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INSTITUTE of
HYDROLOGY

Groundwater

Data System

Users Manual

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2 GENERAL

This section deals with some items which the user should be aware of or may find helpful when operating the system.

2.1 'GENESIS'

has to be used to set up the necessary files before the data system can be first used.   See Appendix A.

2.2 'DATABASE'

is used to start the groundwater data presentation system.

2.3 The station name

defines the point at which the associated data were collected. As the system is hydrogeologically orientated the station would normally be a borehole but does not have to be; for instance it may be a place where rainfall is measured.

The name may be any combination of letters and numbers provided that it is:

(i)   unique for the data system
(ii)   no longer than 8 characters

If the station is being mentioned for the first time on the data system you will be informed and asked to confirm the name.

2.4 The grid reference

used to locate the station is assumed to be based on a Universal Transverse Mercator (UTM) grid and not latitude and longitude. The origin is assumed to be in the bottom left for the northern hemisphere and in the top right for the southern hemisphere.

If a false origin grid is used south of the equator i.e. the origin is the bottom left then when plotting maps do not say that the area is in the southern hemisphere.

2.5 The datum

specified is the one which is used in the measurement of water levels.

If for any reason the datum is changed when the new value is entered the

editor will ask if you want the water level data changed and the data
system will update the readings automatically if you do. This is because
if the datum has been altered physically then rather than have two sets of
water level measurements the original ones will be adjusted by the
difference in the two datums to create a single uniform data set.

The depths in the construction details are normally relative to a ground
level datum.

2.6 The units

used in the data system are metric and are normally specified
at the time of input or editing. In general lengths are in metres or
millimetres, discharge in metre cube per day, temperature in degrees
Celsius and chemical concentrations in milligrams per litre. Because it is
temperature dependent electrical conductivity is assumed to be corrected to
25 deg C.

The date is entered in the form dayday-monthmonth-yearyear $[DDMMYY]$ e.g.
1st January 1986 becomes 010186.

2.7 Square brackets $[\ ]$

are used when data have to be added or for the
answer to a question. These brackets indicate the width of the answer and
any characters lying outside them will be ignored.

2.8 Prompting questions

are used extensively and normally require a Yes 'Y'
or No 'N' answer which may be given in either upper or lower case.

2.9 Default answers

are sometimes supplied within the square brackets and
if the operator wishes to use them it is only necessary to press RETURN .

2.10 The final option on all the menus

is 'Return to a higher menu' and it
is only necessary to press <RETURN> to select the option.

2.11 Classes

are fully dealt with in Section 4 of this Manual.

2.12 A password

may be used to limit the number of people who have access to the data system; this may be especially useful if the computer is shared. The password, which can be added or altered, consists of up to 8 characters.

2.13 Permissions

can be assigned to operators to one of three levels:

(i)   output only

(ii)   output and input

(iii) output, input and edit.

If no permissions are used it is assumed that any person using the system can have access to the whole system.

Permission level (iii) allows those named to have access to the whole system and to add or delete other permissions.

Permission level (ii) allows those named to input or output data but the editing facility is blocked to them. They can give permission for people to input data but not edit it.

The lowest permission level only allows operators to output the data already on the system. All other facilities are blocked.

2.14 If graphics

are being displayed on a terminal then once the output has been finished the system will pause until <RETURN> has been pressed.

2.15 The box

displayed around the screen when using the system shows the version number in the bottom left and the serial number in the bottom right.

These numbers should always be quoted when contacting the Institute of Hydrology.

When operating the data system the words INPUT, EDITOR or OUTPUT appear in the top left corner of the box when appropriate to remind the user of the current operation.

2.16 A pack

is used internally by the data system to make the storage of date more efficient. The system is self checking and when a pack is required the message displayed on the screen is:

'Please wait while the data files are packed'

The operation may take several minutes and has been known to take at least 15 minutes so please be patient.

**** WARNING *****

If the computer is reset or turned off during
packing the data files will be destroyed.

I   THE MAIN MENUS

There are four main menus:

- (i)   the starting menu
- (ii)   input menu (which is divided into field data and laboratory data)
- (iii)   edit menu
- (iv)   output menu

3.1   THE STARTING MENU

On entering the data system by typing <DATABASE> the screen displays the starting menu of ten options.

3.1.1   Input field data

These data types are those which can be measured directly in the field such as pumping tests but also includes input from computer files - see Section 3.2

3.1.2   Input lab data and analysis results

These four data types produce data which are derived from non field measurements such as grain size - see Section 3.3

3.1.3   Edit data

This option allows the operator to use the editing facilities - see Section 3.4

3.1.4   Analyse and output

This option displays the main output menu - see Section 3.5

3.1.5   List stations

This displays on the screen, in groups of 84, the names of all the stations on the data system in the order they were put on. If there are more than 84 pressing RETURN allows a further page of 84 names to be viewed.

3.1.6 Change the password

As described in Section 2.12 it is possible to have a password to limit
access to the data system. This option allows anyone to
change the password or to introduce one. The password is up to five
characters.

3.1.7 Change permissions

In Section 2.13 the three levels of permission were described and this
option allows any operator to change, delete or add permissions up to
the same level as him or herself. A total of 10 permissions are
possible in each of the higher two levels.

3.1.8 Print the last operations log

This option is used mainly in the event of errors and lists the
operations last carried out. This file automatically written to and
from the programs. Please see Appendix F which deals with errors.

3.1.9 Back up or restore the data files

This is used for either making a copy of the data onto a floppy disc or
for allowing a different data system to be reloaded from a floppy disc
into the computer for further operations.
There are a series of questions to guide the user through the procedure.

> 'Do you want to back up the data files? Y/N'
> 'Yes' indicates that you want to save the data files on to a
> floppy disc and
> 'No' is used for reloading an existing data system.

***** WARNING *****

if the reload option is used the data files
already on the computer are destroyed

The operator is then asked to insert the floppy disc and press <RETURN>
when ready. The option may be cancelled at this point by entering the
letter C.

***** WARNING *****

if the back up option is used any files
on the floppy disc will be destroyed

The computer will then request the floppy disc drive and the disc capacity. It may be that all the data may not fit onto a single disc in which case you will be asked to insert another disc.

***** WARNING *****

if the data files extend onto more than one disc then
when they are being restored the discs must be read
in the same order

3.2 THE FIELD INPUT MENU

Before the menu appears the user is asked if they want to input from file. The file is a computer file which contains data in a suitable format for adding to the data system. The data can originate from field instruments such as data loggers or other computers; details of the file formats are given in Appendix III.

The user is also asked if they want to add classes - see Section 4.

The menu displays 11 options which are data types and the return to higher menu option.

3.3 THE LAB INPUT MENU

The menu displays the four data types major ion chemistry, isotopes, grain size and laboratory rock properties, and the return option.

3.4 THE EDIT MENU

In addition to the 14 main data types and the return option the editor menu has 5 other options.

3.4.1 Add or change classes

The classes referred to are the physiographic area, geology, aquifer, data source, lithological terms and geophysical logs. The first four classes are fully dealt with in Section 4.

3.4.2 Remove a station

This is option 16 and is for the complete removal of a station. The user is asked to enter the name of the station to be removed.

3.4.3 Delete all the data

Option 17 enables the user to delete all the data and stations but still retain the classes and other default values.

3.4.4 Delete a sample

Option 18 allows the user to remove a sample from certain data types. The data system askes for the data type from the choice of field chemistry, chemical laboratory analysis, isotope and grain size. The user then specifies station number and then the sample number to be deleted.

3.4.5 Output

Option 19 allows the user to transfer directly from the editor to the output menu without going through the starting menu.

3.5 THE OUTPUT MENU

The output menu is divided into 13 data types and another three options, one of which is return to the starting menu.

3.5.1 Data summary

This option allows the user to produce a summary of the data available for the seleacted stations. The output is in the form of a table with the data types listed across the top; the stations are listed vertically with a star in the appropriate column if at least one piece of that data is on the system.

3.5.2

Option 15 allows the user to move directly to the editor without having
to go through the starting menu.

4. CLASSES AND STATION SELECTION

4.1 CLASSES

One of the main features of the data system is the ability to assign classes to the stations. There are four classes:

Physiographic area

Geological formation

Aquifer

Data source

The first three can have up to 20 user defined sub-classes and data source can have up to 10 sub-classes.
While it is possible to add classes and sub-classes to the data system at any stage it is not possible to delete them; however the user may redefine the sub-classes. For example if 10 aquifer sub-classes have been defined then that data system will alwayus have at least 10 aquifer sub-classes although the names may be altered.

4.1.1 Physiographic area

This class was designed so that the study area or the area covered by the data system could be divided into a maximum of twenty smaller units such as surface water catchments. Each station can then be assigned one sub-class as it is only possible for a station to lie within a single area.

