5	10, 20 and their difference is plotted
7	30, 40 and their difference is plotted
9	all four lists and the differences 10-20 and 30-40

Tabluation is always for all four lists and both differences. Any of the four data files can be eliminated by giving it the file number 00. The corresponding list will be filled with zeros.

The result presentation options are:

<u>Small Map</u> This presentation is designed to provide simple first glance information in the form of a one page printed map. Each gridnode of the model is represented by one line printer character on the map. The range of values of the extracted data is subdivided into 24 classes corresponding to the letters of the alphabet and the value on each node is printed as the corresponding letter at the corresponding printer position. Subdivision of the range of values into classes is either normal or logarithmic. It should be noted that on most printers the vertical spacing between lines is larger than the spacing of horizontal print positions. This causes a vertical exaggeration on the resulting picture. (Example fig. 8).

```
:
:[ /opera /$
CABHYD MODEL OPERATING SYSTEM
FOR RUN PREPARATION ENTER 'PREP'
ELSE ENTER 'RUN' FOR RUNNING THE MODEL
:run /
STATE YOUR NAME PLEASE
:seidel
TYPE IN THE NAME OF THE FILE CONTAINING STARTING POTENTIALS
:star70
TYPE IN NAME OF MANIPULATION FILE TO BE USED
:man001
TYPE IN NAME OF POTENTIALS FILE TO BE PRODUCED
:prg980
TYPE IN NAME OF DISCHARGE FILE TO BE PRODUCED
:drg980
MODEL RUN SUBMITTED
CATALOG DIS,DRG980,ID=DMRXWC .
:
:
```

Figure 7 Sample Dialogue Model Run

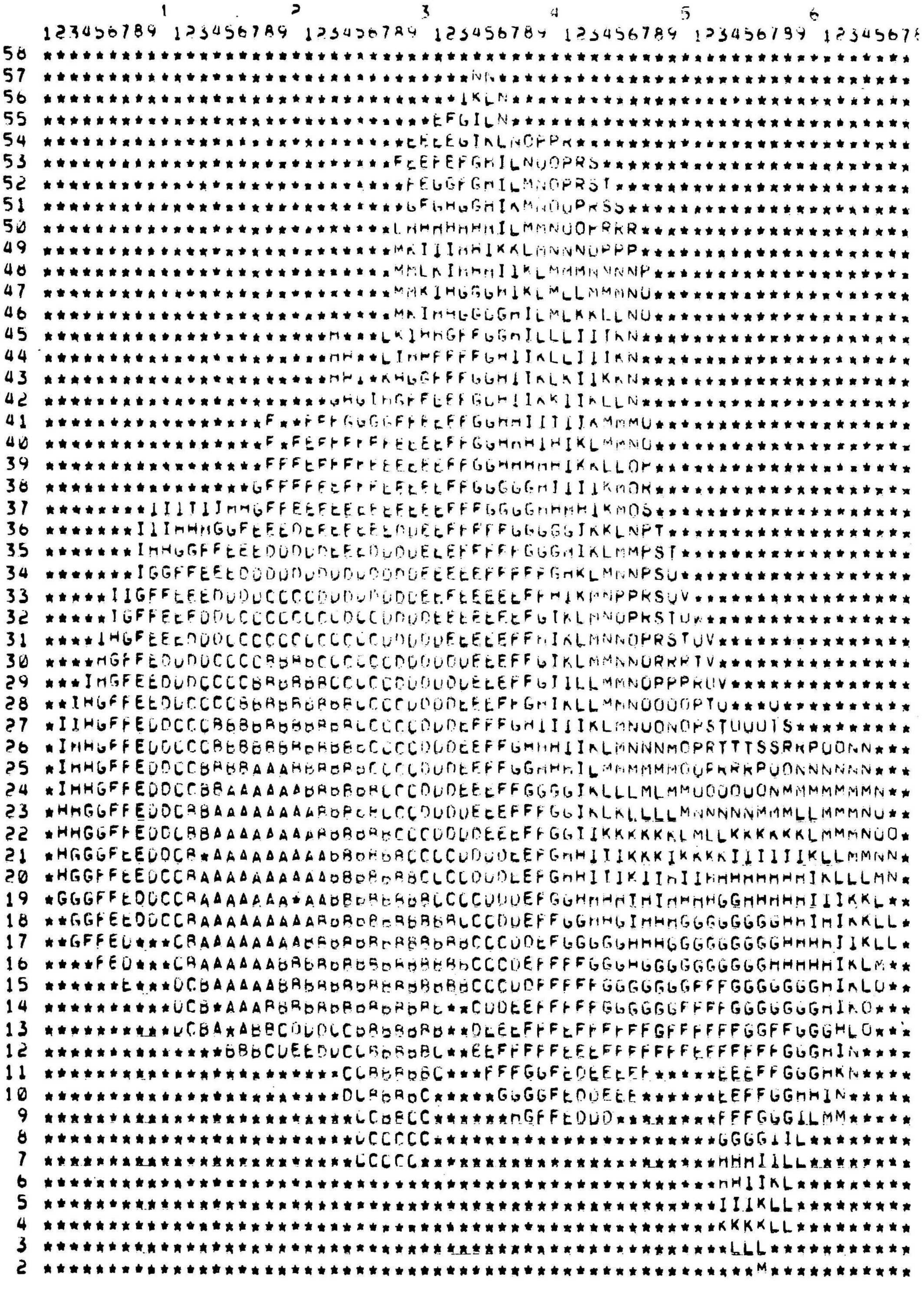


Figure 8 Sample Small Printed Map

Large Map This presentation provides detailed information. Values are printed on a grid almost exactly square and the value on each gridnode is printed as a four digit mantissa together with a two digit exponent. A leading decimal point for the mantissa is assumed but not printed. The printed value $\genfrac{}{}{0pt}{}{3461}{04}$ e.g. stands for $.3461 \times 10^4 = 3461.$ or the value $\genfrac{}{}{0pt}{}{-2588}{-01}$ stands for $-.2588 \times 10^{-1} = 0.02588$. Total size of an assembled map for the 67x58 grid of the model is approximately 1.00 x 0.75 metres. The map is printed in four separate strips which may then be spliced together.

Tabulation vs. Time. This presentation option is one of the two available together with the TIM extraction routine. Up to four data items can be listed simultaneously plus in two separate columns the differences between them. An example of a tabulation is presented as figure 9.

Print-plot of Data vs. Time This is the second presentation option available with TIM. Up to four data items and the differences between pairs can be presented simultaneously. An example using the same data as figure 9 is presented in figure 10. Scaling in the horizontal and vertical directions is automatic. This presentation is intended to provide first glance information. Because there is only 50 vertical print positions available vertical coordinates have to be rounded to match the nearest available position. This produces a stepped appearance of the graphs. The exact values obtained from the tabulation should be used to prepare smooth plots.

Contour Plots This is a machine contouring routine producing output either on a small line plotter (width 25 cm) a large plotter (width 70 cm) or a 35 mm film. If an entire model array of 67 x 58 elements is contoured on the larger plotter the scaling will be almost exactly 1:2500 000 matching many of the available base maps. The user should not attempt to contour incomplete results, e.g. maps of recorded potentials only. The user specifies a minimum, maximum, and a step value for the contours. The user may further specify whether data values at the data points are to be plotted on the same map. Not all data points may be plotted however if doing so would cause overcrowding of numbers. The user may send for plotting either the entire data array or only part of it. A part plot is defined by the limiting grid indices for west, east, south and north. Figure 11 is an example of potentials contoured for the entire basin, figure 12 shows the contour map for only part of it with data points plotted on.

