AGSO

# DOCUMENTATION FOR MURBO: THE MURRAY BASIN BOREHOLE DATABASE: VERSION 1.1



*by*
*Ross Brodie*

## Record 1993/77





AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

*Documentation for*

# *MURBO*

*The Murray Basin Borehole Database*

*Version 1.1*

**Record 1993/77**

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Australian Geological Survey Organisation

Environment Geoscience and Groundwater Program

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**ISSN: 1039-0073**

**ISBN: 0 642 19809 8**

# CONTENTS


1) INTRODUCTION ..... 1

2) DATA SOURCES ..... 1

3) THE DATABASE SCHEMA ..... 2

4) DETAILS OF DATA TABLES ..... 6
- 4.1) Table: GENERAL ..... 6
- 4.2) Table: GEOPHYS ..... 7
- 4.3) Table: POLLEN ..... 8
- 4.4) Table: FORAM ..... 9
- 4.5) Table: STRAT ..... 10
- 4.6) Table: AQINT ..... 11
- 4.7) Table: SWL ..... 12
- 4.8) Table: SAMPLE ..... 13
- 4.9) Table: MAJION ..... 14
- 4.10) Table: MINION ..... 15
- 4.11) Table: ISOTOPE ..... 16

5) DETAILS OF LOOK UP TABLES ..... 17
- 5.1) Table: STATE ..... 17
- 5.2) Table: LOCREL ..... 17
- 5.3) Table: DATEREL ..... 18
- 5.4) Table: BORETYPE ..... 18
- 5.5) Table: DRILLMETH ..... 19
- 5.6) Table: STATUS ..... 20
- 5.7) Table: SHEET100 ..... 20
- 5.8) Table: SHEET250 ..... 23
- 5.9) Table: SHEET1000 ..... 24
- 5.10) Table: AGE ..... 24
- 5.11) Table: GEOL ..... 26
- 5.12) Table: CONFID ..... 26
- 5.13) Table: YIELD ..... 27
- 5.14) Table: INTTYPE ..... 27
- 5.15) Table: QUALSALT ..... 28
- 5.16) Table: ATTYPE ..... 29
- 5.17) Table: ATEQUIP ..... 29
- 5.18) Table: SAMPMETH ..... 30
- 5.19) Table: LAB ..... 30

6) DATA VALIDATION ..... 31
- 6.1) Validation of table GENERAL: ..... 31
- 6.2) Validation of table GEOPHYS: ..... 31
- 6.3) Validation of table POLLEN: ..... 32
- 6.4) Validation of table FORAM: ..... 32
- 6.5) Validation of table STRAT: ..... 32
- 6.6) Validation of table AQINT: ..... 32
- 6.7) Validation of table SWL: ..... 33
- 6.8) Validation of table SAMPLE: ..... 33
- 6.9) Validation of table MAJION: ..... 33
- 6.10) Validation of table MINION: ..... 33
- 6.11) Validation of table ISOTOPE: ..... 33

7) ACKNOWLEDGMENTS ..... 34

8) REFERENCES ..... 34

APPENDIX A: DETAILS OF GEOLOGICAL UNIT CODES STORED IN TABLE GEOL ..... 36


**FIGURES**


Figure 3.1: Schema for Murray Basin Borehole Database
Figure 3.2: Nomenclature used to describe borehole features

## 1) INTRODUCTION

In the Murray Basin, groundwater-related land and surface water salinisation threatens both the regional economy and the natural environment. Under the aegis of the Murray-Darling Basin Commission Groundwater Working Group, a joint commonwealth-state hydrogeological study of the basin has been undertaken to underpin the development of suitable salinity management strategies.

Two major products of the research program are;

i) The Murray Basin Hydrogeological Map Series; a basin wide coverage of 1:250 000 scale maps outlining the relationship between groundwater and salinisation, useable groundwater resources and areas of present and potential salinity hazard.

ii) A regional numerical groundwater model, using the finite difference MODFLOW package, to simulate groundwater flow and calculate salt loads.

The MURBO relational database has been designed to support the hydrogeological mapping and modelling effort, containing the historic record of boreholes drilled within the Murray Basin. The database structure accommodates locational, construction, stratigraphic, hydrogeological, palynological, foraminiferal, potentiometric and hydrochemical data. The database and user interface for data entry and query have been developed using the following SQL-based Oracle RDBMS products:

ORACLE RDBMS Version 6.0[13,22,24]
SQL*Plus Version 3.0.6.5.1[14]
SQL*Forms Version 2.3.30.1.1
SQL*Menu Version 4.1.14

These products are currently maintained on an Intergraph Unix workstation at the Environmental Geoscience and Groundwater Program, Australian Geological Survey Organisation (AGSO). The database will ultimately be operated and maintained within AGSO's corporate Oracle facilities on a Data General Aviion 6240.

MURBO is not designed to duplicate the borehole databases maintained by the state water agencies, which are continually updated to reflect the current status of groundwater bores. The database is the record or 'snapshot' of borehole information used at the time of compilation of the maps and models. The database not only stores factual data (eg water levels, chemical analyses) but also contains a level of interpretation (eg stratigraphy, regional aquifers, % sand estimates).

## 2) DATA SOURCES

Compilation of the hydrogeological maps and numerical models over the Murray Basin involves the co-operative effort between state water agencies (New South Wales Department of Water Resources, Victorian Rural Water Corporation, South Australia Department of Mines & Energy) and AGSO. Responsibility for the compilation of a particular 1:250 000 mapsheet and the attached borehole data is assigned to a sole agency on a geographical basis.