4.1.2 Geological formation

As a hydrogeological data system the geology and in particular the aquifers are of importance. The geological formation class can have up to twenty formation names and each station can be assigned a maximum of five of them.

4.1.3 Aquifer

The aquifer class is similar to the geological formations in that each station can be assigned up to five of the possible twenty sub-classes.

4.1.4 Data source

The data sources referred to in this class can be anything that the user wishes, for example the method of drilling or the type of well such as hand dug or cored. The class has a maximum of ten sub-classes and it is only possible for each station to belong to a single data source sub-class.

4.1.5 Adding classes

When the data system is being initialised using GENESIS the user will be asked if they wish to define the classes, the user will be also asked when entering the main field menu if none have been previously defined. The user may add a class or classes or define or redefine sub-classes at any time using the editing facility.
The process of adding or defining a class is straight forward with the user being guided by a series of simple questions as to which class to add or whether to add, alter or abandon sub-classes.

Whenever an output is requested the user is given the choice of which stations are required.
The first choice is by manual entry or automatic search.

4.2 MANUAL STATION SELECTION

The user is invited to enter the station name for as many stations as required and a blank entry is used to finish input. If a name is entered and the station is not on the data system the user will be told and then able to continue; similarly if the named station does not have the particular data type being requested a message to that effect will be displayed and then entry may continue.
This method of selection can be tedious if a large number of stations are needed and the user should think carefully as to whether full use is being made of the classes or geographic search facility.

4.3 AUTOMATIC STATIONS SELECTION

The user is given another menu which lists the four classes, geographic location and completion of search.

4.3.1 Search by class

When using a class search the procedure is the same for each class.

The sub-classes are displayed and the user asked which one is required; and then whether an inclusive search is required.

Answering 'yes' gives an inclusive search which will only accept those stations which have the requested sub-class.

Answering 'no' will reject those in the sub-class.

A maximum of 5 sub-classes in each class may be chosen.

4.3.2 Search by geographic location

It is possible to use one of four types of geographic search possible on the data system. The stations selected are those which fall within the selected criteria.

4.3.2.1 Quadrilateral area

The user is asked for the co-ordinates of the four corners of a quadrilateral in sequence. This means that the user may start at any corner and go in either direction but must continue in that direction to each corner in turn.

4.3.2.2 Given radius

The user is asked to give the co-ordinates of the centre of a circle and also its radius, in the same units as the co-ordinate system.

4.3.2.3 Profile

This allows the user to select those stations which fall either on, or within a specified distance of, a straight line. The user is asked for the co-ordinates of each end of the line and the maximum distance from the line. The distance is either side of the line and the units are the same as the co-ordinate system.

4.3.2.4 Nearest Point

The nearest point option allows the user to choose the 'n' nearest stations to a specified point. The user has to input the co-ordinates of the point and a value of 'n' up to a maximum of 100.

These extensive classification and selection facilities give the data system a large potential to aid data analysis. However it is up to the user to make the most of this potential and careful consideration, at least an awareness of the classification definitions should be made at an early stage in the use of the data system.

5   MAPS

Like station selection map production is common to all data types with a
map output option.
When GENESIS is run the user is invited to set up default map parameters.
However every time a map option is run the user can alter, retain or update
the default values.

5.1   THE MAP PARAMETERS

5.1.1   Scale

This is a standard scale as the ratio of one unit on the map to units on
the ground;   e.g. 1:100000 means one millimetre on the map is equivalent
to 100000 millimetres (100 metres) in the field.

5.1.2   Hemisphere

As described in Section 2.4 the system assumes an origin in the bottom
left corner in the northern hemisphere and in the top right corner south
of the equator.
If a false origin grid is used in the southern hemisphere inform the
data system that it is a northern one.

5.1.3   Page size

The plotters most microcomputers use are capable of taking paper sizes
no larger than A3.   The map option allows the user to select A3, A4 and
to define the plotting size.

5.1.4   Page orientation

Conventionally maps are drawn with the eastings along the long side
i.e. with A3 paper the map would form a pull-out in a report which could
be viewed without turning the page.   However the user may be working on
an area which is larger in a north-south direction and this option
allows the page orientation to be turned through a right angle to
accommodate this possibility.

5.1.5 Grid reference accuracy

The grid reference can be determined from any scale map and this can reflect in the number of figures quoted. For convenience the data system allows the user flexibility in the number of figures but the user must say the accuracy being used so that the system can produce a map accordingly.

5.1.6 Title box position

All maps have a title box which contains the project name, map title, scale and figure number. The box may be positioned in any corner to allow for uneven distribution of points.

5.1.7 Grid line interval

Maps normally have a grid overlay to aid location. This facility allows the user to define the scale interval between the lines. There is an option to permit no grid lines.

5.1.8 Co-ordinates of the bottom corner

Obviously it is not practical to plot maps from the grid origin so the co-ordinates of the bottom left corner can be defined (the top right corner south of the equator).

5.2 EDITING

It is possible to edit any or all of the map parameters. This is done when the user has called for a map. On completion of the edit the user is asked whether the new values are to become the default values.

5.3 TITLES

5.3.1 Map title

The user is asked to enter the title of the map, a default title is given. A maximum of 54 characters is allowed.

5.3.2 Figure number

The user is asked for a figure number, entering RETURN means none is required. A maximum of 10 characters can be used.

5.4 BOUNDARIES

The data system asks if boundaries are to be included. Boundaries are the following features:

    roads

    rivers

    coastline

    contours

A lake can be regarded as a circular river. Coastlines have to be differentiated as a thicker pen is used for them.

These boundaries are stored in a special file created by the user to a standard format - see Appendix E.

5.5 DEVICE

The user is asked which plotting device the output is required on. The user is returned to the device choice after plotting.

6 SITE LOCATION

Site location is used to define the station except for the name. The
system checks each station name when it encounters one and if it is not on
the system a message alerts the user. If the user is in an input or edit
mode the system asks for confirmation that it is a new name and not a
typing error. This means that new stations can be added to the data system
at any time and through any data type.

If the user does not wish to add a particular item because it is not
available or the value is suspect the data system will assume that it is
missing (it can be added or altered later using the editor). If a
parameter has the value zero then zeros should be entered.

6.1 INPUT

This is option 1 on the main field input menu and displays a menu.

6.1.1 Master site reference

This is a message facility which the user can use as a reminder if the
station is related to a more important one known as the 'master site'.
An example of this is an observation borehole associated with a pump
well.

6.1.2 Grid reference

6.1.2.1 Eastings

This is the easting part of the station location using the
standard UTM grid as described in Section 2.4. The eastings
are the grid lines labelled along the top and bottom of the
map.

6.1.2.2. Northings

This is the complimentary half of the reference. The
northings are the grid lines labelled on the sides.

6.1.3 Datum elevation

This is the elevation of the measuring datum relative to the national
datum. It is mainly for calculating the elevation of the water surface.

6.1.4 Total depth

This is the total depth of the borehole as drilled.

A second page is displayed giving the user the opportunity to enter the sub-classes that the station falls into.

6.2 EDITING

The editing is identical to the input except that while the input is used only the first time that the station location data are added the editor can be used as often as the user needs.
It is possible to change the sub-classes already defined. If the datum is altered the user will be asked if they would like the water level data corrected. As the water levels are measured from the datum any alterations because the datum has physically changed will make a step appear in the water levels; by answering 'yes' the data system will automatically adjust existing readings by the difference between the new and old datums.

6.3 OUTPUT

There are two alternative output forms.

6.3.1 Listing

This asks for station selection and then prints out a table. The table gives the station name, grid reference and datum elevation.

6.3.2 Map

6.3.2.1 Differentiated by class
allows the user to assign different pens to up to eight different sub-classes.

6.3.2.2 Data type
stations which have a particular data type can be selected. For example all sites which have at least one chemistry sample.

6.3.2.3 Annotated points
gives the option of plotting the station name next to the station symbol.

7   STATION DETAILS

Station details is option 2 of the Field Input Menu. It comprises of 7
separate pages of questions which enable the user to enter full details
relating to general information and construction of each station. Each page
is accessed from a menu which includes an option to the end station entry
and return to a higher menu.

Because the data system is designed for hydrogeological use it is assumed,
for construction details, that the station is a borehole.

The user may enter as much or as little of the data as are available.
Subsequent additions or alterations are carried out through the editor.
The data system assumes that if just <RETURN> is pressed that piece of data
is missing. If the user wants the system to record a zero input then zero
must be entered.