EXTRAPOLATION VS NEW DISCHARGE FOR AREA BOUNDED BY 21-22,15-18

FILE NUMBER	10	30	-0	-0		
DATA TYPE	P	P	Q	Q		
AQUIFER NO.	2	2	2	2	COL1-COL2	COL3-COL4
YEAR						
1981	89.179	87.398	0.000	0.000	1.781	0.000
1982	89.179	85.990	0.000	0.000	3.189	0.000
1983	89.178	84.751	0.000	0.000	4.426	0.000
1984	89.177	83.664	0.000	0.000	5.513	0.000
1985	89.176	82.693	0.000	0.000	6.483	0.000
1986	89.175	81.811	0.000	0.000	7.364	0.000
1987	89.174	80.998	0.000	0.000	8.175	0.000
1988	89.173	80.243	0.000	0.000	8.930	0.000
1989	89.172	79.533	0.000	0.000	9.638	0.000
1990	89.171	78.864	0.000	0.000	10.307	0.000
1991	89.170	78.228	0.000	0.000	10.942	0.000
1992	89.169	77.623	0.000	0.000	11.546	0.000
1993	89.168	77.044	0.000	0.000	12.124	0.000
1994	89.167	76.489	0.000	0.000	12.678	0.000
1995	89.166	75.956	0.000	0.000	13.210	0.000
1996	89.165	75.443	0.000	0.000	13.722	0.000
1997	89.164	74.949	0.000	0.000	14.216	0.000
1998	89.163	74.472	0.000	0.000	14.692	0.000

Figure 9 Sample Tabulation vs Time

EXTRAPOLATION VS NEW DISCHARGE FOR AREA BOUNDED BY 21-22,15-18

CHARACTER A FILE 10 DATA P AQUIFER 2
CHARACTER B FILE 30 DATA P AQUIFER 2
CHARACTER C FILE -0 DATA Q AQUIFER 2
CHARACTER D FILE -0 DATA Q AQUIFER 2 CHARACTER O=A-B CHARACTER I=

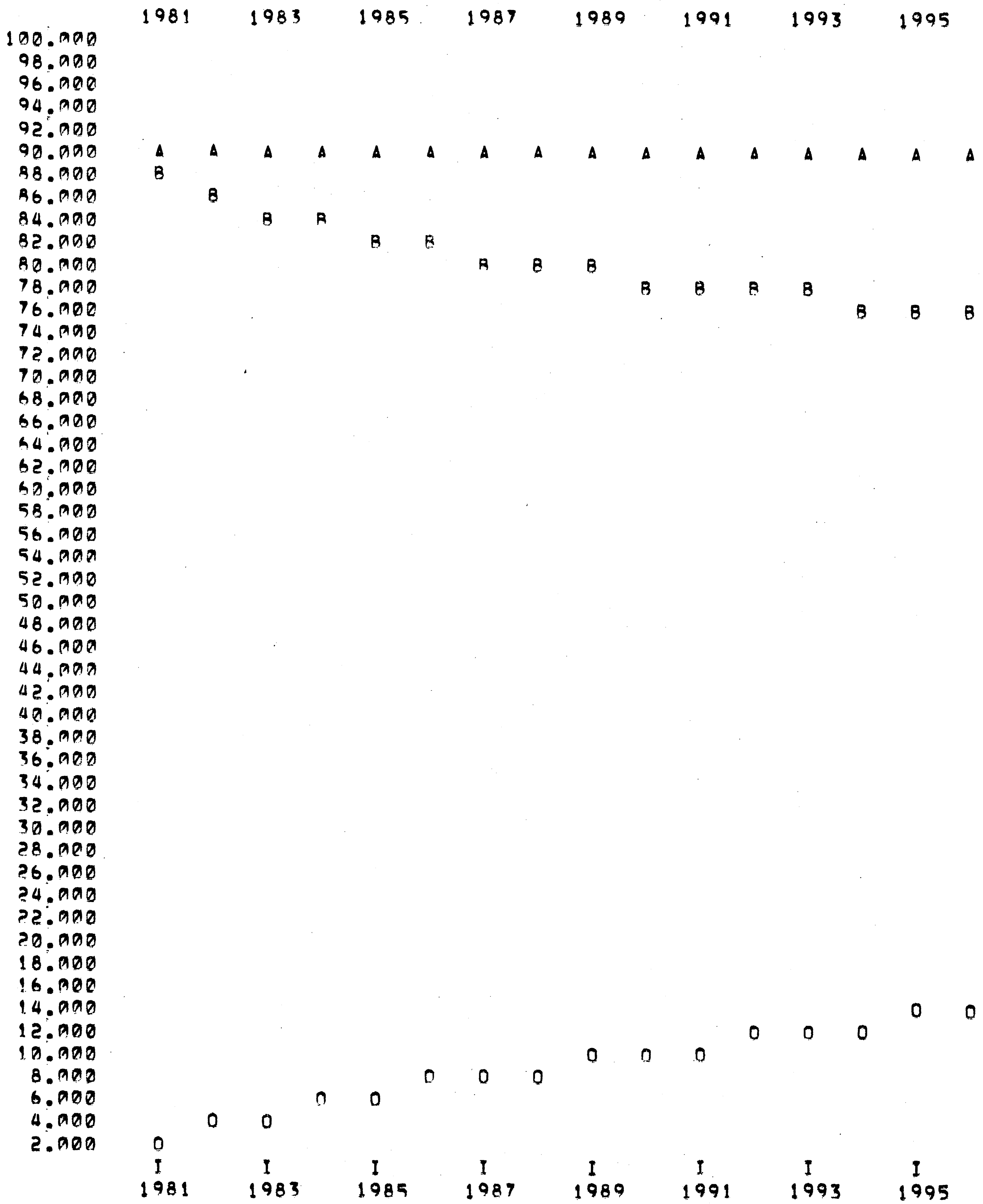


Figure 10 Sample Print Plot

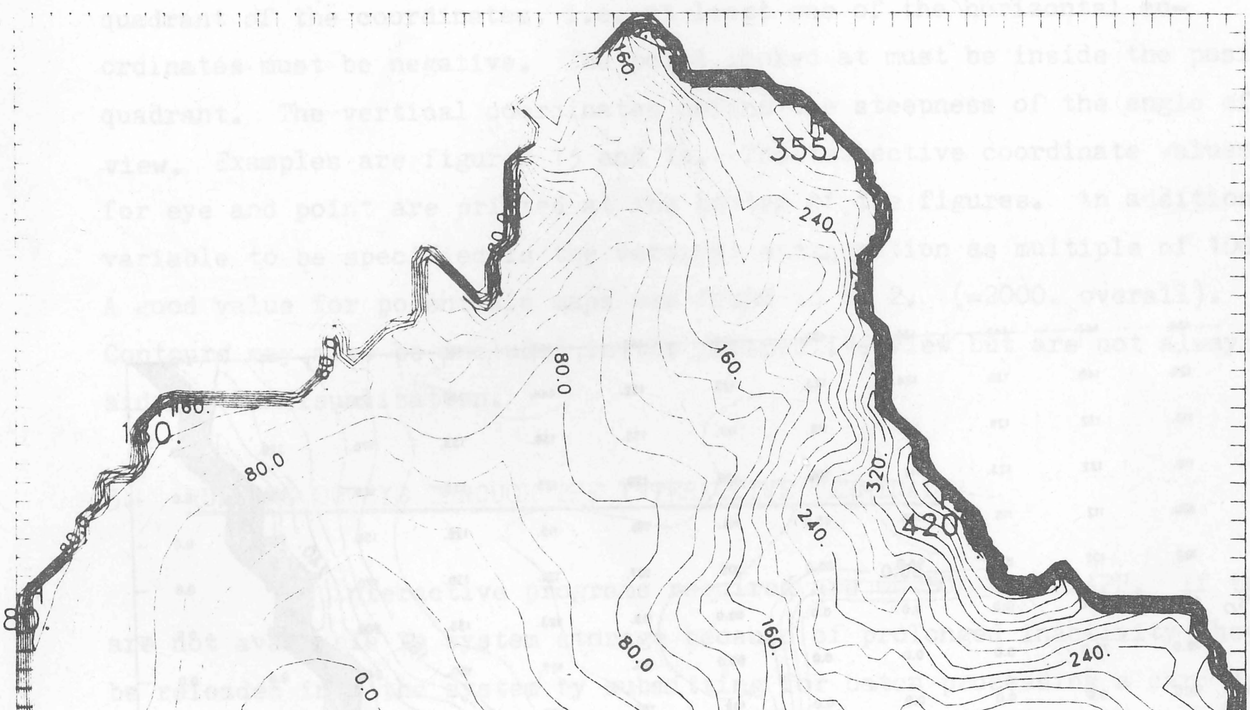
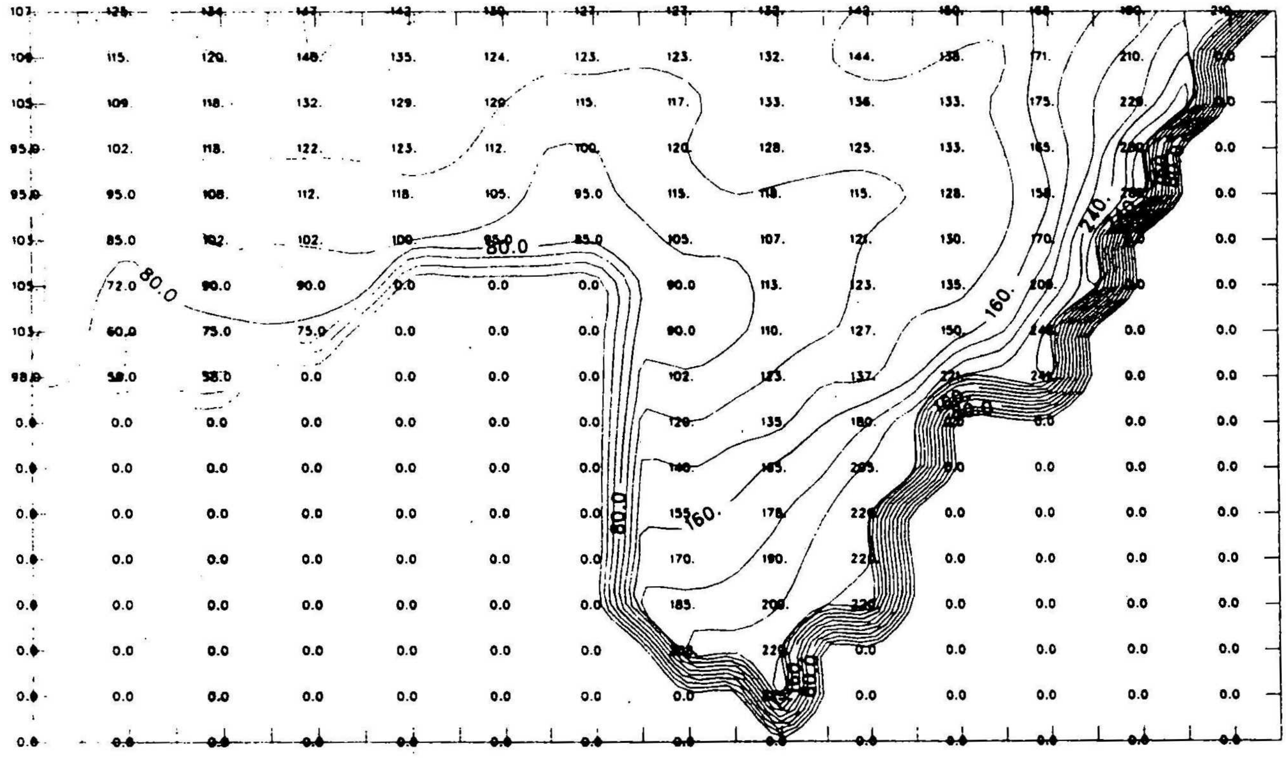