The principal data sources are the groundwater databases maintained by the agencies responsible for water resource management within each state. In New South Wales, the Department of Water Resources (DWR) is the data repository for over 60 000 water supply boreholes, containing details on location, construction, head, yield and hydrochemical measurements.[2] Open-file archives of exploration drilling in central-western NSW , mainly for coal or uranium, are available from the Geological Survey of New South Wales.[8]

The Geological Survey of Victoria maintains archives of geological information which has been collected under the auspices of mining leases. This information is usually categorised by the lease to which it applies. Groundwater related information collected within Victoria is collated by legislative enabling statute by the Rural Water Corporation. This information is held within the states' Groundwater Data Base (GDB)[5]. The GDB stores comprehensive information on the geology, stratigraphy and hydrogeology for approximately 85,000 bores. Additional information on non-groundwater bores, such as location, depth and owner, is also stored. In total, some 120,000 bores have information stored in the GDB. Regular updates and on-going backlog loading continues.

The South Australian Department of Mines & Energy (SADME) archives mainly in microfiche form, construction details, geological logs, construction details, water analyses and pump test data for over 106 000 water bores.[2] SADME is currently implementing a new corporate database for mineral, stratigraphic and water wells.

In addition to the historic borehole record, an extensive drilling program has been initiated under the current work program. Drilling has been targeted in areas of scarce historic data, principally in western New South Wales, and provides both stratigraphic information and additions to the groundwater monitoring network.

In the course of establishing a basin-wide stratigraphic framework, AGSO has access to the interpreted downhole stratigraphy of some 3000 boreholes, via the BORESTRA database.[8] The database was designed to facilitate the preparation of structure contour and isopach maps of the principal Cainozoic stratigraphic units. Petroleum exploration wells sited over the Pre-Cainozoic infrabasins are also useful sources of stratigraphic and palynological data.

## 3) THE DATABASE SCHEMA

A schema for the relational MURBO database is presented in Figure 3.1. Table GENERAL holds borehole location, elevation and construction details. The primary key field BOREID is a unique borehole identifier used to link other data tables. The BOREID field typically holds the borehole identifier assigned by the custodian agency responsible for that particular borehole.

Subsidiary look up tables store codes used to reference the state (STATE) and 1:100 000 scale mapsheet where the borehole is located (SHEET100), the relative accuracy of both its position (LOCREL) and construction date (DATEREL), the current uses (BORETYPE), condition (STATUS) and the drilling method(s) used during construction (DRILLMETH).[18]

The hierarchical relationship between 1:1 million, 1:250 000 and 1:100 000 mapsheets is defined by linking the tables SHEET1000, SHEET250 and SHEET100 respectively. The field SHEET100 is used to link the SHEET100 look up table to the GENERAL data table. The latitude, longitude and AMG coordinates of the southwest corner of each 1:100 000 mapsheet are also stored in table SHEET100. This forms the basis of checking on gross errors in borehole location.

A one-to-one relationship is maintained between tables GENERAL and GEOPHYS. The latter records the existence (Y or N) of logs for a range of downhole geophysical probes routinely used. Only one suite of borehole logs is recorded for each borehole.

Table STRAT records the downhole stratigraphy, as tops and thicknesses of geological units encountered. The field UNIT uses the accepted abbreviations for geological units of the Murray Basin as detailed in the look up table GEOL.[7,9] Descriptions of lithology, age range, depositional environment and geomorphology are held for each UNIT in table GEOL. The UNIT field forms part of the primary key of many data tables, allowing direct querying of palynology, aquifer

parameters, the SWL record and field chemistry on the basis of a distinct geological unit.

The POLLEN table records palynological data, including age ranges, palaeoenvironment, pollen speciation and diagnostic ratios for the sampling results now accumulating for the Murray Basin.[23] Analogous fields are used in the table FORAM to record foraminiferal sampling. The various age estimates use a hierarchical code developed to define subdivisions of geological time, as stored in table AGE. The code is flexible in the extent to which geological time is subdivided, from eras to subunits of epoch.

Table AQINT stores details on the aquifer interval(s) encountered during drilling and/or constructed for each borehole. The primary key is a composite of the fields BOREID, UNIT and INTTOP. Look up tables are used to reference qualitative estimates of salinity (QUALSALT) and the construction type (INTTYPE). Aquifer test conditions and interpreted hydrogeological parameters may also be recorded.

The potentiometric record for a particular aquifer interval of a borehole is maintained in table SWL. The standing water level may be stored relative to the top of casing as generally measured (SWLTOC), to the natural surface (SWLNS) or to AHD (RWL). This accommodates the various data used in the databases maintained by the state water agencies from which the majority of groundwater levels are sourced. The RWL data is used to generate potentiometric surfaces of regional aquifers.

The database structure for groundwater chemistry reflects field procedure - typically an aquifer interval is sampled, field measurements are taken and samples are dispatched to one or more laboratories. Data on the field sampling phase is stored in table SAMPLE. The primary key SAMPREF is used as a system-generated unique identifier to link to subsequent lab analyses, whether they be for major ions (MAJION), minor ions (MINION) and/or isotopes (ISOTOPE). The look up table SAMPMETH details the sampling method used.

Figure 3.2 outlines some of the terminology used in the context of an operating bore.