7.1   INPUT

7.1.1   Page 1 - Location and general information

7.1.1.1   Site location

up to 68 characters can be used to describe the location of
the station.

eg: 12.5 km along main road and 6.5 m south by gate

7.1.1.2   Datum description

up to 16 characters used to describe the datum used to measure
water levels from - see Section 2.5

eg: top of casing

7.1.1.3   Elevation of ground level

the elevation of any ground level datum relative to national
datum.

7.1.1.4   Date drill started

the date that work started drilling the station.

7.1.1.5   Date of completion

the date that work on the statin was finished.

7.1.1.6 Contractor

up to 16 characters for the name of the contractor who built the station.

7.1.1.7 Rig type

up to 16 characters to describe the type or name of the drilling rig used to construct the station.

7.1.1.8 Drilling technique

there is space available for up to 4 drilling techniques with associated depths. The technique or method is up to 12 characters and the depths are 'from' and 'to'.

eg: cable tool from 0.0 to 56.4

7.1.1.9 Drilling fluid tuype

there is space for up to 4 different drilling fluids with depths. The type of fluid is defined in up to 12 characters and the depths are 'from' and 'to'.

eg: polymer from 45.0 to 97.0

7.1.1.10 Drilling mud

up to 16 characters to specify the commercial or brand name of drilling fluid.

7.1.2 Page 2 - Drilled and reamed diameters

7.1.2.1 Azimuth

the direction in which a non-vertical borehole goes relative to some datum.

7.1.2.2 Inclination

the angle from the vertical a non-vertical borehole was drilled at.

7.1.2.3 Drilled diameters

up to 5 different diameters used in constructing the borehole. The information needed is 'from' and 'to' depths and drill diameter.

7.1.2.4 Reamed diameters

up to 5 different diameters which the borehole was reamed out to. The information needed is 'from' and 'to' depths and reamed diameter.

7.1.3. Page 3 - Formation and water samples

7.1.3.1 Formation sampling method

up to 32 characters to describe the method of sampling.
eg: Bulk collection of cuttings

7.1.3.2 Coring/sampling depth

up to 10 sets of depths giving 'from' and 'to' details.

7.1.3.3 Water struck

up to 5 depths at which water was struck.

7.1.3.4 Water samples

up to 5 sets of data relating to water samples taken during drilling. The information needed is depth, temperature and conductivity. These data do not appear automatically in the other relevant data types.

7.1.4 Page 4 - Casing details

7.1.4.1 Casing type

up to 16 characters to describe the casing.
eg: mild steel

7.1.4.2 Casing diameters

space for up to 5 different casing diameters. The information needed is 'from' and 'to' depths and diameter.

7.1.4.3 Sediment trap

the length and diameter of a sediment trap. The trap, located below the deepest screen, collects any material which may enter the borehole without blocking the screen.

7.1.5 Page 5 - Screen details

7.1.5.1 Screen type
up to 16 characters to describe the type of screen.

eg: wire wound steel

7.1.5.2 Screen diameters
space for up to 5 different screen diameters or slot sizes. The data needed are 'from' and 'to' depths, diameter and the slot size.

7.1.6 Page 6 - Pack and backfill construction

7.1.6.1 Backfill
up to 20 characters to describe the material used to backfill and the 'from' and 'to' depths. Backfill is the filling of excess drilling with some material; for example if a borehole is stilled to 1000 m but only the upper 600 m are needed.

7.1.6.2 Pack type
up to 16 characters to describe the pack. This may be a general name, a commercial or brand name.

7.1.6.3 Pack construction
up to 10 sets of information relating to the borehole pack. Each set needs up to 8 characters to describe the material and the 'to' and 'from' depths.

7.1.7 Page 7 - Pump and development

7.1.7.1 Dipper pipe details
this section is only used if a separate dipping facility has been included in the borehole. The details needed are the 'from' and 'to' depths and diameter. There is space also for up to 16 characters for comments.

7.1.7.2 Development method
up to 16 characters to describe the method used to develop the borehole.

eg: jetting/airlift

7.1.7.3 Development time

up to 8 characters to describe the length of time developing
took. This should include units.

eg: 4.5 days

7.1.7.4 Development comments

up to 32 characters may be used.

7.1.7.5 Pump type

up to 16 characters to describe the type of pump installed.

7.1.7.6 Depth to intake

the depth of the pump intake.

7.1.7.7 Pump capacity

the maximum discharge the pump could deliver under the
conditions existing in the well.

7.1.7.8 Operational rate

the discharge of the pump when operating normally. This would
only really apply to a production well.

7.1.7.9 Rising main details

the details needed are the diameter and up to 16 characters to
describe the rising main.

7.2 EDITING

The construction details editor is exactly the same as the input with the
seven pages. To skip over the correct entries press <RETURN>. To correct
an entry or add an entry type in the new value and to delete an entry type
'delete'.

7.3 OUTPUT

There is a choice of two output form: graphical or listing.

7.3.1 Listing

The listing consists of a printed page containing only that data that

are available for the selected stations. Each station is given a
separate page.

7.3.2 Graphical

The user is given a choice of single or multiple station selection. If
multiple selection is indicated the diagrams will be produced in
succession with a pause after each one; only a single station will be
shown in each diagram.
After selection the user will be asked for the vertical scale as a ratio
of plot to actual measurement eg 1:1000 means that every millimetre on
the plot is equivalent to one metre in reality. The plotting size for
each page is 240 mm but the plot can continue onto successive pages.
The output shows the depth, the lithological log, the rate of
penetration log and the construction details with all depths relative to
ground level.

This is more fully described in Section 8.4.3.

8 LITHOLOGIES

This data type allows a simplified version of the lithological log to be used on the data system. There is sufficient space on the system to allow a maximum of 500 units per station.

8.1 TERMS

When a data system is being initialised using GENESIS the user is asked if they want the default primary, secondary and tertiary lithological terms which are listed in Appendix B. If the default values are not required the user may or may not enter values. Every time the lithology input is used the user is given the opportunity to add further terms up to the maxima of 20 primary, 40 secondary and 40 tertiary. It has been found that it is useful to define a bank term.
The tertiary term is assumed to be an adjective which describes the first two terms and is placed in the output as such; i.e. in the order primary, tertiary, secondary.
The terms can be altered, added or deleted using the 'add or change classes' option in the main edit menu.

8.2 INPUT

8.2.1 Depths

The user is asked whether the top and bottom of the layer is going to be entered on just the base in which case it assumes that the sequence is continuous from the surface down. The top of the layer, if requested is entered and the depth to the base of the layer.

8.2.2 Terms

The three terms have to be entered. A list of the terms is displayed and the corresponding number entered.

8.2.3 Comments

A space for up to 76 characters of comment is provided.

8.3 EDITING

There are full interactive editing facilities. However it is not possible to add a layer using the editor; this has to be done using the input.

8.3.1 Scrolling

The descriptions of the layers are displayed on the screen. The layer being edited is shown highlighted. To move layers the user may scroll the log by entering 'U' to move up or 'D' to move down.

8.3.2 Depths

The depths may be altered by overtyping the existing values. <RETURN> will cause the depth to be left alone.

8.3.3 Lithologies

The lithologies are edited in exactly the same way as they are entered. Because of the way the system operates the edited descriptions will not appear on the screen until the entry has been scrolled off and then back.

8.3.4 Comments

The comment can be edited by over typing with the correct version.

8.3.5 Deleting

The layer which is highlighted can be deleted by entering the deletion option.

On completion of the station edit press <RETURN> to continue.

8.4 OUTPUT

There are four output options as well as the return option.

8.4.1 Output to printer

The log for each selected station is printed out. The listing gives the station name, co-ordinates and elevation. Opposite the depths the primary, secondary and tertiary terms are printed with any additional comments on succeeding lines.

8.4.2 Write to file

Details of the file format are given in Appendix D.

8.4.3 Plot

This is a summary plot showing a graphical representation of the borehole. The station location is described and the lithological log, rate of penetration log and the construction details drawn. If necessary the plot will extend onto two or more sheets or paper.
The lithological log is shown as a column divided at the stated layers with the primary, secondary and tertiary descriptions written opposite. If the plot representation of the layer is less than the character height of 2mm the description is not included. The comments are not reproduced.
The rate of penetration log is shown in a histogram form with the average time over the depth interval.
The construction details are the drilled and reamed diameters and the casing and screen diameters; with the screen shown. The struck water levels and final rest water level are also shown.

The user is first asked to choose between single station and multiple station entry. If multiple entry is selected then system will pause between stations to allow the operator to change paper and parameters. The user is lead through a series of questions which fix the scales.

8.4.3.1 Penetration scale
The screen displays the maximum rate of penetration used in any other plots used and the maximum for the station. The user is invited to choose one of them or else enter a different value.