FIGURE 11 SAMPLE CONTOUR MAP WHOLE BASIN

INDEX RANGE W 1 E 67 S 1 N 58

Record 1978/70



CONTOUR FROM 0. TO 400.00 CONTOUR INTERVAL OF 20.000 PT(3.3)= 0.

FIGURE 12 SAMPLE CONTOUR MAP PART OF BASIN

INDEX RANGE W 40 E 67 S 1 N 17

Record 1978/70

Perspective 3D Plots These plots are provided to aid the visualization of complex surfaces. They are most useful for demonstrating the shapes of surfaces like aquifer tops or bottoms (structure contours) potentials, or drawdowns. Again the entire or part of the array may be specified. The angle of view and the perspective effect are controlled by specifying in actual (not grid) coordinates the location of the eye and the location of the point in the object looked at. These coordinates refer to the origin of the model grid (point 1.1) and are in kilometres for the horizontal and metres for the vertical direction. The eye must be outside the positive quadrant of the coordinates, i.e. at least one of the horizontal co-ordinates must be negative. The point looked at must be inside the positive quadrant. The vertical coordinates define the steepness of the angle of view. Examples are figures 13 and 14. The respective coordinate values for eye and point are printed at the bottom of the figures. An additional variable to be specified is the vertical exaggeration as multiple of 1000. A good value for potentials maps was found to be 2. (=2000. overall). Contours may also be included in the perspective view but are not always aiding the visualization.

5. RUNNING OUTSYS THROUGH THE INTERACTIVE TERMINAL

The interactive programs required are OUTBOX and GRAPH. If they are not available in system storage because of prolonged inactivity they can be reloaded into the system by submitting for batch processing a card deck called DISCO. All interactive programs for the GABHYD model operating system are reloaded by this program at the same time.

Before using the interactive programs described below the user should have completed the step by step preparation described in 4.1 i.e. all output requirements have been grouped and listed together with the relevant option codes and parameters.

5.1 Extracting and Printing Data Using OUTBOX

Log into ED on the interactive terminal (Appendix A) then type

[/OUTBOX/$

This starts the main branch of the program and OUTBOX requests the user to specify four data files (10, 20, 30, 40) one by one by supplying the

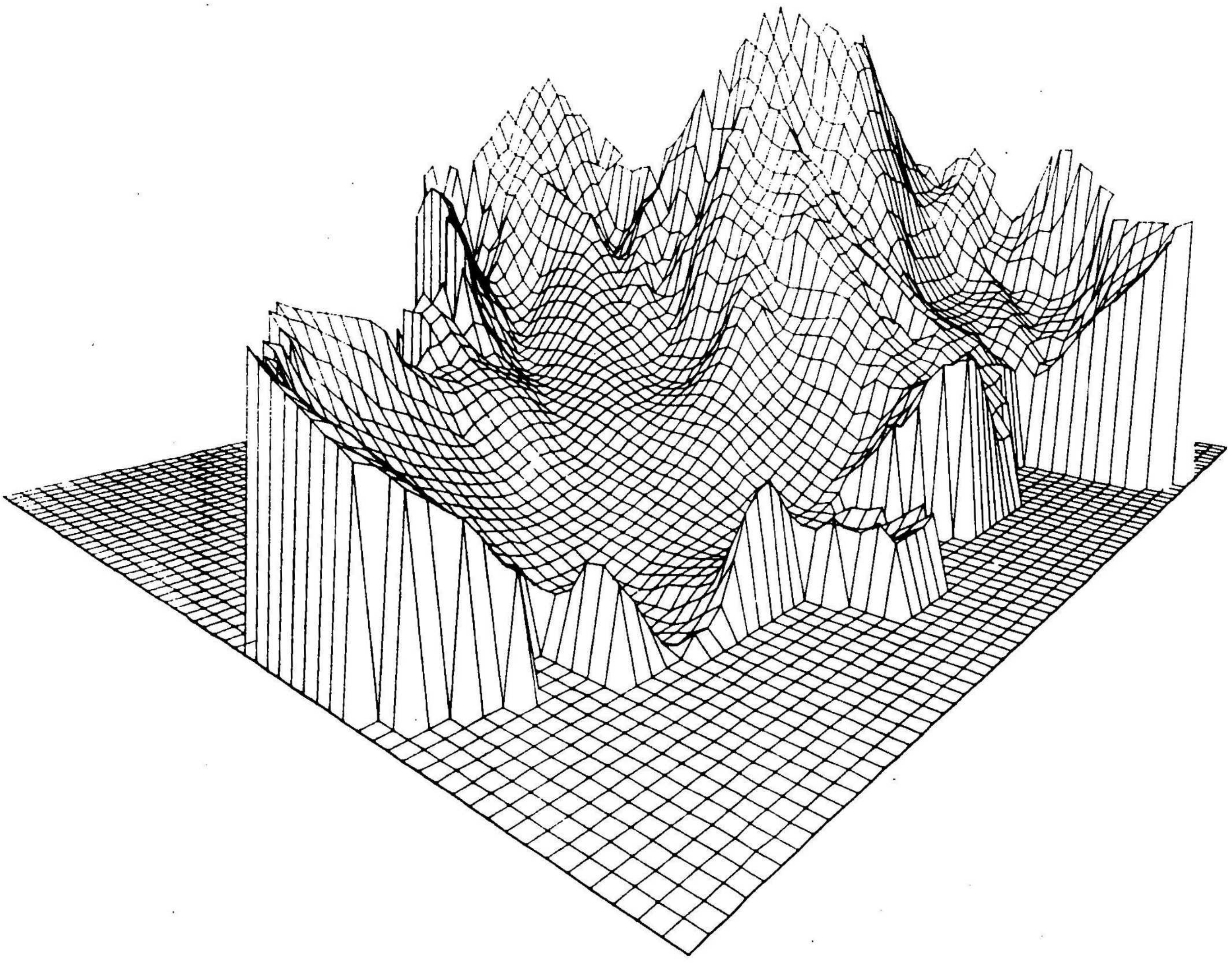


FIGURE 13 SAMPLE PERSPECTIVE VIEW LOW ANGLE

INDEX RANGE W 1 E 67 S 1 N 58		EYE AT.	-500.	-400.	300.
VERT. EXAGGERATION	2000.	LOOKING AT	500.	500.	200.