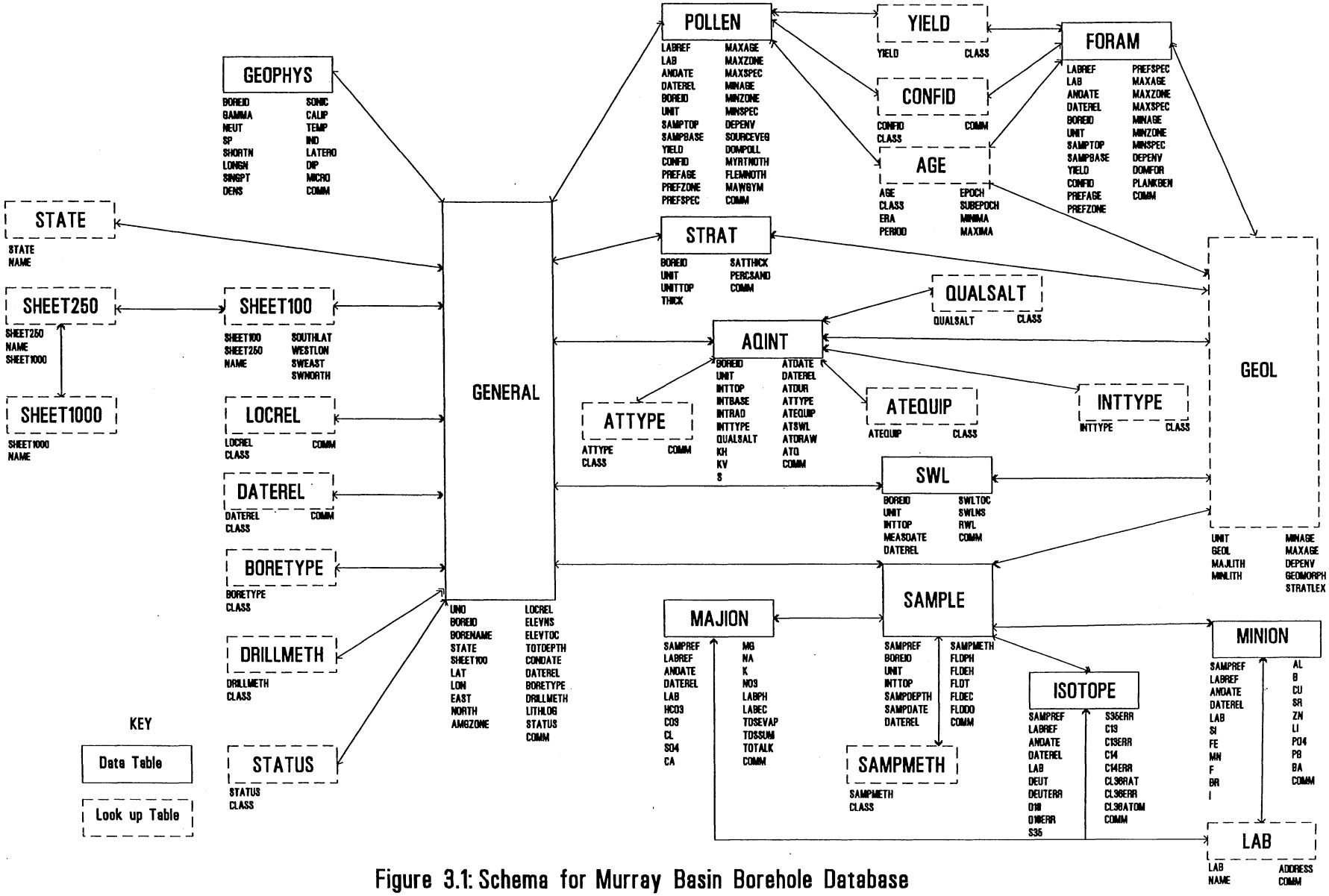
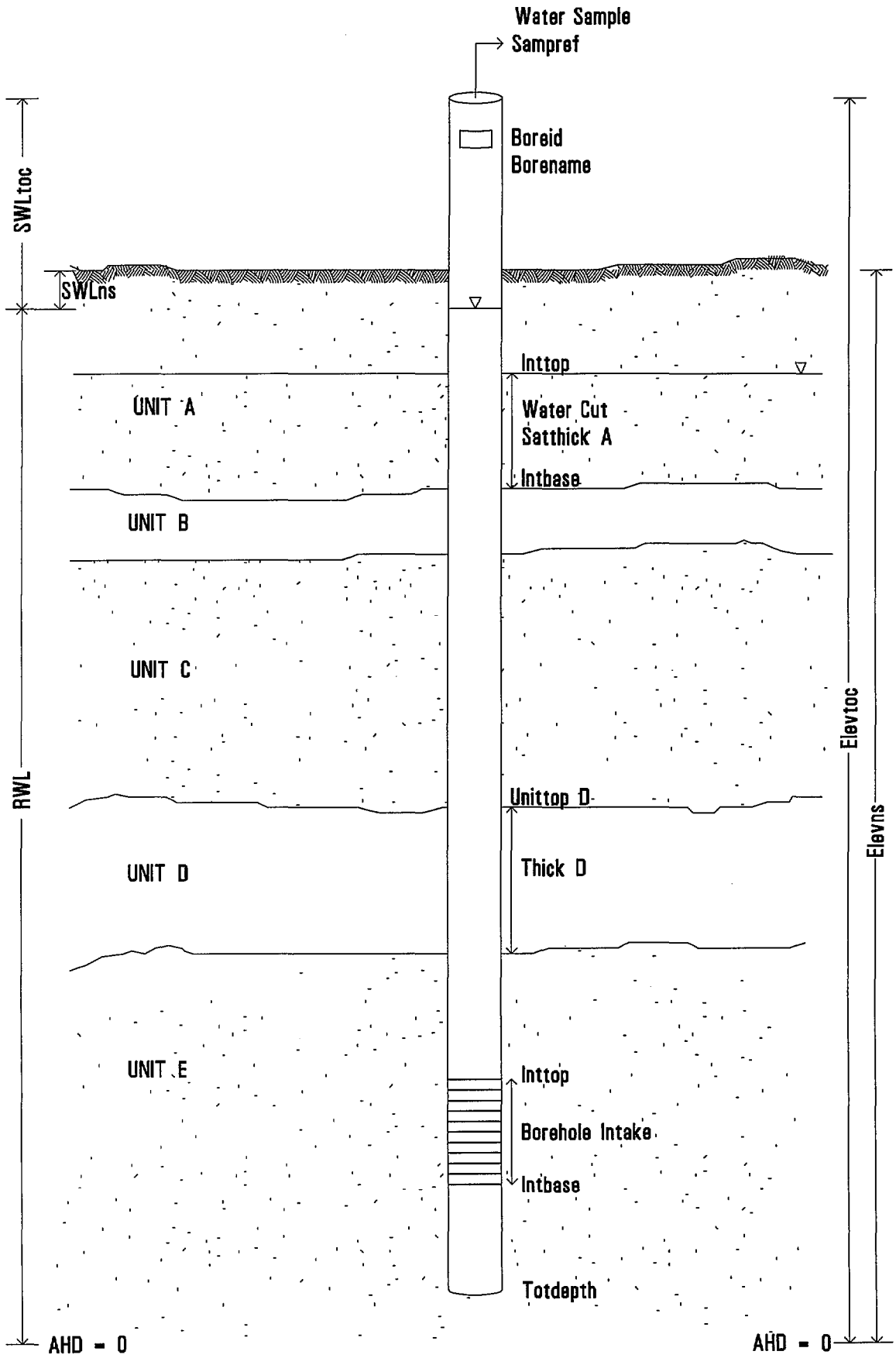