8.4.3.2 Construction diameters

As in Section 8.4.3.1 except the values refer to the drill diameters.

8.4.3.3 Vertical scale

The vertical scale is the ratio of plot measurement to actual measurement eg 1:1000 means that for every metre (1000 mm) in reality the plot will be one millimetre long. The vertical scale is 240 mm long.

8.4.4 Cyclongram map

A cyclogram is a method of presenting data in a series of concentric rings centred on the station. The lithologies are shown using this method with the surface or top most layer as the twelve o'clock position in the outer ring.
The user is asked for the usual station and map parameter selections and then two further questions relating to cyclograms.

8.4.4.1 Number of cycles

The number of cycles are the number of rings required for the map.

8.4.4.2 Cycle length

The cycle length is the depth interval that one cycle or ring is equivalent to. For example suppose all boreholes are less than 100 metres deep and the number of cycles selected is 5; then the length per cycle, to include all the data, would be 20 metres. If a cycle length of 10 was chosen then only the top 50 metres would be displayed.

9 RATE OF PENETRATION LOGS

When non-percussive drilling the time taken to drill a metre can be a reflection of the strata being drilled. This data type allows the user to enter time and depths and the data system processes the data to produce rate of penetration logs.

There is room on the system to have a maximum of 660 readings per station.

9.1 INPUT

9.1.1 Depths

The 'from' and 'to' depths in metres are required. These are the depth at which timing started and the depth timing finished.

9.1.2 Time

This is the time in hours, minutes and seconds taken to drill between the depths given.

The trailing zeros have to be entered; i.e. for a time of 1 hour and 5 minutes the time entered has to be 10500.

9.2 EDITING

The penetration rate editor is straight forward with the user selecting the station and the system displaying the data. The depths and time may be alteered or a set of readings deleted.

9.3 OUTPUT

In addition to the return to the main output menu there are three options.

9.3.1 Verification

The verification facility checks that the time is sensible i.e. not more than 24 hours, 60 minutes and 60 seconds. It also checks that the depths have been entered sequentially and are continuous and do not exceed the total depth. If there are no errors a message is displayed; if there are errors the line will be printed together with an error message.

Verification does not edit the data but assists the user in detecting

potential errors and drawing attention to them.

9.3.2   Output to printer

The rate of penetration logs are printed for the selected stations with
each station starting on a new page.
The output comprises of the station name, its co-ordinates, elevation
and total depth. The data are tabulated as depth from, depth to and the
rate as minutes per metre.

9.3.3   Write to file

The data for the selected stations are written to a file. Details of
the output format are given in Appendix D.

A graphical representation of the log is combined with the lithological log
and construction details. This is fully described in Section 8.4.4.

10 PUMPING TESTS

The data system is capable of handling the three main types of pump tests and packer tests. These are step or production tests, constant rate or aquifer tests and recovery tests.

There is sufficient room on the system to allow up to 20 tests per station and a maximum of 985 pairs of time/water level readings per test.

10.1 INPUT

The user is asked which type of test is being dealt with and then lead through a series of questions most of whih are common to all types.

10.1.1 Test description

10.1.1.1 Date and time
These are the date and time of the start of the test.

10.1.1.2 Number of steps
A maximum of 6 steps are allowed. For aquifer and recovery tests one step is used.

10.1.1.3 Pump well
The user is first asked if the readings relate to the pump well. If they do not the station number of the pump well and the distance of the pump well are inputted.

10.1.1.4 Depth to rest water
This is the initial depth to water from the datum taken just before pumping starts.

10.1.1.5 Pump rate and duration
For each step the pump rate, in cubic metres per day, and the duration of pumping, in minutes, are needed. In the case of a recovery test this means the pump rate that was used and the duration of the pumping before the start of the recovery phase.

10.1.1.6 Packer tests

Packer tests need the depth interval as 'to' and 'from' depths.

10.1.2 Test data

The data are input as the time since the start of the step and the depth to water pairs. In a production test the system automatically detects the start of a new step by the apparent decrease in time. The steps do not have to have the same number of readings. For a recovery test the time can either be entered as the total test time or the time since pumping stopped (which is probably easier).,
The drawdowns are automatically calculated.

10.2 EDITING

In the event of more than one test being recorded for the same station the data system lists the date and type of each test so that the user can select the test that needs editing.
The user also specifies the type of test, so that it is possible to alter the test type. For each test the user is given a choice of what to do.

10.2.1 Test description

The test description as given in Section 10.1.1 can be altered.

10.2.2 Alter existing readings

Using this option data pairs can be altered, deleted or left alone.

10.2.3 Add new readings

In the event a partial test being put on the data system this option allows the user to add the rest of the data.

10.2.4 Delete entire test

This allows the user to delete a test.

10.2.5 Abort this edit

If the user has made a serious error in editing the test then it is possible to abort the edit i.e. restore the test to its original state.

10.3 OUTPUT

There are seven output options.

10.3.1 List all tests

This lists all the pump tests that are present for the selected stations.

10.3.2 List all aquifer tests

This lists all the aquifer (constant rate) tests for the selected stations.

10.3.2 List all aquifer tests

This lists all the aquifer (constant rate) tests for the selected stations.
The output describes the test and then lists as two sets of columns the elapse time, depth to water and drawdown. If the test does not fit on a single page, continuation pages are automatically produced.

10.3.3 List all production tests

This lists all the production (step) tests for the selected stations. A brief heading is given and each step is listed as elapsed time from the start of the step, depth to water and drawdown. The first three steps are listed on the first page and the remaining steps are on the second page.

10.3.4 List all recovery tests

This lists all the recovery tests for the selected stations. The test description is printed and the processed data are then listed as the time since pumping stopped, the total test time, the ratio of the two

times, the depth to water and the residual drawdown.

10.3.5 List selected test

This allows the user to select and output any single test. The user
selects the station and the tests associated with that station are
displayed to enable the user to select the required one.

10.3.6 Output to file

All the datas for a single specified test is written to a computer file
in a standard format. Details of the file structure are given in
Appendix D.

10.3.7 Plot a test

This allows the user to plot a single specified test. The graph is
plotted on A4 with time along the longer side.
Production tests are plotted as log time against drawdown with each step
starting at the time equal to one.
Recovery tests are plotted as log time ratio against residual drawdown.
For aquifer tests there is a choice of three graphs

10.3.7.1 Working plot
This plot log-log plot is A3 size. It is designed to have the
scales as the same size as type curves for ease of user
interpretation.

10.3.7.2 Log-log plot
This plot on log-log is A4 size and is similar to the output
for the other types of test.

10.3.7.3 Long-linear plot
This plot is similar to the log-log plot.

11   TIME SERIES

The time series data types are water level, conductivity, temperature and
barometric pressure. They are all dealt with in a similar manner with a
few type-specific items.

The data system has space for a maximum of 660 readings per station for
each of the four time series data types. A set of readings comprises of
the date, time and value; if the time is absent it makes no more space.

The measurements are the depth to water from the station datum, the
conductivity in micro-siemen corrected to 25 deg.C, temperature in degrees
Celsius and pressure in millibars.

The data automatically sorts the time series into date order but not into
time order. This means that for sets of readings which fall on the same
day they must be entered onto the data system in correct time order.

11.1   INPUT

The various data may be input through the field input menu at any time.
The data required are the date and reading with an optional time value.

11.2   EDITING

Each data type has its own editor which enables the data to be altered or
deleted. Times may be added to existing readings.
The water level readings can be altered by changing the station datum - see
Section 6.2

11.3   OUTPUT

Each data type has a choice of six forms of input.

11.3.1   Verification

This is a simple data checking routine to make sure that the data fall
within user defined limits, failure to do so results in the particular
data being printed out together with a diagnostic message. It is then

up to the user to decice on whether there is a genuine error or not and to correct it through the editor. The verification checks that the date is sensible, user defined maximum and minimum are not exceeded and that a user defined rate is not exceeded.

11.3.1.1 Water level verification

The default values are zero, the total depth and ten per cent of the difference between readings. If there is no total depth a value of one thousand is assumed.

11.3.1.2 Conductivity verification

The default values are zero, one hundred thousand and ten per cent of the difference between readings.

11.3.1.3 Temperature verification

The default values are zero, one hundred and ten per cent.

11.3.1.4 Barometric pressure verification

The default values are nine hundred, one thousand and sixty and ten per cent of the difference between readings.

11.3.2 Data availability

This option produces a listing which shows the months that have at least one reading. The user makes a station selection and enters the start and finish years and, if relevant, the date of the end of the project. A maximum of fourteen years can be covered in any listing.

11.3.3 List data

This option prints a list of the data for each selected station between user defined dates. In water levels the listing gives the level as depth to water and as an elevation relative to the national datum.