Record 1978/70

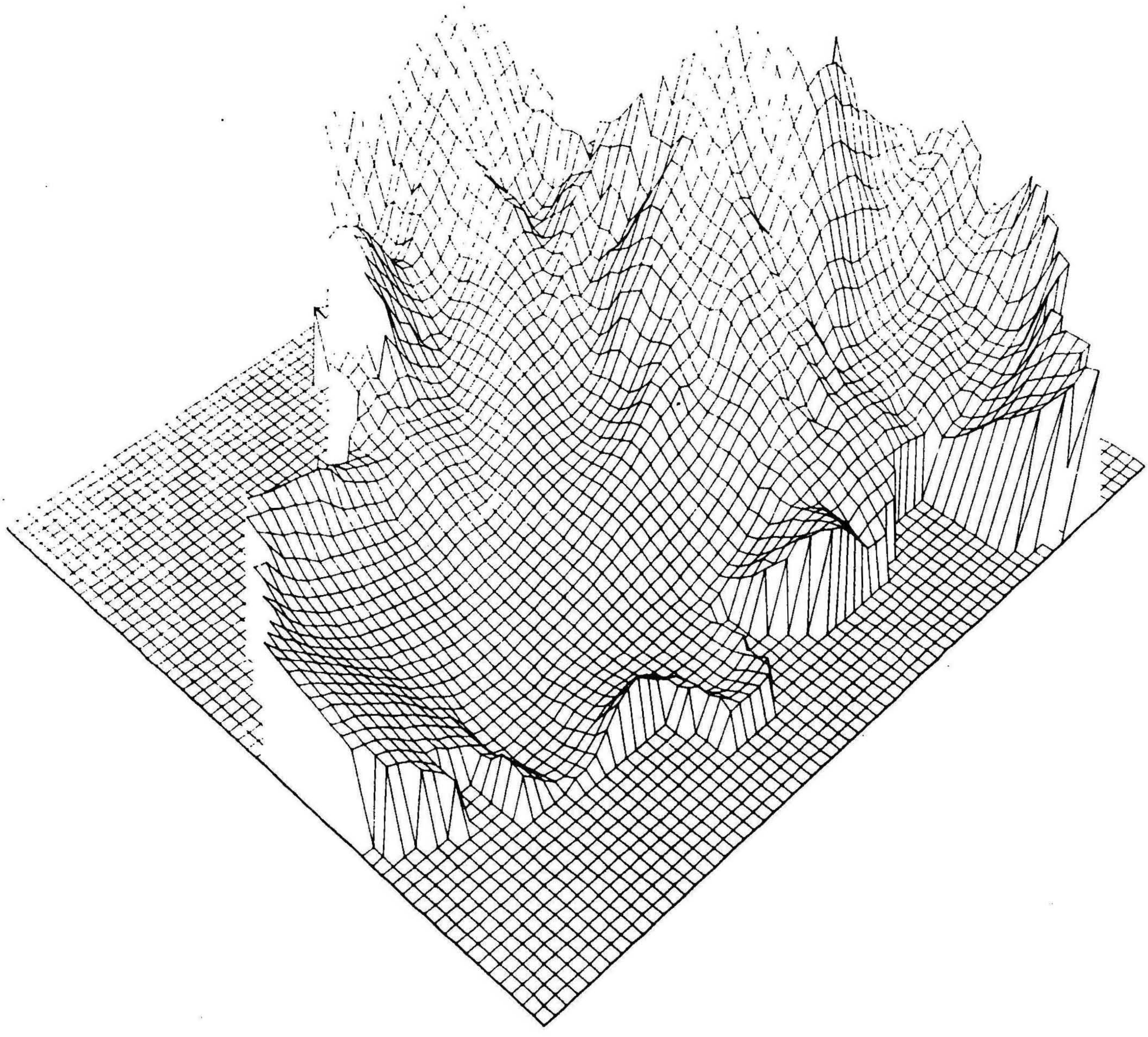


FIGURE 14 SAMPLE PERSPECTIVE VIEW STEEP ANGLE

INDEX RANGE W 1 E 67 S 1 N 58 EYE AT, -1000. -1000. 1500

VERT. EXAGGERATION 2000. LOOKING AT 500. 500. 300.

Record 1978/70

file name and if necessary the cycle number of the appropriate file e.g.
CORLEV, CY=2
specifies cycle 2 of data file CORLEV, if the cycle number is omitted the most recent cycle is referenced. The user then specifies the name of the extraction routine, e.g.
MAP
the legal extraction routine names are listed on table 6.
The program then branches to the requested extraction routine.
MAP identifies itself through the message
MAP PLOTTING ROUTINE MAPPLOT
WHICH DATA FILE IS TO BE SEARCHED (10, 20, 30, 40)?
the user replies with the appropriate number, e.g.
30
the user is then asked to specify the data type (see table 7) e.g.
Q
then MAP asks for the year for which the data were written, e.g.
1965
then the aquifer number, e.g.
2
then whether normal or logarithmic spacing is to be used.
This applies to the Small Map presentation option (see 4.2) only, e.g.
N
then the user specifies the presentation option as Small Map (S), Large Map (L), both of these (B) or writing of the special plot file for contouring or 3D plots (D). Note that only one such plotfile may be generated for each separate OUTBOX processing run. e.g. specify
B
then the user specifies the space required for fitting the output rounded to the nearest 10 characters, e.g.
60
and then to types in the actual title, e.g.
TRIAL OUTPUT MAP
finally the user returns to the main branch of OUTBOX by typing
20$

FUN identifies itself as FUNCTION OF TWO ROUTINE. The user is asked to specify the file number for the first of the two data files, e.g.
10
then the data type code, e.g.
P

then the year for which the data were written, e.g.

1960

then the same information is provided for the second data file.

The user then specifies normal or logarithmic spacing for any Small Map presentations, e.g.

L

then the space required for the output title, e.g.

70

then one of the function codes as listed in 4.2, e.g.

-

then the map title, e.g.

DRAWDOWN MAP 1960

and then returns to the main branch of OUTBOX by typing

20$

<u>DIS</u> identifies itself as ROUTINE TO CALCULATE REGIONAL OR TOTAL DISCHARGE.

The user is requested to specify the file number for the discharge data file, e.g.

30

the time step for the calculation in years and as two digits, e.g.

05

the starting year, e.g.

1950

the final year, e.g.

1970

the aquifer number, e.g.

2

the type of presentation option (S, L, or B), e.g.

S

whether the discharge is to be summed for part (region) of the basin (R) or for the entire basin (T) e.g.

R

the western limit of the region as grid index in two digits, e.g.

09

and likewise the eastern, southern, and northern limit, the space set aside for the title, e.g.

60

the actual text of the title, e.g.

TOTAL DISCHARGE 1950-1960, REGION 09/15/10/20
the user then types
20$
to return to the main branch of OUTBOX

LEA identifies itself as VERTICA LEAKAGE FLOW ROUTINE.
The user is requested to specify the number of the file which contains the hydraulic parameters, e.g.
40
then the year for which these had been stored, e.g.
1970
the file number for the potentials file, e.g.
10
the corresponding year, e.g.
1970
the aquifer number for which the leakage is required, e.g.
2
normal or logerithmic spacing for Small Maps, e.g.
N
the presentation option, e.g.
B
the space required for the title, e.g.
50
the code specifying the leakage direction, which may be U, D, +, A, e.g.
A
then the actual title, e.g.
LEAKAGE MAP 1970
and finally to return to the main branch
20$

BOU identifies itself as BOUNDARY DISCHARGE ROUTINE.
The user is requested to specify the number of the file which contains the hydraulic parameters, e.g.
40
the year for which these had been stored, e.g.
1970
the file number for the potentials data, e.g.
10

the year, e.g.