Figure 3.1: Schema for Murray Basin Borehole Database

Figure 3.2: Nomenclature used to describe borehole features.



## 4) DETAILS OF DATA TABLES

Data tables store the attributes of a borehole including location, construction, stratigraphy, aquifer details as well as the historic record of standing water levels and hydrochemistry.

### 4.1) Table: GENERAL

This table contains general information relating to boreholes; essentially location, elevation, depth and construction. The primary key BOREID is a unique borehole identifier, typically assigned by the state water agencies. This identifier is a component of the primary key for many of the other data tables. The UNO field stores a system generated unique borehole reference integer which is used to link the database to the Arc/Info geographical information system used at AGSO. The GIS contains spatial datasets compiled from the mapping and modelling, as well as natural resource, geological and geophysical information.

Borehole location is stored as decimal degrees (LAT and LON) or AMG coordinates (EAST and NORTH). The latitude (LAT) is stored as a negative value. Elevation with respect to AHD are recorded for the natural surface (ELEVNS) and the top of casing (ELEVTOC). The LITHLOG field is used to note the existence of any lithological logs ('Y' or 'N'). Look up tables are used to assign codes to some of the borehole attributes: STATE, SHEET100, LOCREL, DATEREL, BORETYPE, STATUS and DRILLMETH.

```
SQL> describe general
```

| Name | Null? | Type |
|---|---|---|
| UNO | | NUMBER(7,0) |
| BOREID | NOT NULL | CHAR(10) |
| BORENAME | | CHAR(30) |
| STATE | | CHAR(1) |
| SHEET100 | | NUMBER(4) |
| LAT | | NUMBER(7,5) |
| LON | | NUMBER(8,5) |
| EAST | | NUMBER |
| NORTH | | NUMBER |
| AMGZONE | | NUMBER(2,0) |
| LOCREL | | CHAR(1) |
| ELEVNS | | NUMBER(5,2) |
| ELEVTOC | | NUMBER(5,2) |
| TOTDEPTH | | NUMBER(6,2) |
| CONDATE | | DATE |
| DATEREL | | CHAR(4) |
| BORETYPE | | CHAR(4) |
| DRILLMETH | | CHAR(4) |
| LITHLOG | | CHAR(1) |
| STATUS | | CHAR(4) |
| COMM | | CHAR(250) |

```
SQL> select column_name, comments from user_col_comments where table_name = 'GENERAL';
COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------
UNO          SYSTEM GENERATED UNIQUE BOREHOLE REFERENCE NUMBER
BOREID       UNIQUE BOREHOLE IDENTIFIER, USUALLY ASSIGNED BY DATA SOURCE
BORENAME     NAME OF BOREHOLE
STATE        CODE FOR STATE WITHIN WHICH BOREHOLE IS LOCATED, REFERENCING STATE.STATE
SHEET100     1:100 000 MAPSHEET NUMBER WITHIN WHICH BOREHOLE IS LOCATED, REFERENCING SHEET100.SHEET100
LAT          LATITUDE OF BOREHOLE IN DECIMAL DEGREES
LON          LONGITUDE OF BOREHOLE IN DECIMAL DEGREES
EAST         AMG EASTING OF BOREHOLE
NORTH        AMG NORTHING OF BOREHOLE
AMGZONE      AMG ZONE OF BOREHOLE, EITHER 54 OR 55
LOCREL       CODE FOR METHOD OF DETERMINING BOREHOLE LOCATION, REFERENCING LOCREL.LOCREL
ELEVNS       ELEVATION OF NATURAL SURFACE AT BOREHOLE, METRES AHD
ELEVTOC      ELEVATION OF BOREHOLE TOP OF CASING, METRES AHD
TOTDEPTH     TOTAL DRILL DEPTH OF BOREHOLE, METRES
CONDATE      DATE OF COMPLETION OF BOREHOLE CONSTRUCTION
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMPLETION OF BOREHOLE CONSTRUCTION, REFERENCING
             DATEREL.DATEREL
BORETYPE     CODE FOR PRINCIPAL PURPOSE(S) OF BOREHOLE, REFERENCING BORETYPE.BORETYPE
DRILLMETH    CODE FOR DRILLING METHOD(S) USED DURING BOREHOLE CONSTRUCTION, REFERENCING
             DRILLMETH.DRILLMETH
LITHLOG      FLAG FOR EXISTENCE OF LITHOLOGICAL LOG, Y OR N
STATUS       CODE FOR CURRENT CONDITION OF BOREHOLE, REFERENCING STATUS.STATUS
COMM         GENERAL COMMENTS ABOUT BOREHOLE
```