11.3.4 Output to file

There is a choice of two types of output to file. Please see Appendix D for file structure.

11.3.4.1 All the data

This will write all the data to file that there is for the selected stations.

11.3.4.2 Single date data

This will write to file a single set of data provided it falls on a user defined date or within a user defined number of days either side that date up to a maximum of 28 days.
In the event of two dates lying the same number of days either side the given date the system always takes the date before the given date. If there is more than one reading on a given date the system will take the first one it finds.

11.3.5 Time series graph

It is possible to plot data from up to three selected stations on each graph.
The user is asked a series of questions relating to the graph.

11.3.5.1 Time scale

There is a choice of six time scales available.

(i)   24 hours - the user specifies the date and start time.
(ii)   10 days - the user specifies the start date.
(iii) 1 month - the user specifies the start month and year.
It automatically starts at the beginning of the month.
(iv)   6 months - the user specifies the start month and year.
It automatically starts at the beginning of the month.
(v)   1 year   - the user specifies the start month and year
(vi)   Greater than a year - the user specifies the start and end years. The system automatically starts on 1st January and finishes on 31st December.

11.3.5.2 Set Y-axis

The user can either specify the minimum and maximum values for the Y-axis or let the system automatically scale it.
The user has to enter the nunmber of Y-axis scale divisions required. The system will then divide the range into that many units and lebel the axis.

11.3.5.3 Hydrographs only

The user can decide on whether to plot the hydrograph as depth to water or elevation. If depth of water is chosen the Y-axis is inverted so that the minimum value is at the top of the axis.

Once the time and vertical scales have been decided the system asks for the device the output is to appear on.

11.3.5.4 Type of line

There is a choice of line style for the plots. These are points only, points joined with a solid line or a solid line. The lines are straight line segments linking each point.

11.3.6 Maps

For all the time series maps there is the normal station selection. For water levels the user is given the choice of a depth to water or an elevation of water map.

As the map will represent the data for a specific date and the readings may be spread over a period of time there must be a facility which allows the user to chose the date and limits. The user is asked if nearest date or linear interpolation is required.

11.3.6.1 Nearest date

The nearest date feature will select the reading which is nearest to the requested date within the limits set provided that there is no requested date within the limits set provided that there is no reading for that date. If there are two dates lying the same numberr of days either side of the requested date then the system selects the one before the date. If there is more than one reading for the same date the system will select the last one entered onto the data system.

11.3.6.2 Linear interpolation

Interpolation will take the two nearest stations which lie either side of the date provided they fall within the limits. It then calculates the daily rate of change between the two readings and using that rate calculates the reading for the requested date.

The usual map generating questions are then asked. The map shows the selected stations, provided they have data, annotated with the reading.

The data system can handle laboratory analyses together with any associated field determinations.

There is sufficient room on the system to allow up to 20 analyses per station for both chemistry types. The 8 major ions are default values and the user may define a further 11 ions.

The field determinations are entered and edited separately from the laboratory determinations but they are joined together to form a single coherent output.

Note:

Care must be taken in the sample numbering system as each laboratory or field sample has to have a unique identifier. The system uses the four right hand characters when checking to make sure the identifier does not already exist on the data system.

The user is advised to also read Appendix G which gives further details on the output of the chemistry data in particular the processing which is carried out automatically.

12.1 INPUT

12.1.1 Field determinations

The sample number is the only item which has to be entered; any of the others may be added, altered or deleted at a later time. A missing entry may be made by pressing <RETURN> but a zero entry has to be entered as such.

12.1.1.1 Sample number

This must be unique to the data system and can be up to 8 characters.

12.1.1.2 Sample date

The date that the sample was taken.

12.1.1.3 Depth

The depth that the sample was taken at.

12.1.1.4 Temperature

The temperature, in degrees Celsius, of the water at the time of sampling.

12.1.1.5 Conductivity

The electrical conductivity, in microSiemen, of the sample.

12.1.1.6 pH

The pH of the sample.

12.1.1.7 eH

The eH of the sample.

12.1.1.8 HCO3

The field determination of bicarbonate as milligrams per litre.

12.1.1.9 Comments

Space of up to 12 characters for general comments.

12.1.1.10 Sample preparation

The user is given a choice of three sample preparations. The sample referred to has been taken for laboratory analysis.
(i) unfiltered – there has been no special preparation
(ii) filtered – the sample has been filtered to remove extraneous particles.
(iii) filter+acid – the sample has been filtered and divided with one portion acidified with concentrated hydrochloric acid to fix the cations.

12.1.2 Laboratory analysis

The firt time that the laboratory chemistry is used the user is invited to enter up to 11 ionic names not already listed; (those listed are Na Ca Mg K Cl HCO3 SO4 NO3). Subsequently the user is asked whether more ions are required. It is possible in the edit mode to alter or delete ion names. Units are in milligrams per litre.

Because of the way the system operates the standard chemical symbol (without the charge) should be used for the ion names. Non-standard

items may be used but if total dissolved solids or alkalinity are
required they must be entered as:

TDS - total dissolved solids

ALK - alkalinity (method not specified)

ALK(M) - alkalinity as methyl organge

ALK(P) - alkalinity as phenolphthalene

12.1.2.1 Lab analysis number

Up to 8 characters forming a unique reference may be used.

12.1.2.2 Field number

This is the field determination reference associated with the
particular sample.

12.1.2.3 Analysis date

The data that the laboratory analysis was performed on.

12.1.2.4 Depth

The depth the sample was taken at.

12.1.2.5 Laboratory measurements

The results of conductivity, pH and ionic determinations taken
in the laboratory with units in milligrams per litre.
If a determination was not made a null entry may be made by
pressing <RETURN>; a zero entry has to be made as a figure
zero. If an ion is present but at a concentration less than
the confidence limit of the determination the results may be
prefixed with the 'less than' symbol.

12.2 EDITING

Both the chemistry types can be fully edited through the Editor. A sample
can be deleted from the data system using option 18.

The field determinations may be added, altered or deleted. The major ions
editor allows the user to delete or alter the ion names; the
determinations may be added, altered or deleted.

If a field chemistry is added to the data system then its number must be
added to the laboratory determination.

12.3 OUTPUT

In addition to the return option there are 5 output options.

The output listing combines the field and laboratory determinations. The major ion balance is calculated, ions exceeding international standards are starred and classes calculated. Four analyses are listed per page. Appendix G gives more details on the output.

12.3.1 List all data

This will list all analyses for the selected stations.

12.3.2 List selected samples

This allows the user to select individual samples from the selected stations and list them.

12.3.3 Write to file

Details of the file format are given in Appendix D.

12.3.4 Piper diagram

This is a graphical output showing the piper or trilinear diagram. The standard three fields are drawn and the selected analyses plotted and labelled. Below the plot there is a key showing the station and sample numbers.

In the interest of clarity there is a maximum of 30 points on each plot. The data system will pause after every 30 points.

The user is given a choice of four methods of selecting the samples for the selected stations.

12.3.4.1 All samples
this will give all the samples for the selected stations.

12.3.4.2 By depth
the user is allowed to specify the minimum and maximum depths and if the sample lies within the range it will be plotted.

12.3.4.3 By data

the user selects a date and a number of days either side of
the date up to a maximum of 28000 days (about 75 years).

12.3.4.4 Manually

the samples are listed for each station and the user selects
the ones required.

The user is given the opportunity to give a title and figure number.

12.3.5 Ion concentration map

The user can produce a map of a selected ion concentration. The user is
asked for the ion required, which includes the user defined ones,
conductivity and pH. The stations are selected as usual.

The user then has a choice of three methods of selecting the samples.

12.3.5.1 Depth

the user specifies the minimum and maximum depths.

12.3.5.2 Date

the user specifies a date and the number of days either side
of it up to a maximum of 28000 days (about 75 years).

12.3.5.3 Manually

the data system displays the samples together with date and
depth for each station and the user selects the one required.

The user is then guided through the standard map parameter questions.

13   ISOTOPES

The data system can handle stable isotopes, deutrium (H-2) and oxygen 18 (O-18) and tritium (H-3). The results of carbon dating can also be stored on the system.

There is sufficient room on the data system to have a maximum of 20 samples per station.

13.1   INPUT

13.1.1   Sample number

The user has to enter a sample number which relates to each data set. The sample number can be up to 8 characters. Because of the way the system operates the four right hand characters have to be unique to the sample numbers for the station.

13.1.2   Date

The date is the one the user wishes. It would normally be the date of sampling.

13.1.3   Results

The data that may be put onto the data system are the stable isotopes (‰), tritium as tritium units (TU) and the results of carbon dating including the age.
Any missing results can be added through the editor.