1970

the aquifer number for which the boundary discharge is required, e.g.

2

whether normal or logarithmic spacing is required on only Small Maps, e.g.

L

the presentation option code S, L, or B, e.g.

B

the space required for the title, e.g.

50

the actual text of the title, e.g.

BOUNDARY DISCHARGE 1970

and finally to return to the main branch of OUTBOX

20$

TIM identifies itself as VARIABLES VS TIME PLOT AND TABULATION. The user is requested to specify one by one for four data files the file number (00 if not to be used), e.g.

10

the data type code (table 7), e.g.

P

the aquifer number, e.g.

2

After specifying these for all four files the user then specifies the time range and step by the starting year, e.g.

1940

the final year, e.g.

1970

the time step in years as two digits, e.g.

05

the code for the presentation option as tabulation (T), quick-plot (Q), or both (B), e.g.

B

the plotting function code (see 4.2 for details), e.g.

1

then the range of gridnodes for which data are extracted by their indices as two digits, first for the western limit, e.g.

15

then likewise for east, south, and north, then the user types in the actual text of the title, e.g.
CHANGES IN POTENTIALS 1940 to 1960
which may be up to 60 characters long and then types
20$
to return control to the main branch.

Main Branch After typing 20$ the user is asked to provide the name of an extraction routine, if another one is to be run in the same processing step or to type SUBMIT, e.g.
SUBMIT
the user is then specified to provide a name for steering the generated plot file, e.g.
JB PLOT
the message
JOB SUBMITTED
then indicates that the job has been sent to the computer for actual processing.

5.2 Plotting Contour Maps and Perspective Views Using GRAPH

GRAPH operates on the plotfile which is written through using PROCCO for batch processing or OUTBOX on the interactive terminal. To operate GRAPH log into ED on the interactive terminal (Appendix A) and type
[/GRAPH/$
GRAPH identifies itself by replying
OUTPUT PLOTTING ROUTINE and requests the user to specify the section to be plotted by their grid node indices.
Through OUTBOX an entire array was extracted and stored on the plotfile. The user can select any specific portion of it or the entire array for plotting by specifying indeces, e.g. 51, 67, 40, 50, as indices for west, east, south, north. The user can then chose a perspective 3D view by typing
5$ or a contour plot by typing
10$.

Perspective 3D View The user specifies the vertical exaggeration as a multiple of 1000, e.g.

0.5

then the coordinates for the eye position, horizontal coordinates in km, vertical coordinates in m, e.g.

-1000., -1000., 400.

specifies -1000. km west, -1000. km south, 400.m up.

Data must be separated by commas as shown. Next the user specifies likewise the coordinates of the point looked at, e.g.

500., 400., 200.

and then by code whether contours are to be drawn (1) or not drawn (0), e.g.

1

Then control returns to the main branch.

Contour Plot The user specifies on the same line and separated by a comma the lower and the higher limits for contours, e.g.

0., 400.

then the contour interval, e.g.

20.

a code to indicate whether data points are to be plotted on (1) or not (0), e.g.

0

then control returns to the main branch.

Main branch On return to the main branch the user is requested to type 14$ for output on the small plotter, 15$ for the large plotter and 16$ for 35 mm film, e.g.

16$

Output on 35 mm negative is the clearest, and enlargements from it are suitable as publishable figures. Finally the user provides the name of the plotfile which was generated through OUTBOX for this purpose, e.g.

YBPLOT

and the job is sent for processing automatically.

6. NOTES ON MODEL OPERATION THROUGH BATCH PROCESSING

All major programs belonging to GABHYD are available in object code on a program library called GABLIB on the demountable magnetic disc pack reserved for the GAB project. The programs for running the model

and analysing the output are:
MANMOD for coding the manipulation file
RUNMOD for running the model
PROCCO for extracting and printing output
PLOTAR for contouring and 3D perspective views
All subroutines called by these programs are available on the same library and need not be specified separately.

To run one of these programs through batch processing the user has to set up a deck of control cards to:

attach the program library GABHYD
attach all data files required by the program
load the relevant main program
execute that program
store the program output files

For all programs, except RUNMOD, the user also has to provide the data expected through the standard input file, e.g. the coding instructions for MANMOD. To do so the user must be familiar with the programs and it is recommended that he consult the description of the GABHYD model (Seidel, 1978) for details.

Acknowledgement: The line plotter routines accessed by some of the output programs utilize the NCAR Graphics package modified for use on CSIRONET by J.F. O'Callaghan and K.G. Shields.

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Seidel G.E. Description of the GABHYD Model of the Great Artesian Basin, Bur.Miner.Resour.Aust. Rec. (in prep.)

APPENDIX A INSTRUCTIONS FOR USING THE INTERACTIVE TERMINAL

The following instructions apply to the CSIRONET interactive system based on the CDC CYBER 76 computer in Canberra and refer to the CRT console terminal by CDC with standard keyboard.

The interactive programs prescribed in this manual are what is called "Box Programs" written with the instructions available through ED, the interactive editing program of CSIRONET. Therefore the user has to connect with ED to access the interactive programs for running GABHYD.

On the terminal's keyboard there are a number of control keys which are blue instead of black. The ones of particular importance are:

CNTRL for some special commands as described below
RETURN "carriage" return without line feed
↓ line feed and carriage return
The SHIFT key corresponds in function to the upper case shift key on a type writer

To type in a line the user first types as on a type writer and then uses the ↓ (line feed) key to transmit the typed line. To remove typing errors the user may delete the last typed character by operating simultaneously the special control key CNTRL and the key for G (Bell). An audible bleep will indicate the deletion of the character. The deleted character will remain in the line as displayed but will not be transmitted. Alternatively the user may cancel the entire line before transmitting it by using the RETURN key instead of the linefeed and by typing a fresh line. Once a line has been transmitted by operating the linefeed key it cannot be recalled.

Before "logging in" the user should ensure that the system is operating by typing first CNTRL and P simultaneously and then ?. The system should reply:
NODE EST = time of day
and display a colon on the next line indicating that commands may be entered.

To log in the user must have access to the account codes for the GAB project registered with the CSIRO.

To log in type

*CYI

the computer replies

PROJECT ID ?

reply with the project code, the computer then replies

USER ID ?

enter the user code, the computer then asks

NODE?

the correct reply for transactions at the BMR is CP, then

SYSTEM?

reply with ED, then the computer replies

ED VERSION date of version

*NUL

and displays a colon indicating readiness for further commands.
From now on the user should continue as described for the individual interactive program.
If at any time the computer replies

PERMANENT FILE NOT IN SYSTEM

it is likely that one of the interactive programs needed is no longer available in system storage and should be reloaded by running program DISCO.

If at any time the session has to be terminated, e.g. because of an irrecoverable error the user can log out at any time by typing simultaneously CNTRL and P, and then T.

During the running of an interactive program the execution sequence can be restarted by typing in 1$ at any point where the user is requested to type n$, with n any number other than 1. The exception is when running OUTBOX where a re-start should be carried out by typing

[/OUTBOX/$

After an interactive program has completed normally the user can log out by typing in

Q

to which the computer will reply

SYSTEM?

the logging out is then completed by typing another

Q

Alternatively the "emergency Stop" CNTRL and P, then T may be used to log out at any time.