## 4.2) Table: GEOPHYS

This data table flags the existence of downhole geophysical logs for boreholes. Either 'Y' or 'N' is assigned to each of the various logging techniques routinely used. The primary key for the table is the unique borehole identifier, BOREID.

```
SQL> describe geophys

 Name                           Null?    Type
 ------------------------------ -------- ----
 BOREID                         NOT NULL CHAR(10)
 GAMMA                                   CHAR(1)
 NEUT                                    CHAR(1)
 SP                                      CHAR(1)
 SHORTN                                  CHAR(1)
 LONGN                                   CHAR(1)
 SINGPT                                  CHAR(1)
 DENS                                    CHAR(1)
 SONIC                                   CHAR(1)
 CALIP                                   CHAR(1)
 TEMP                                    CHAR(1)
 IND                                     CHAR(1)
 LATERO                                  CHAR(1)
 DIP                                     CHAR(1)
 MICRO                                   CHAR(1)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'GEOPHYS';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------
BOREID       UNIQUE BOREHOLE IDENTIFIER
GAMMA        EXISTENCE OF DOWNHOLE GAMMA LOG
NEUT         EXISTENCE OF DOWNHOLE NEUTRON LOG
SP           EXISTENCE OF DOWNHOLE SPONTANEOUS POTENTIAL LOG
SHORTN       EXISTENCE OF DOWNHOLE SHORT NORMAL RESISTIVITY LOG
LONGN        EXISTENCE OF DOWNHOLE LONG NORMAL RESISTIVITY LOG
SINGPT       EXISTENCE OF DOWNHOLE SINGLE POINT RESISTIVITY LOG
DENS         EXISTENCE OF DOWNHOLE DENSITY LOG
SONIC        EXISTENCE OF DOWNHOLE SONIC LOG
CALIP        EXISTENCE OF DOWNHOLE CALIPER LOG
TEMP         EXISTENCE OF DOWNHOLE TEMPERATURE LOG
IND          EXISTENCE OF DOWNHOLE INDUCTION LOG
LATERO       EXISTENCE OF DOWNHOLE LATEROLOG
DIP          EXISTENCE OF DOWNHOLE DIPMETER LOG
MICRO        EXISTENCE OF DOWNHOLE MICROLOG
COMM       . COMMENTS ON GEOPHYSICAL LOGS OF BOREHOLE
```

## 4.3) Table: POLLEN

The POLLEN table holds data from palynological analyses of downhole lithological samples. The age estimates, the predicted depositional environment, the index and dominant pollen species and diagnostic pollen ratios are included as data attributes. The estimates of preferred, minimum and maximum age use the codes stored in the look up table AGE. The unique primary key is a composite of the LABREF and LAB fields. Look up tables CONFID and YIELD store the codes used to estimate the confidence level and pollen yield respectively.

```
SQL> describe pollen

 Name                           Null?    Type
 ------------------------------ -------- ----
 LABREF                         NOT NULL CHAR(20)
 LAB                                     CHAR(20)
 ANDATE                                  DATE
 DATEREL                                 CHAR(4)
 BOREID                         NOT NULL CHAR(10)
 UNIT                                    CHAR(4)
 SAMPTOP                                 NUMBER(6,2)
 SAMPBASE                                NUMBER(6,2)
 YIELD                                   NUMBER(1,0)
 CONFID                                  NUMBER(1,0)
 PREFAGE                                 CHAR(6)
 PREFZONE                                CHAR(50)
 PREFSPEC                                CHAR(100)
 MAXAGE                                  CHAR(6)
 MAXZONE                                 CHAR(50)
 MAXSPEC                                 CHAR(100)
 MINAGE                                  CHAR(6)
 MINZONE                                 CHAR(50)
 MINSPEC                                 CHAR(100)
 DEPENV                                  CHAR(50)
 SOURCEVEG                               CHAR(50)
 DOMPOLL                                 CHAR(100)
 MYRTNOTH                                NUMBER(5,3)
 FLEMNOTH                                NUMBER(5,3)
 MAWGYM                                  NUMBER(5,3)
 COMM                                    CHAR(250)

SQL> select column_name, comments from user_col_comments where table_name = 'POLLEN';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------
LABREF       SAMPLE REFERENCE NUMBER ASSIGNED BY LABORATORY OR PALYNOLOGIST
LAB          NAME OF LABORATORY OR PALYNOLOGIST, REFERENCING LAB.LAB
ANDATE       DATE OF COMPLETION OF PALYNOLOGICAL ANALYSIS
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMPLETION OF PALYNOLOGICAL ANALYSIS, REFERENCING
             DATEREL.DATEREL
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         CODE FOR GEOLOGICAL UNIT FROM WHICH SAMPLE WAS TAKEN, REFERENCING GEOL.UNIT
SAMPTOP      DEPTH TO TOP OF SAMPLING INTERVAL FROM NATURAL SURFACE, METRES
SAMPBASE     DEPTH TO BASE OF SAMPLING INTERVAL FROM NATURAL SURFACE, METRES
YIELD        ESTIMATE OF POLLEN YIELD FROM SAMPLE, REFERENCING YIELD.YIELD
CONFID       QUALITATIVE RATING OF LEVEL OF CONFIDENCE IN PALYNOLOGICAL INTERPRETATION,
             REFERENCING CONFID.CONFID
PREFAGE      CODE FOR PREFERRED AGE, REFERENCING AGE.AGE
PREFZONE     PREFERRED PALYNOLOGICAL ZONATION
PREFSPEC     INDEX SPECIES FOUND IN SAMPLE SUGGESTING PREFERRED AGE
MAXAGE       CODE FOR MAXIMUM AGE, REFERENCING AGE.AGE
MAXZONE      PALYNOLOGICAL ZONATION OF MAXIMUM AGE ESTIMATE
MAXSPEC      INDEX SPECIES USED FOR MAXIMUM AGE ESTIMATE
MINAGE       CODE FOR MINIMUM AGE, REFERENCING AGE.AGE
MINZONE      PALYNOLOGICAL ZONATION USED FOR MINIMUM AGE ESTIMATE
MINSPEC      INDEX SPECIES USED FOR MINIMUM AGE ESTIMATE
DEPENV       INTERPRETED PALAEOENVIRONMENT BASED ON PALYNOLOGY
SOURCEVEG    SOURCE OF VEGETATION
DOMPOLL      DOMINANT POLLEN SPECIES IN SAMPLE
MYRTNOTH     POLLEN RATIO MYRTACEAE/NOTHOFAGIDITES
FLEMNOTH     POLLEN RATIO N.FLEMINGII/NOTHOFAGIDITES
MAWGYM       POLLEN RATIO P.MAWSONII/GYMNOSPERM
COMM         GENERAL COMMENTS ON PALYNOLOGICAL SAMPLE
```