13.2   EDITING

In the event of more than one sample for the station the user is invited to enter the one for editing.
At this stage it is possible to add missing analyses as well as alter incorrect ones.

13.3   OUTPUT

There are five output options in addition to the return to the main output menu.

13.3.1 All the data

This will list all the data for all the samples which belong to the selected stations.

13.3.2 Stable isotope data

This option allows the user to list just the stable isotope data for the selected stations.

13.3.3 Stable isotope and tritium data

This is similar to 13.3.2 except that the tritium results are also included.

13.3.4 Given date data

This option allows the user to list the data for a given date or up to 28 days from the date. The operator is asked for the date and also the permitted number of days either side of it up to a maximum of 28.

13.3.5 Write to file

The data for the selected stations are written to a named file. Please see Appendix D for the format.

14 GRAIN SIZE

This data type is for handling sieve analysis with weight retained for each sieve being entered.

There can be up to 25 user defined items (sieves). It is possible to have up to 20 analysis for each station.

14.1 INPUT

When the gain size input option is first selected the user will be told and then invited to define the items. There is a maximum of 25 items and it is possible to alter them through the editor. Every subsequent time the input is used the data system will give the user the opportunity to add further items.

The item defiinition is exactly as the user entered and is up to 8 characters. Although it is assumed that the items are sieve sizes in millimeters it need not necessarily be so; this also allows the user to define the 'pan' or less than '<'.

14.1.1 Sample number

Each sample has to be assigned a sample number. Because of the way the system handles the sample number the four right hand characters have to be unique within the samples for each station.

14.1.2 Date

The sampling date is required.

14.1.3 Depth

The depth that the sample was taken can be entered.

14.1.4 Original weight

The weight of the original sample has to be given as it is used in processing the data.

14.1.5 Weight retained.

The user enters the weight retained by the individual sieves. If one or more of the sieves were not used then press <RETURN> to give a missing entry. If there was no part retained then zero (0.0) should be entered.

14.2 EDITING

The user may delete or alter the sieve sizes when using the edititor. It is also possible to alter all the other data except for the sample number.

14.3 OIUTPUT

There are three options in addition to returning to the main output menu. When printing output each station is started on a new page.

14.3.1 List all data

This will list all the samples for the selected stations. The data are processed so that the output comprises of the percentage weight retained and the cumulative per cent passing and being retained.

14.3.2 List selected samples

This enables the user to select individual samples for output. If the selected stations have more than one sample each the samples are listed and the user invited to enter the sample required.

14.3.3 Write to file

The samples of the requested stations are written to file. Please see Appendix D for the format details.

15 LABORATORY ROCK PROPERTIES

The data system is capable of storing the results of laboratory tests to determine rock properties.

There is sufficient room on the data system to have a maximum of 20 samples per station.

15.1 INPUT

15.1.1 Sample number

The user has to enter a sample number which relates to each data set. The sample number can be up tp 8 characters. Because of the way that the data system operates the four right hand characters have to be unique to the sample numbers for that station.

15.1.2 Date

The user may put in any convenient date such as date of sampling or date of analysis.

15.1.3 Results

The data are added in response to the prompts displayed. The data that can be put in are:
- depth
- dry density (Kg/m3)
- mean grain density (Kg/m3)
- porosity (as a fraction)
- permeability (m/d)
- specific yield

Any missing results can be added later through the editor.

15.2 EDITING

In the event of more than one sample for the station the user is invited to enter the one required for editing.
At this stage it is possible to add missing data as well as altering incorrect ones.

15.3 OUTPUT

There are four output menu options in addition to the return to the main
output menu.

15.3.1 All the data

This will list all the data for all the samples which belong to the
selected stations.

15.3.2 List density and porosity

This will list the sample number, date, depth, both densities and
porosity for the selected stations.

15.3.3 List data for given depth

This option allows the user to output the data for any depth range. The
user is invited to enter the minimum and maximum depths, which can have
the same values.

15.3.4 Write to file

The data for the selected stations are written to a named file. The
details of the file format are given in Appendix D.

16 GEOPHYSICAL LOGS

Geophysical logs should be regarded as a future expansion facility for the data system. There is room on the data system to define up to 20 geophysical logs. The system does not store or handle the actual data but labels the stations with those logs run.

16.1 INPUT

The twelve default values, listed in Appendix B, or up to twenty user defined log types may be added when setting up the data system using 'GENESIS'. If no types were defined then the first time the user selects geophysical logs the system asks for type names.

The user is allowed to assign a maximum of ten log types per station.

16.2 EDITING

Option 15 of the main editor menu allows the user to add, alter or delete log types.

There is no editing facility for altering the type of logs assigned a station.

16.3 OUTPUT

The only output forms for geophysical logs are within the extended station location and the single station all data listing.

APPENDIX A - GENESIS

To set up a data system the user has to type <GENESIS> which will run the
system initialisation program.

***** WARNING *****

If GENESIS is used any existing data systems on the
same disc drive will be destroyed.

The user will have to respond to a series of questions.

A.1 Existing files

The user is warned that existing data files will be
destroyed and given the opportunity to stop.
The data files are then opened and initialised.

A.2 Number of Stations

The user is asked to enter the maximum number of
stations that will be needed on the data system. There is a maximum of
1000 allowed.

***** WARNING *****

It is not possible to increase the number of stations
once the data system is operational.

A.3 Project title

This is the main title which appears on all output, it
can have up to 24 characters. Once it has been entered the user will be
asked to confirm it. Once it has been ocnfirmed it is not possible to
alter it.

A.4 Password

It is possible for the user to enter a password up to 5
characters long. This can be altered, deleted or added from the starting
menu.

A.5 Permissions

The user can set up level 2 and level 3 permissions at this stage. They can be added, altered or deleted from the starting menu.

A.6 Classes

The user may define any of the classes. This may be carried out through the editor at a later date if desired.

A.7 Geophysical logs

The user may enter the names of the geophysical logs or choose the default values listed in Appendix B. It is possible to add, alter or delete names at a later date.

A.8 Lithological terms

The three sets of lithological terms, primary, secondary and tertiary, may be added or the default values chosen. It is possible to add, alter or delete names at a later date.

APPENDIX B - DEFAULT VALUES

B.1 Lithologies

The following are the primary, secondary and tertiary lithological terms
that are used as default values if requested in GENESIS. Up to 20 primary,
40 secondary and 40 tertiary terms may be defined.

Primary terms	Secondary terms	Tertiary terms
white	clay	slightly clayey
grey	silt	clayey
black	fine sand	slightly silty
pink	medium sand	silty
red	coarse sand	slightly sandy
reddish brown	fine gravel	sandy
brown	medium gravel	very sandy
orange	coarse gravel	slightly gravelly
yellow	cobbles	gravelly
yellowish green	boulders	very gravelly
olive	peat	coarse
green	breccia	medium
blue	conglomerate	fine
purple	greywacke	calcareous
	sandstone	arenaceous
	siltstone	heterogeneous
	mudstone	homogeneous
	shale	laminated
	agglomerate	cemented
	coal	interstratified
	limestone	vuggy
	dolomite	fissured
	chalk	weathered
	anhydrite	thickly bedded
	gypsum	medium bedded
	halite	thinly bedded
	tuff	porous
	volcanic breccia	very porous
	marble	honeycombed

Primary terms	Secondary terms	Tertiary terms
	quartzite	massive
	andesite	very loose
	basalt	loose
	diorite	medium dense
	dolerite	very dense
	gabbro	very soft
	granite	soft
	gneiss	firm
	rhyolite	stiff
	schist	very stiff
	slate	

B.2 Geophysical logs

The following are the default geophysical logs which are used when called from GENESIS, a total of 20 logs can be defined.

SP

SPR

Gamma

Caliper

Fluid conductivity

Temperature

Differential temperature

16" Normal

64" Normal

Gamma-gamma (Density)

Neutron

Sonic

APPENDIX C - FORMAT OF INPUT FILES

It is possible to add three data types to the data system via input files; these are depth to water, water quality and pump tests. The system identifies the data type by the file name qualifier so it is important to make sure that it is correct for the data type.