APPENDIX B LISTINGS OF INTERACTIVE PROGRAMS

```
BOX PROGRAM OPERA
1
?/GABHYD MODEL OPERATING SYSTEM/?/FOR RUN PREPARATION ENTER 'PREP'/2$3$
2
O@E?/ELSE ENTER 'RUN' FOR RUNNING THE MODEL/Z'0'
3
O(S/RUN/9$@=)O(S/PREP/4$@=)?/INVALID REPLY, START AGAIN/
4
C/MANMOD/S/SEI/3L6-?/STATE YOUR NAME PLEASE/I'0'10FJ5$6$7$8$
5
S/MAN,/?/TYPE IN THE NAME OF THE MANIPULATION FILE TO BE WRITTEN/I'0'
6
S/*EOP/?/TYPE IN RUNNING INSTRUCTIONS AS PER MANUAL/
7
?/FOLLOWING THE LAST INSTRUCTION (END) DEPRESS LINE FEED KEY TWICE/V/?/
8
\K/MODPRE/?/PREPARATION JOB SUBMITTED, CHECK RESULTS BEFORE RUNNING MODEL/
9
C/RUNMOD/S/SEI/3L6-?/STATE YOUR NAME PLEASE/I'0'S/POT,/10$11$12$13$14$
10
?/TYPE IN THE NAME OF THE FILE CONTAINING STARTING POTENTIALS/I'0'S/MAN,/
11
?/TYPE IN NAME OF MANIPULATION FILE TO BE USED/I'0'2FS/CAP,/
12
?/TYPE IN NAME OF POTENTIALS FILE TO BE PRODUCED/I'0'S/DIS,/
13
?/TYPE IN NAME OF DISCHARGE FILE TO BE PRODUCED/I'0'
14
\K/MODRUN/?/MODEL RUN SUBMITTED/
```

CONTROL CARDS PROGRAM MANMOD

```
MANMOD,YL1,YU1,T200.
COMMENT.      SEIDEL                    EXT462 GAB
MOUNT,VSN=C020,SN=DMR5341.
ATTACH,GAB,GABLIB,ID=DMRXWC,SN=DMR5341.
ATTACH,ARTCA1,ARTCA1,ID=DMRXWC,SN=DMR5341.
ATTACH,SUBCA1,SUBCA1,ID=DMRXWC,SN=DMR5341.
ATTACH,ARTCA2,ARTCA2,ID=DMRXWC,SN=DMR5341.
ATTACH,COL,CORLEV,ID=DMRXWC,SN=DMR5341.
ATTACH,POT,RUNPOT,ID=DMRXWC,SN=DMR5341.
ATTACH,ODIS,RUNDIS,ID=DMRXWC,SN=DMR5341.
REQUEST,MAN,*PF,SN=DMR5341.
REQUEST,DIS,*PF,SN=DMR5341.
LIBRARY,*,GAB,*.
LIBLOAD,GAB,MANMOD.
EXECUTE,MANMOD.
CATALOG,MAN,,ID=DMRXWC.
EXIT,U.
RETURN,GAB,ARTCA1,SUBCA1,ARTCA2,COL,POT,ODIS,MAN,DIS.
EXIT,S.
RETURN,GAB,ARTCA1,SUBCA1,ARTCA2,COL,POT,ODIS,MAN,DIS.
```

CONTROL CARDS PROGRAM RUNMOD

```
RUNMOD,YL1,YU1,T400,P1000.
COMMENT.     SEIDEL                EXT460 GAB
MOUNT,VSN=C020,SN=DMR5341.
ATTACH,GAB,GABLIB,ID=DMRXWC,SN=DMR5341.
ATTACH,GEO,MODGEO,ID=DMRXWC,SN=DMR5341.
ATTACH,HYD,MODHYD,ID=DMRXWC,SN=DMR5341.
ATTACH,POT,,ID=DMRXWC,SN=DMR5341.
ATTACH,MAN,,ID=DMRXWC,SN=DMR5341.
REQUEST,DIS,*PF,SN=DMR5341.
REQUEST,CAP,*PF,SN=DMR5341.
LIBRARY,*,GAB,*.
LIBLOAD,GAB,RUNMOD.
EXECUTE,RUNMOD.
EXIT,U.
CATALOG,CAP,,ID=DMRXWC.
CATALOG,DIS,,ID=DMRXWC.
EXIT,U.
RETURN,GAB,GEO,HYD,POT,MAN,DIS,CAP.
EXIT,S.
RETURN,GAB,GEO,HYD,POT,MAN,DIS,CAP.
```

BOX PROGRAM OUTBOX

```
1
C/OUTSYS/2$3$4$5$7$8$9$10$11$12$13$14$
2
?/PLEASE SUPPLY ON LINE BELOW NAME (AND CYCLE NO.) OF DATA FILE 10/
3
S/TEN,/I'0'?/NAME OF DATA FILE 20/S/TWE,/I'0'2H//
4
?/NAME OF DATA FILE 30/S/THI,/I'0'3H//
5
?/NAME OF DATA FILE 40/S/FOU,/I'0'4H//
6
?/TYPE IN NAME OF OUTPUT ROUTINE FOR NEXT STEP OR SUBMIT/8$9$10$11$12$13$1
7
?/SELECT OUTPUT OPTION AND TYPE IN NAME OF APPROPRIATE ROUTINE/
8
OS/*EOP/Z'0'J(1'S/SUB/16$@=)OS/*EOP/
9
FJ(1'S/MAP/[/MAPBOX/$@=)OS/*EOP/
10
FJ(1'S/FUN/[/FUNBOX/$@=)OS/*EOP/
11
FJ(1'S/LEA/[/LEABOX/$@=)OS/*EOP/
12
FJ(1'S/BOU/[/BOUBOX/$@=)OS/*EOP/
13
FJ(1'S/DIS/[/DISBOX/$@=)OS/*EOP/
14
FJ(1'S/TIM/[/TIMBOX/$@=)15$6$
15
OS/*EOP/FE?/OK SMART GUY, LET US TRY AGAIN/
16
E?/TYPE NAME FOR PLOTFILE/O1OFS/PLO,/I'0'\K/OUT/?/JOB SUBMITTED/
```

BOX PROGRAM MAP

```
1
?/MAP PLOTTING ROUTINE MAPPLOT/E2BS/*EOP/?/O/2$3$4$5$6$7$8$17$
2
?/WHICH DATA FILE IS TO BE SEARCHED (10,20..) ?/Z'0'J
3
?/WHAT IS THE TYPE OF DATA (E.G. F OR Q) ?/10RI'0'J
4
?/FOR WHICH YEAR HAD THEY BEEN STORED ?/14RI'0'J
5
?/WHAT IS THE AQUIFER NO. ?/23RI'0'J
6
?/NORMAL OR LOG. SPACING (N OR L) ?/28RI'0'J
7
?/SMALL (S) MAP, LARGE (L) MAP, OR 3D PLOT (D) ?/30RI'0'J
8
?/LENGTH OF MAPTITLE IN CHARACTERS/33RI'0'J
17
?/TYPE IN THE MAP TITLE/Z'0'J?/TYPE 20$ TO CONTINUE/
20
[/OUTBOX/6$
```

BOX PROGRAM FUN

```
1
?/FUNCTION OF TWO ROUTINE/E20S/*EOP/Z/F/2$3$4$5$6$7$8$17$18$
2
?/FOR FIRST DATA FILE SPECIFY:/?/NUMBER OF FILE (10,20..)/Z'0'J
3
?/DATA TYPE CODE ?/10RI'0'J?/YEAR ?/14RI'0'J?/AQUIFER NO.?/23RI'0'J
4
?/FOR SECOND DATA FILE:/?/NUMBER OF FILE ?/4RI'0'2-J
5
?/DATA TYPE CODE ?/12RI'0'-J?/YEAR ?/18RI'0'4-J?/AQUIFER NO.?/25RI'0'J
6
?/NORMAL OR LOG. SPACING (N OR L) ?/28RI'0'J
7
?/SMALL (S), LARGE (L) MAP, OR 3D PLOT (D) ?/30RI'0'J
8
?/MAP TITLE LENGTH IN CHARACTERS/33RI'0'J?/SPECIFY FUNCTIONAL RELATION/
17
?!VALID CODES ARE:+,-,*,/,A,M,P,E!35RI'0'J
18
?/TYPE IN MAP TITLE/Z'0'?/TYPE 20$ TO CONTINUE/
20
17H//18H//(/OUTBOX/6$
```