### 4.4) Table: FORAM

The FORAM table holds data from foraminiferal analyses in a similar fashion to the POLLEN table. The unique primary key is a composite of the LABREF and LAB fields. Look up tables CONFID and YIELD store the codes used to estimate the confidence level and foram yield respectively.

```
SQL> describe foram
 Name                           Null?    Type
 ------------------------------ -------- ----
 LABREF                         NOT NULL CHAR(20)
 LAB                                     CHAR(20)
 ANDATE                                  DATE
 DATEREL                                 CHAR(4)
 BOREID                         NOT NULL CHAR(10)
 UNIT                                    CHAR(4)
 SAMPTOP                                 NUMBER(6,2)
 SAMPBASE                                NUMBER(6,2)
 YIELD                                   NUMBER(1,0)
 CONFID                                  NUMBER(1,0)
 PREFAGE                                 CHAR(6)
 PREFZONE                                CHAR(50)
 PREFSPEC                                CHAR(100)
 MAXAGE                                  CHAR(6)
 MAXZONE                                 CHAR(50)
 MAXSPEC                                 CHAR(100)
 MINAGE                                  CHAR(6)
 MINZONE                                 CHAR(50)
 MINSPEC                                 CHAR(100)
 DEPENV                                  CHAR(50)
 DOMFOR                                  CHAR(100)
 PLANKBEN                                NUMBER(2,2)
 COMM                                    CHAR(250)
```

```
SQL> select column_name, comments from user_col_comments where table_name = 'FORAM';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------
LABREF       SAMPLE REFERENCE NUMBER ASSIGNED BY LABORATORY OR FORAMINIFERALOGIST
LAB          NAME OF LABORATORY OR FORAMINIFEROLOGIST, REFERENCING LAB.LAB
ANDATE       DATE OF COMPLETION OF FORAM ANALYSIS
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMPLETION OF FORAM ANALYSIS, REFERENCING DATEREL.DATEREL
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         CODE FOR GEOLOGICAL UNIT FROM WHICH SAMPLE WAS TAKEN, REFERENCING GEOL.UNIT
SAMPTOP      DEPTH TO TOP OF SAMPLING INTERVAL FROM NATURAL SURFACE, METRES
SAMPBASE     DEPTH TO BASE OF SAMPLING INTERVAL FROM NATURAL SURFACE, METRES
YIELD        ESTIMATE OF FORAM YIELD FROM SAMPLE, REFERENCING YIELD.YIELD
CONFID       QUALITATIVE RATING OF LEVEL OF CONFIDENCE IN FORAM INTERPRETATION,
             REFERENCING CONFID.CONFID
PREFAGE      CODE FOR PREFERRED AGE, REFERENCING AGE.AGE
PREFZONE     PREFERRED FORAM ZONATION
PREFSPEC     INDEX SPECIES FOUND IN SAMPLE SUGGESTING PREFERRED AGE
MAXAGE       CODE FOR MAXIMUM AGE, REFERENCING AGE.AGE
MAXZONE      FORAM ZONATION OF MAXIMUM AGE ESTIMATE
MAXSPEC      INDEX SPECIES USED FOR MAXIMUM AGE ESTIMATE
MINAGE       CODE FOR MINIMUM AGE, REFERENCING AGE.AGE
MINZONE      FORAM ZONATION USED FOR MINIMUM AGE ESTIMATE
MINSPEC      INDEX SPECIES USED FOR MINIMUM AGE ESTIMATE
DEPENV       INTERPRETED PALAEOENVIRONMENT BASED ON FORAMINIFERA
DOMFOR       DOMINANT FORAM SPECIES IN SAMPLE
PLANKBEN     RATIO BETWEEN PLANKTONIC AND BENTHONIC FORAMINIFERA
COMM         GENERAL COMMENTS ON FORAM SAMPLE
```

### 4.5) Table: STRAT

The STRAT table details downhole stratigraphy. The primary key is a composite of the fields BOREID, UNIT and UNITTOP, uniquely defining each stratigraphic unit intersected in a borehole. Generally, accepted abbreviations for units in the Murray Basin Cainozoic succession as well as the Pre-Tertiary basement are used in the UNIT field, linking to the primary key of table GEOL.