C.1 Site location and construction details

The file qualifier is .SIT
The format for each station is:

    line 1 station name (8A1)

    line 2 blank

    line 3 site description (64A1)

    line 4 grid reference - easting, northing (2I6)

    line 5 datum elevation (F8.3)

    line 6 completion date DDMMYY (F7.0)

    line 7 contractor (16A1)

    line 8 no. of drilled diameters minus 1 (NDIAM-1)

        no of casing diameters minus 1 (NCAS-1)

        no of screen diameters minus 1 (NSCN-1)

        depth water struck (8X.3I5,F8.3)

    line 9 to line 8+NDIAM

        drill diameter (mm), depth from, depth to (F5.0,2F8.3)

    line 9+NDIAM casing type (16A1)

    line 10+NDIAM to line 10+NDIAM+NCAS

        casing diameter (mm), depth from, depth to (F5.0.2F8.3)

    line 11+NDIAM+NCAS to line 11+NDIAM+NCAS+NSCN

        screen diameter (mm), depth from, depth to (F5.0.2F8.3)

    one blank line

C.2 Lithology

C.3 Pump tests

The file qualifer is .PTS
The format for each station is:

    line 1 station name (8A1)

    line 2 number of water levels minus one and date (DDMMYY)

        (I5.12X.F7.0)

line 3 number of steps NSTP (for aquifer and recovery tests
        NSTP=1) (I4)

line 4 station name of pump well (8A1)

line 5 rest water level (F8.2)

line 6 pump rate, duration (F8.2.F9.2)

line NSTP+5 repeat line 6

line NSTP+6 time (in decimal minutes), depth to water
        (F9.2.F7.2)

C.4 Depth to water

The qualifer is .WLV

The format for each station is the same:

    line 1 station name (8A1)

    line 2 number of water levels minus one (I5)

    line 3 date (DDMMYY) and depth to water (F7.0.F8.3)

    repeat line 3

C.5 Water quality

The file qualifer is .WQL

The format for each station is:

    line 1 station name (8A1)

    line 2 number of readings minus one (I5)

    line 3 date (DDMMYY), conductivity, temperature (F7.0.F8.1.F6.2)

    repeat line 3

D — FORMAT OF OUTPUT FILES

The output files have the lqualifier .DAT with the user defining the drive and file name.

The following abbreviations have been used in this Appendix:

X the easting part of the grid reference

Y the northing part of the grid reference

Z the elevation of the station

no. number

date is an integer in the form YYMMDD

D.1 Site location

Site location has no file output.

D.2 Station details

Station details has no file output

D.3 Lithological logs

line 1   station name (1X.A8)

line 2   depth from, depth to, codes (numbers), codes (words) (1X.2F10.3.I10.96A1)

line 3   additional comments (if present) (1X.19A4)

D.4 Rate of penetration logs

line 1   station name, X, Y, Z, no. of readings (2X.A8.2I10.F10.3.I10)

line 2   depth from, depth to, time (2F10.3.I10)

D.5 Pumping tests

line 1   station name, X, Y, Z, date, time, no. of steps (2X.A8.2I10,F10.3.3I10)

line 2   discharge, time for first three steps (blank if not used) (3(2F10.2))

line 3   as for line 2 for steps 4 to 6 (3(2F10.2))

line 4   pump well name, pump well distance (blank if not given)
            (2X.A8.F10.2)

line 5   rest water level, type of test, no. of readings
            (F10.3.2I10)

line 6   time (in minutes), depth to water (2F10.3)

D.6   Time series

The time series (water level, conductivity, temperature and barometric
pressure) offer the user a choice of output type.

D.6.1   Single date

There is a single line of output per station:
       station name, X, Y, Z, date, time, value
       (2X.A8.2I10.F10.3.2I10.F10.3)

D.6.2   All data

The format for each station is:
       line 1   station name, X, Y, Z, no. of readings
                (2X.A8.2I10.F10.3.I10)

       line 2   date, time, value (2I10.F10.3)

D.7   Chemistry

       line 1   ion names five per line 5(2X.2A4)
                up to 4 lines
for each station:
       The absence of an item is indicated by the value -999.0
       line 1 station name, X, Y, Z, no. of samples, no. of ions
                (2X.A8.2I10,F10.3.2I10)

       line 2   Field chemistry (if absent line 2 is -999.0)
                sample no., sampling date, depth, temperature, EC.pH.
                eH, HCO3 (2X.2A4.I10.6F10.2)

       line 3   Field chemistry (if absent line 3 is -999.0)
                comments, sample preparation (3A4.I6)

       line 4   lab chemistry
                lab sample no., analysis date, depth, EC, pH, Na, Ca, Mg
                (2X.2A4.I10.6F10.2)

line 5 lab chemistry

K, Cl, HCO3, SO4, NO3, plus 3 user defined names

(8F10.3)

line 6 lab chemistry

up to 8 user defined names (if applicable) 8F10.3

D.8 Isotopes

line 1 station name, X, Y, Z, no. of samples

(2X.A8.2I10.F10.3.I10)

D.9 Grain size

line 1 station name, X, Y, Z, no. of samples, no. of sieves

(2X.A8.2I10.F10.3.2I10)

line 2 up to 5 lines of sieve sizes each being (5(2x.8A1))

line   date, original weight, depth (I10.F10.1.F10.2)

line   up to 5 lines of weight retained each being (5F10.1)

D10 Laboratory rock properties

line 1 station nane,m X, Y, Z (2X.A8.2I10.F10.3)

line 2 sample no., date, depth, dry density, grain density,

porosity, permeability, specific yield

(2X.2A4.I10.6F10.2)

D.11 Geophysical logs

Geophysical logs have no file output.

APPENDIX E - FORMAT OF BOUNDARY FILE

The boundary file is used when maps are plotted. In order to change the output from points on a grid to a map additional features are needed such as roads and rivers which enable the viewers to orientate themselves. The boundary file contains the necessary data to plot these additional features.

The file has the name DBBOUND.DAT prefixed by the drive number.

NOTE: The data system only uses this file if boundaries are requested in the mapping selections. The user has to create the file to the format given. The data system does not save the file.

The types of feature that can be added are ROAD, RIVER, LAKE, COAST and CONTOUR. The feature is entered as the Easting and Northing pairs using the same grid as the stations. Each grid reference will be linked to the preceding one by a straight line. Roads and contours use the same pen, rivers and lakes use the same pen (a lake can be thought of as a circular river) the coast uses a different pen.

The format for each feature type is the same:
     line 1 feature name (in upper case)
     line 2 number of grid references - maximum of 999 (I3)
     line 3 onwards the grid reference as Easting and Northing
          (2F10.0)

APPENDIX F – ERRORS

F.1 Typing erros

The majority of errors that will be encountered using the data system will be the result of typing errors or by pressing <RETURN> more than once in response to a prompt.
This kind of error can easily be corrected using the editing facilities.

F.2 System error

There are errors with a diagnostic message generated by the computer operating system. The user should refer to the systems manual for an interpretation of the message.
An error occurring immediately after typing <DATABASE> may be caused by the files relating to the data system not being present because of accidental erasure.
This may be overcome by copying the back-up disc directly onto the default hard drive using the operating system.
If the system error is not due to the data files missing they should be treated in the same way as a data system error.

F.3 Data system error

In the unlikely event of serious error occurring the data system will display a message.
Should this happen please carry out the following procedure:

1 Write down the message

2 Repeat the operation that caused the message

3 If the error does not reoccur then continue

4 If the message is repeated:

    a)   return to the starting menu and select option 8 (print last operations log)

    b)   contact the Institute of Hydrology and supply the following information:

    (i) version and serial number of the data system

    (ii) the error message displayed on the screen

    (iii) briefly describe the operation that caused the error

    (iv) send the operations log by post

The address of the Institute is to be found at the front of this manual.

APPENDIX G - CHEMISTRY

This appendix describes the methodology of the chemistry output and details the conversion factors and limits used. The appendix is divided into two parts. The first part describes the output features given in the chemistry output and the second part describes those additional features of the extended chemistry output as given in the single station data listing.

G.1 STANDARD OUTPUT

G.1.1 Ionic conversion

The ions are entered as milligrams per litre and converted to milliequivalents per litre using:

sodium	Na	0.043498	chloride	Cl	0.028206
calcium	Ca	0.049900	bicarbonate	HCO3	0.016389
magnesium	Mg	0.082288	sulphate	SO4	0.020821
potassium	K	0.025577	carbonate	CO3	0.033328

G.1.2 Ionic balance

The balance is calculated by

$$([sum\ cations]-[sum\ anions])/([sum\ cations]+[sum\ anions])*100$$

Ga3 Ionic limits

The limits that we have chosen conform to those recommended by World Health Organisation (WHO) and the US Environmental Protection Agency. The WHO references re the 1971 International Standards for Drinking Water and 1984 International Guidelines for Drinking Water Quality.

These standards include those used in both forms of output

	Highest desirable	Maximum permissible
pH	6.5 and 8.5-9.2	<6.5 and >9.2
TDS	500	1000
total hardness	100	500
Na	200	
Ca	75	200
Mg	30	150
K	-	-
Cl	250	600
HCO3	-	
SO4	250	400
NO3	45	45

milligrams per litre

Minor ions	Highest desirable	Maximum permissible
AS		0.05
Cd		0.005
Cr		0.05
Cu	0.05	1.0
CN		0.1
F	0.6	1.5
Fe	0.1	0.3
Pb		0.05
Mn	0.05	0.1
Se		0.01
Zn		5.0

milligrams per litre

G.1.4 Alkalinity

As the subject of alkalinity and species is complicated please see the diagram which expreses it more clearly.