BOX PROGRAM LEA

```
1
?/VERTICAL LEAKAGE FLOW ROUTINE/E20S/*EOP/Z/L/2$3$4$5$6$7$8$
2
?/FOR HYDR.PARAMETERS SPECIFY FILE NO.(10,20...)/Z'0'J?/YEAR/14RI'0'J
3
?/FOR POTENTIALS SPECIFY FILE NO./4RI'0'2-J?/YEAR/18RI'0'J
4
?/AQUIFER NO.?/23RI'0'J?/NORMAL OR LOGARITHMIC SPACING (N OR L) ?/
5
28RI'0'J?/SMALL (S) OR LARGE (L) MAP ?/30RI'0'J
6
?/MAP TITLE LENGTH IN CHARACTERS ?/33RI'0'J
7
?/LEAKAGE UP (U),DOWN (D),BALANCE (+),OR ALL (A) ?/35RI'0'J
8
?/TYPE IN MAP TITLE/Z'0'?/TYPE 20$ TO CONTINUE/
20
(/OUTBOX/6$
```

```
BOX PROGRAM BOU

1
?/BOUNDARY DISCHARGE ROUTINE/E285/*EOP/Z/8/2$3$4$5$6$7$
2
?/FOR HYDR. PARAMETERS SPECIFY FILE NO.(10,20...)/Z'0'J?/YEAR/14RI'0'J
3
?/FOR POTENTIALS SPECIFY FILE NO./4RI'0'2-J?/YEAR/18RI'0'J
4
?/AQUIFER NO.?/23RI'0'J?/NORMAL OR LOG. SPACING (N OR L) ?/
5
28RI'0'J?/SMALL (S) OR LARGE (L) MAP ?/30RI'0'J
6
?/MAP TITLE LENGTH IN CHARACTERS ?/33RI'0'J
7
?/TYPE IN MAP TITLE/Z'0'?/TYPE 20$ TO CONTINUE/
20
I/OUTBOX/6$

BOX PROGRAM DIS

1
?/ROUTINE TO CALCULATE REGIONAL OR TOTAL DISCHARGE/E285/*EOP/Z/S/2$3$4$5$6
$7$8$17$
2
Z/  /J?/DATA FILE NO. (10,20..) ?/4RI'0'J?/TIME STEP (YEARS) IN 2 DIGITS/
3
8RI'0'J?/STARTING YEAR ?/14RI'0'J?/ENDING YEAR ?/18RI'0'J
4
?/AQUIFER NO./23RI'0'J28RI/N/J?/SMALL (S) OR LARGE (L) MAP ?/
5
30RI'0'J?/DISCHARGE FOR REGION (R) OR TOTAL AREA (T)/35RI'0'J
6
?/SPECIFY LIMITS OF REGION OR AREA BY NODE INDICES (E.G.03 OR 58)/
7
?/WESTERN LIMIT ?/38RI'0'J?/EASTERN ?/42RI'0'J?/SOUTHERN ?/46RI'0'J
8
?/NORTHERN ?/50RI'0'J?/LENGTH OF TITLE IN CHARACTERS ?/33RI'0'2-J
17
?/TYPE IN MAP TITLE/Z'0'?/TYPE 20$ TO CONTINUE/
20
I/OUTBOX/6$
```

BOX PROGRAM TIM

```
1
?/VARIABLES VS TIME PLOT AND TABULATION/E20S/*EOP/Z/T/2$3$4$5$6$7$8$19$
2
?/UP TO FOUR DATA FILES MAY BE USED, FILES NUMBERED 00 ARE IGNORED/
3
?/FOR FIRST DATA FILE SPECIFY FILE NO./Z'0'J?/DATA TYPE/10RI'0'J
4
?/AQUIFER NO./23RI'0'J?/SECOND FILE NO./4RI'0'2-J?/DATA TYPE/12RI'0'-J
5
?/AQUIFER NO./25RI'0'-J?/THIRD FILE NO./2RI'0'2-J?/DATA TYPE/11RI'0'-J
6
?/AQUIFER NO./24RI'0'-J?/FOURTH FILE NO./6RI'0'2-J?/DATA TYPE/13RI'0'-J
7
?/AQUIFER NO./26RI'0'-J?/TIME INTERVAL FROM YEAR/14RI'0'4-J?/TO ?/18RI
'0'4-J
8
?/TIME STEP IN YEARS (2 DIGITS) ?/6RI'0'2-J
19
L/TIMBOA/$
1
?/OUTPUT AS TABLE (T), QUICKPLOT (Q), OR BOTH (B) ?/2$3$4$5$6$
2
30RI'0'J32RI/06/J?/FUNCTION CODE ? (CONSULT TABLE)/35RI'0'J
3
?/VARIABLES AVERAGED OVER A REGION BOUNDED BY/
4
?/WESTERN LIMIT NODE INDEX (2 DIGITS)/38RI'0'J?/EASTERN ?/42RI'0'J
5
?/SOUTHERN ?/46RI'0'J?/NORTHERN ?/50RI'0'J
6
?/TYPE IN TITLE/Z'0'?/TYPE 20S TO CONTINUE/
20
L/OUTBOX/6$
```

CONTROL CARDS PROGRAM OUTSYS

```
OUTJOB,YL1,YD1,T200.
COMMENT.   GAB (SEIDEL EXT460)
MOUNT,VSN=C020,SN=DMR5341.
ATTACH,GAB,GABLIB,ID=DMRXWC,SN=DMR5341.
ATTACH,GEO,CALGEO,ID=DMRXWC,SN=DMR5341.
REQUEST,PLO,*PF.
ATTACH,TEN,,ID=DMRXWC,SN=DMR5341.
ATTACH,TWE,,ID=DMRXWC,SN=DMR5341.
ATTACH,THI,,ID=DMRXWC,SN=DMR5341.
ATTACH,FOU,,ID=DMRXWC,SN=DMR5341.
DISPOSE,OUTPUT,ST=RIOCP,*PR.
LIBRARY,*,GAB,*.
LIBLOAD,GAB,PROCCO.
EXECUTE,PROCCO.
CATALOG,PLO,,ID=DMRXWC,RP=3.
EXIT,U.
RETURN,GAB,GEO,TEN,TWE,THI,FOU.
```

BOX PROGRAM GRAPH

```
1
C/PLOTAR/?/ROUTINE FOR PLOTTER OUTPUT/S/*EOP/2$3$4$
2
?/SPECIFY LIMITS OF SECTION TO BE PLOTTED BY INDICES IN ORDER/
3
?/WEST, EAST, SOUTH, NORTH (E.G. 1,67,1,58)/Z'0'J
4
?/TYPE 5$ FOR A 3D, 10$ FOR A CONTOUR PLOT/
5
OS/*EOP/Z/3D/F?/SPECIFY VERT. EXAGGERATION AS MULTIPLE OF 1000/6$7$8$
9$13$
6
Z/25,25,/J6R1'0'J?/SPECIFY LOCATION OF EYE RELATIVE TO OBJECT/
7
?/E.G.-900.,-600.,500. FOR X,Y,Z/Z'0'
8
?/COORDINATES OF POINT IN OBJECT LOOKED AT/Z'0'
9
?/CODE FOR CONTOURS DRAWN (1) OR NOT DRAWN (0)/Z'0'
10
OS/*EOP/Z/CO/F?/LOW AND HIGH LIMITS FOR CONTOURS ?/Z'0'11$12$13$
11
?/SPECIFY CONTOUR INTERVAL/Z'0'?/TYPE CODE 1 IF DATA POINTS ARE/
12
?/TO BE PLOTTED, CODE 0 IF NOT/Z'0'
13
?/TYPE 14$ FOR OUTPUT ON SMALL, 15$ FOR LARGE PLOTTER, OR 16$ FOR 35MM
 FILM/
14
?/TYPE IN NAME OF PLOTFILE/OS/PLO,/I'0'\K/PLO/?/JOB SUBMITTED/
15
S/*EOS/F6EOS/DISP/JZ/DISPOSE,TAPE1,*PK./JBE14$
16
S/*EOS/F14EOS/PLOTK/2EBZ/ATTACH,COMTRAN./Z/COMTRAN./17$14$
17
S/DISP/Z/DISPOSE,TAPE1,*FL=C3S,ST=COMCP./JBE
```