The field PERCSAND, an estimate of percentage sand averaged over the thickness of the unit, is particularly useful in averaging hydrogeological parameters derived from pump tests. This may be estimated from either the geophysical or lithological logs. The following criteria has been used to derive a PERCSAND for a sequence of interbedded sediments from driller's logs [20]:

Sandy Clay = 40% Sand
Clayey Sand = 60% Sand
Sandstone, Sandrock = 80% Sand
Drift = 100% Sand

```
SQL> describe strat

 Name                           Null?    Type
 ------------------------------ -------- ----
 BOREID                         NOT NULL CHAR(10)
 UNIT                           NOT NULL CHAR(4)
 UNITTOP                                 NUMBER(6,2)
 THICK                                   NUMBER(6,2)
 SATTHICK                                NUMBER(6,2)
 PERCSAND                                NUMBER(4,1)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'STRAT';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         CODE FOR GEOLOGICAL UNIT, REFERENCING GEOL.UNIT
UNITTOP      DEPTH TO TOP OF UNIT FROM NATURAL SURFACE, METRES
THICK        DOWNHOLE TOTAL THICKNESS OF UNIT, METRES
SATTHICK     DOWNHOLE SATURATED THICKNESS OF UNIT, METRES
PERCSAND     PERCENTAGE SAND AVERAGED OVER DOWNHOLE THICKNESS OF UNIT
COMM         COMMENTS ON INTERSECTION OF GEOLOGICAL UNIT
```

### 4.6) Table: AQINT

The AQINT table contains the record of aquifer intervals intersected downhole. These may be water cuts intersected and tested during drilling or the final production intake for the operating bore. Each aquifer interval may be distinguished by the composite primary key made up of the fields BOREID, UNIT and INTTOP. Subsequent pump test data, water level measurements and hydrochemical sampling may be referenced back to an aquifer interval of a particular borehole. Look up tables are used for the construction type (INTTYPE) and qualitative estimates of groundwater salinity (QUALSALT). Basic aquifer test variables and interpreted hydrogeological parameters are also included in the table.

```
SQL> describe aqint

 Name                           Null?    Type
 ------------------------------ -------- ----
 BOREID                         NOT NULL CHAR(10)
 UNIT                                    CHAR(4)
 INTTOP                                  NUMBER(6,2)
 INTBASE                                 NUMBER(6,2)
 INTRAD                                  NUMBER(4,3)
 INTTYPE                                 CHAR(4)
 QUALSALT                                NUMBER(1)
 KH                                      NUMBER
 KV                                      NUMBER
 S                                       NUMBER
 ATDATE                                  DATE
 DATEREL                                 CHAR(4)
 ATDUR                                   NUMBER
 ATTYPE                                  CHAR(4)
 ATEQUIP                                 CHAR(1)
 ATSWL                                   NUMBER(5,2)
 ATDRAW                                  NUMBER(5,2)
 ATQ                                     NUMBER
 COMM                                    CHAR(100)
```

```
SQL> select column_name, comments from user_col_comments where table_name = 'AQINT';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         GEOLOGICAL UNIT COMPRISING AQUIFER INTERVAL, REFERENCING GEOL.UNIT
INTTOP       METRES DEPTH TO TOP OF BOREHOLE INTAKE INTERVAL FROM NATURAL SURFACE
INTBASE      METRES DEPTH TO BASE OF BOREHOLE INTAKE INTERVAL FROM NATURAL SURFACE
INTRAD       METRES RADIUS OF BOREHOLE INTAKE
INTTYPE      CODE(S) FOR CONSTRUCTION TYPE OF BOREHOLE INTAKE, REFERENCING INTTYPE.INTTYPE
QUALSALT     QUALITATIVE SALINITY ESTIMATE CODE, REFERENCING QUALSALT.QUALSALT
KH           ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY, M/DAY
KV           ESTIMATED VERTICAL HYDRAULIC CONDUCTIVITY, M/DAY
S            ESTIMATED STORAGE COEFFICIENT
ATDATE       DATE OF COMMENCEMENT OF AQUIFER TEST
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMMENCEMENT OF AQUIFER TEST, REFERENCING DATEREL.DATEREL
ATDUR        DURATION OF AQUIFER TEST, DAYS
ATTYPE       CODE FOR TYPE OF AQUIFER TEST, REFERENCING ATTYPE.ATTYPE
ATEQUIP      CODE FOR TYPE OF AQUIFER TEST EQUIPMENT, REFERENCING ATEQUIP.ATEQUIP
ATSWL        STANDING WATER LEVEL IN METRES RELATIVE TO NATURAL SURFACE, POSITIVE BEING ARTESIAN,
             AT START OF AQUIFER TEST
ATDRAW       STANDING WATER LEVEL IN METRES RELATIVE TO NATURAL SURFACE, POSITIVE BEING ARTESIAN,
             AT END OF AQUIFER TEST.
ATQ          AVERAGE AQUIFER TEST DISCHARGE RATE, CUBIC METRES/DAY
COMM         COMMENTS ON AQUIFER INTERVAL
```