CARBONATE CHEMISTRY

1. Species computed from alkalinity

m - methyl orange
p - phenolphthalene

all in mg/l

Alkalinity as $CaCO_3$

How many determinations

ONE (m)

TWO (m) & (p)

Yes — $ph < 10.3$ — No

Yes — $(m - 2p) > 0$ — No

BICARBONATE only
(m) • 1.2

CARBONATE only
(m) • 0.6

BICARBONATE
(m - 2p) • 1.2

CARBONATE
2p • 0.6

CARBONATE
(m - p) • 1.2

HYDROXYL
(2p - m) • 0.34
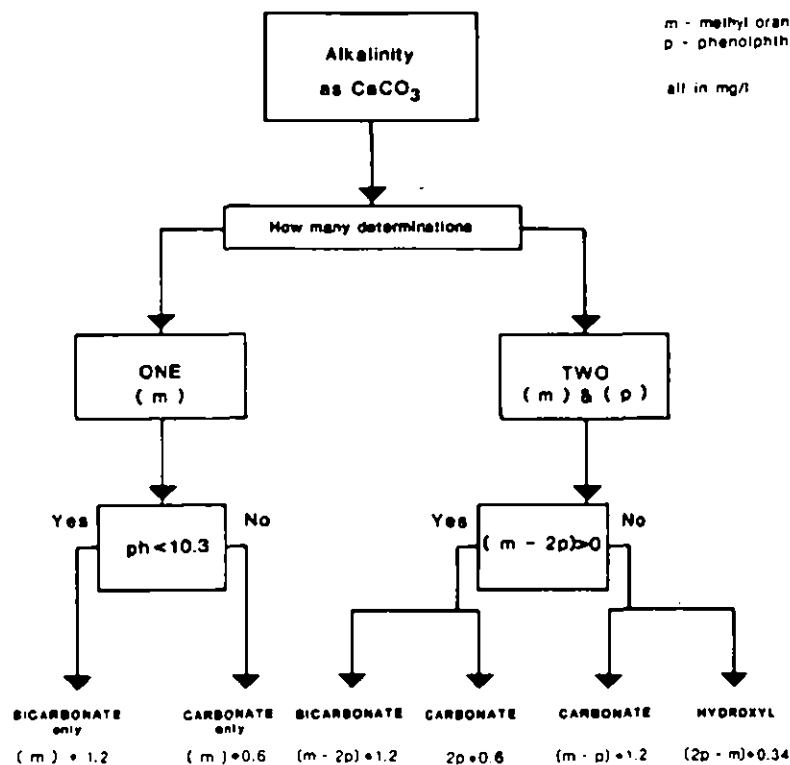
2. Alkalinity computed from species

(a) BICARBONATE only

Yes — $ph\ 4.5\ to\ 8.3$ — No

Alkalinity $(HCO_3 / 1.2)$ — error

(b) CARBONATE only
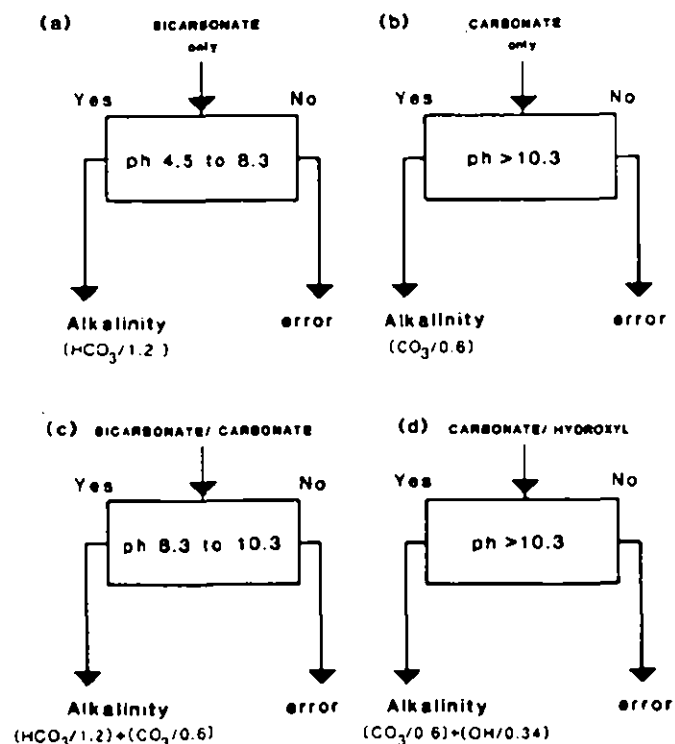
Yes — $ph > 10.3$ — No

Alkalinity $(CO_3 / 0.6)$ — error

(c) BICARBONATE / CARBONATE

Yes — $ph\ 8.3\ to\ 10.3$ — No

Alkalinity $(HCO_3 / 1.2) + (CO_3 / 0.6)$ — error

(d) CARBONATE / HYDROXYL

Yes — $ph > 10.3$ — No

Alkalinity $(CO_3 / 0.6) + (OH / 0.34)$ — error

(e) Any other combination is an error

all in mg/l with alkalinity as $CaCO_3$

G.1.5 Hardness

G.1.5.1 Total hardness
is calculated by : $Ca*2.497+Mg*4.15$

G.1.5.2 Non carbonate hardness
is the total hardness minus the alkalinity

G1.1.5.3 Hardness class
is a descriptive term indicating the degree of hardness

soft	less than 60 mg/l as CaCO3
moderately hard	61 to 121 mg/l
hard	122 to 180 mg/l
very hard	greater than 180 mg/l

G.1.6 Total dissolved solids (TDS)

In addition to the laboratory dermination (if present) a calculated TDS is given.

This is calculated by : sum cations+sum anions

G.1.7 Classes

G.1.7.1 Domestic

There are three classes and are defined as:

class 1   all major ions fall within defined limits

class 2   one or more major ions exceed the highest desirable limits but are less than the maximimm permissible limits

class 3   one or more major ions exceed the maximum permissible limits.

G.1.7.2 Agricultural

The agricultural class is made up of two sub-classes:

(1)   salinity hazard class
this is based on the electrical conductivity (EC) of the water which is corrected to 25 degrees Celsius.

range of ECL	class
ECL<2.398	C1
2.398<ECL<2.875	C2
2.875<ECL<3.352	C3
3.353<ECL<3.699	C4
3.699<ECL<	C5

where ECL=Log10(EC)

(ii) sodium absorption ration (SAR)
this is determined from the cations
SAR=Na/SORT ([Ca+Mg]/2)   in milliequivalents per litre

range of SAR	class
SAR <(-4.414ECL+18.828)	S1
(-4.414ECL+18.828)< SAR<(-6.769ECL+31.538)	S2
(-6.769ECL+31.538)< SAR<(-8.829ECL+43.658)	S3
(-8.829ECL 43.658)<SAR<31	S4
31 < SAR	S5

The agricultural class is based on the US Department of
Agricultural Salinity Laboratory Handbook No 60.

G.1.7.3   Residual sodium carbonate (RSC)

This is an indicator for the suitability of the water for irrigation
purposes.
RSC=(HCO3+CO3)-(Ca+MG)   in milliequivalents per litre

< 1.25	suitable
1.25-2.5	marginal
> 2.5	unsuitable

G.1.7.4   Stability index (SI)

This is the Ryznar index and is calculated using the equation:

$$SI=2*pHs-pH$$

where pHs is the calculated pH from :
pHs=11.19519-log(Ca)-log(alkalinity)+(TDE*0.000025)

where Ca and alkalinity are in mg/l
the last term is the ionic strength and is an approximation.

G.2 EXTENDED OUTPUT

This form of output has been designed to give all available
information in a tablular form.

It starts by defining the sample numbers, dates of collection and
analysis and description. Details of the field and laboratory
determinations are shown next to each other for easy comparison.
Laboratory bicarbonate, carbonate and hydroxyl are shown with a number in
brackets indicating an error.

The weathering residue is calculated from:

$$[1-(x/Cl)sea*(Cl/x)sample]*100$$

where the standard sea water is:

Sodium	10500	Chloride	19000
Calcium	400	Bicarbonte	142
Magnesium	1350	Sulphate	2700
Potassium	380	Nitrate	0.1
		Silica	6.4

The sample classifications are straight forward with the data system
placing an 'X' against the appropriate number. The classes are the same as
for the standard output.