PROGRAM PLOTAR

```
      PLOTAR,T37,P300.
      COMMENT.    SPIDEL FXT460
      ATTACH,B,NCARUTILITIES.
      ATTACH,C,NCARSMOOTH.
      ATTACH,E,NCARSPF.
      ATTACH,TAPE4,FWRXDATAD.
      ATTACH,PLO,,ID=DMRXWC.
      LIBRARY,B,C,E.
      FTN,SL,A.
      LGO.
      ATTACH,PLOTRAN.
      PLOTRAN.
      DISPOSE,TAPE1,*PM.

      PROGRAM PLOTAR(INPUT,OUTPUT,TAPE1,TAPE2,TAPE8,TAPE4,
     1TAPE6=OUTPUT,TAPE10=INPUT,PLO,TAPE11=PLO)
      DIMENSION X(100),Y(100),Z(90,90),M(2,90,90),S(6),TP(10),
     1A(90,90),TA(4),TB(4),TC(4),TD(4)
      COMMON/LEV/Z
      COMMON/SRFACE/IFR,ISTP,IROTS,IDRX,IDRY,IDRZ,IUPPER,ISKIRT,
     1NCLA,THETA,HSKIRT,CHI,CLO,CINC
      LEVEL 2,Z
      READ(10,90) SELCO
      DO 2 N=1,4
      TA(N)=TB(N)=TC(N)=TD(N)=10H
    2 CONTINUE
      IDRZ=1
      ISKIRT=1
      NCLA=10
   90 FORMAT(A2)
C READ ARRAY DIMENSIONS,TITLE AND ARRAY
      READ(11,91) LY,LX
   91 FORMAT(11X,2I3)
      READ(11,92) (TP(I),I=1,10)
   92 FORMAT(10A10)
      DO 100 I=1,LX
      READ(11,93) (Z(I,K),K=1,LY)
   93 FORMAT(10E11.5)
  100 CONTINUE
C READ INDEX RANGES TO BE PLOTTED
      READ(10,*) NXA,NXZ,NYA,NYZ
      ENCODE(35,9000,IA) NXA,NXZ,NYA,NYZ
 9000 FORMAT(14HINDEX RANGE W:,I3,3H E:,I3,3H S:,I3,3H N:,I3)
C READ COORDINATE INTERVALS AND VERTICAL SCALING FACTORS
      IF(SELCO.EQ.2H3D) READ(10,*) DX,DY,DV
C READ LINE OF SIGHT COORDINATES
      IF(SELCO.EQ.2H3D) READ(10,*) S(1),S(2),S(3)
      IF(SELCO.EQ.2H3D) READ(10,*) S(4),S(5),S(6)
      IF(SELCO.EQ.2H3D) READ(10,*) IDRZ
C READ HIGH AND LOW LIMITS FOR CONTOUR OR HALFTONE
      IF(SELCO.EQ.2H3D) GO TO 10
```

```
      READ(10,*) FLO,HT
   10 CONTINUE
C READ OTHER SPECIAL PARAMETERS FOR CONREC OR HAFTON
      IF(SELCO.NE.2HCO) GO TO 11
      READ(10,*) FINC
      READ(10,*) NHI
      NDOT=NSET=0
   11 CONTINUE
      IF(SELCO.NE.2HHA) GO TO 12
      READ(10,*) NLEV
      READ(10,*) NOPT,NPRM
      ISPV=1
      SPVAL=-9999.
   12 CONTINUE
C SCALE AXES AND LINE OF SIGHT
      IF(SELCO.NE.2HSO) GO TO 101
      DO 102 I=NXA,NXZ
      IX=I-NXA+1
  102 X(IX)=I*DX
      DO 103 K=NYA,NYZ
      KY=K-NYA+1
  103 Y(KY)=K*DY
      ENCODE(32,9001,TB) S(1),S(2),S(3)
 9001 FORMAT(8HEYE AT:,3X,3F7.0)
      ENCODE(32,9002,TC) S(4),S(5),S(6)
 9002 FORMAT(11HLOOKING AT:,3F7.0)
      DDV=1000.*DV
      ENCODE(32,9003,TD)DDV
 9003 FORMAT(18HVERT. EXAGGERATION,2X,F10.0,2X)
      S(3)=S(3)*DV
      S(6)=S(6)*DV
  101 CONTINUE
C ASSIGN PLOT ARRAY
      NN=0
      DO 104 K=NYA,NYZ
      DO 104 I=NXA,NXZ
      NN=NN+1
      A(NN)=Z(I,K)
      IF(SELCO.EQ.2H3D.AND.A(NN).EQ.-9999.) A(NN)=0.
      IF(SELCO.EQ.2H3D) A(NN)=A(NN)*DV
  104 CONTINUE
      MX=NX=NXZ-NXA+1
      NY=NYZ-NYA+1
      WRITE(6,900) (TP(I),I=1,10)
  900 FORMAT(1X,10A10)
      CALL LINE(0,0,1024,0)
      CALL LINE(1024,0,1024,150)
      CALL LINE(1024,150,0,150)
      CALL LINE(0,150,0,0)
      CALL PWRX(50,110,TP,50,0.7,0,2)
      CALL PWRX(50,70,TA,40,0.5,0,2)
      CALL PWRX(50,40,TD,40,0.5,0,2)
      CALL PWRX(520,70,TB,40,0.5,0,2)
```

```
      CALL PWRX(520,40,TC,40,0.5,0,0)
      CALL FRAME
      IF(SELCO.NE.2HSF) GO TO 105
      CALL SRFACE(X,Y,A,M,MX,NA,NY,S,0.)
  105 CONTINUE
      IF(SELCO.NE.2HCO) GO TO 106
      CALL CONREC(A,MX,NA,NY,FLO,HI,FINC,NSET,NHI,NDOT)
  106 CONTINUE
      IF(SELCO.NE.2HHA) GO TO 107
      CALL HAFTON(A,MX,NA,NY,FLO,HI,NLEV,NOPT,NPRM,ISPV,SPVAL)
  107 CONTINUE
      CALL FRAME
      CALL PWRT(50,500,10HEND PLOT  ,10,5,0,1)
      CALL FRAME
      END

VUPORT=0/25/0/30
SUBPORT=0/25/0/5
SUBPORT=0/25/5/30
CHTYP=4
SCALE=L

DEV=LMETRIC
FRAMES=1/1
EXEC
VUPORT=0/70/0/73.4
ROTAT=90
SCALE=L
FRAMES=2/3

VUPORT=2000/12000/2000/14000
SUBPORT=2000/12000/2000/4000
SUBPORT=2000/12000/4000/14000
SCALE=L
CHTYP=4
TRANS=-1
```

APPENDIX C NAMING CONVENTIONS FOR DATA FILES

1. Model Parameter Files

These files are attached to the model automatically and are the result of the latest model calibration.

MODGEO	model geometry codes
MODHYD	model hydraulic parameters (vertical permeabilities, storativities, directional transmissivities)
CORLEV	groundelevation/temperature corrections (metres)
CALTHI	aquifer thickness

2. Recorded Data Files

These data were obtained from the records directly, i.e. without processing through the model. Where several recorded data items were available for the same gridnode they were averaged.

VSN7310, Label $POTINTS$ magnetic tape. Recorded potentials 1880-1970

VSN6171, Label $RUNDIS$ magnetic tape. Recorded well discharges 1880-1970

HIDI00	recorded discharges	1880-1900
HIDI20	recorded discharges	1900-1920
HIDI40	recorded discharges	1920-1940
HIDI60	recorded discharges	1940-1960
HIDI70	recorded discharges	1960-1970

Whenever possible the smallest data file containing the required data should be used to reduce the data search time.

3. Interpolated Data Files - Model Starting Conditions

In many areas, in particular where the model geometry is coarse in relation to the aquifer geometry a significant difference was observed between the actually recorded potentials and the closest potentials consistent with hydraulic continuity within the model. These differences were recorded as an additive correction in file RECCOR. The interpolated data files were obtained by

- reading the recorded potentials
- subtracting RECCOR to produce "aquifer potentials"
- interpolating potentials by model where none are recorded

When model generated potentials are compared to recorded values the corrections from RECCOR should be added to the model potentials or subtracted from the recorded potentials.

START	steady state potentials 1880
STAR00	interpolated (starting condition) potentials 1880-1900
STAR20	interpolated potentials 1900-1920
STAR40	interpolated potentials 1920-1940
STAR60	interpolated potentials 1940-1960
STAR70	interpolated potentials 1960-1970
RECCOR	additive correction recorded - model potentials 1970
RUNDIS	copy of HIDI70
RUNPOT	copy of STAR70

4. <u>Extrapolation Data Files</u>

EXP00	potentials extrapolated by model 1970-2000
EXD00	discharges extrapolated by model 1970-2000

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