### 4.7) Table: SWL

The SWL table contains the historic record of standing water level measurements of particular aquifer intervals. These includes levels measured from water cuts intersected during drilling, as well as routine observations made of operating bores. The primary key is a composite of the fields BOREID, UNIT, INTTOP and MEASDATE. Head measurements may be recorded relative to the top of casing as commonly measured (SWLTOC), to the natural surface (SWLNS) or to AHD (RWL). The field RWL should be stored at the precision accorded by the measurement of both SWLTOC (or SWLNS) and GENERAL.ELEVTOC (or GENERAL.ELEVNS). Artesian bores have positive SWL measurements, while watertable and subartesian bores have negative SWL measurements.

```
SQL> describe swl

 Name                           Null?    Type
 ------------------------------ -------- ----
 BOREID                         NOT NULL CHAR(10)
 UNIT                                    CHAR(4)
 INTTOP                                  NUMBER(6,2)
 MEASDATE                                DATE
 DATEREL                                 CHAR(4)
 SWLTOC                                  NUMBER(6,2)
 SWLNS                                   NUMBER(6,2)
 RWL                                     NUMBER(6,2)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'SWL';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         CODE FOR GEOLOGICAL UNIT COMPRISING AQUIFER, REFERENCING GEOL.UNIT
INTTOP       DEPTH TO TOP OF AQUIFER INTERVAL FROM NATURAL SURFACE, METRES
MEASDATE     DATE OF STANDING WATER LEVEL MEASUREMENT
DATEREL      CODE FOR RELIABILITY OF DATE FOR STANDING WATER LEVEL MEASUREMENT, REFERENCING
             DATEREL.DATEREL
SWLTOC       STANDING WATER LEVEL IN METRES RELATIVE TO TOP OF CASING, POSITIVE BEING ARTESIAN
SWLNS        STANDING WATER LEVEL IN METRES RELATIVE TO NATURAL SURFACE, POSITIVE BEING ARTESIAN
RWL          ELEVATION OF STANDING WATER LEVEL, AHD
COMM         COMMENTS ON SWL MEASUREMENT
```

## 4.8) Table: SAMPLE

The SAMPLE table records field sampling of groundwater derived from particular aquifer intervals. The primary key SAMPREF is a system generated number referencing a sampling episode of a particular aquifer interval (defined by the fields BOREID, UNIT, INTTOP) on a particular day (SAMPDATE) and depth (SAMPDEPTH). SAMPREF is then used to link any subsequent laboratory analyses (major ion, minor ion &/or isotope) undertaken on the water sample. Routine field measurements such as pH, Eh, temperature, conductivity and dissolved oxygen are held in this table.

```
SQL> describe sample

 Name                           Null?    Type
 ------------------------------ -------- ----
 SAMPREF                        NOT NULL NUMBER(7)
 BOREID                                  CHAR(10)
 UNIT                                    CHAR(4)
 INTTOP                                  NUMBER(6,2)
 SAMPDEPTH                               NUMBER(6,2)
 SAMPDATE                                DATE
 DATEREL                                 CHAR(4)
 SAMPMETH                                CHAR(1)
 FLDPH                                   NUMBER(3,1)
 FLDEH                                   NUMBER(4)
 FLDT                                    NUMBER(4,1)
 FLDEC                                   NUMBER(6)
 FLDDO                                   NUMBER(3,1)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'SAMPLE';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
SAMPREF      SYSTEM GENERATED SAMPLE REFERENCE NUMBER
BOREID       UNIQUE BOREHOLE IDENTIFIER
UNIT         CODE FOR GEOLOGICAL UNIT COMPRISING SAMPLED AQUIFER
INTTOP       DEPTH TO TOP OF AQUIFER INTERVAL FROM NATURAL SURFACE, METRES
SAMPDEPTH    GROUNDWATER SAMPLING DEPTH FROM NATURAL SURFACE, METRES
SAMPDATE     DATE OF GROUNDWATER SAMPLING
DATEREL      CODE FOR RELIABILITY OF DATE FOR GROUNDWATER SAMPLING, REFERENCING DATEREL.DATEREL
SAMPMETH     CODE FOR SAMPLING METHOD USED, REFERENCING SAMPMETH.SAMPMETH
FLDPH        FIELD PH MEASUREMENT
FLDEH        FIELD EH MEASUREMENT IN MILLIVOLTS
FLDT         FIELD GROUNDWATER TEMPERATURE IN DEGREES CELSIUS
FLDEC        FIELD ELECTRICAL CONDUCTIVITY IN US/CM
FLDDO        FIELD DISSOLVED OXYGEN IN MG/L
COMM         COMMENTS ON GROUNDWATER SAMPLING OF BOREHOLE
```

## 4.9) Table: MAJION

The MAJION table stores the major ion chemistry for groundwater from particular aquifer intervals. Details on the origin of the water sample may be derived from table SAMPLE via the common field SAMPREF. The primary key is a composite of SAMPREF and LABREF, accommodating duplicate samples. Major ion analyses and routine lab measurements such as conductivity, pH and alkalinity are included in the table. Where ion analyses are below the detection limit, a negative value is entered in the field eg. -0.1 is recorded for an analysis less than a 0.1mg/L detection limit. This acknowledges that detection limits have improved significantly with the advent of new technologies.
An analysis with a value less than a detection limit of 5 mg/L usually (recorded as <5 mg/L in lab results) is different from a later analysis of 5.0 with a detection limit of 0.1 mg/L. Note that the analytical results may require recalculating, depending on how they were originally reported eg. nitrate values expressed as N in lab records require recalculation to NO3.

```
SQL> describe majion
```

| Name | Null? | Type |
|---|---|---|
| SAMPREF | NOT NULL | NUMBER(7) |
| LABREF | | CHAR(20) |
| ANDATE | | DATE |
| DATEREL | | CHAR(4) |
| LAB | | CHAR(20) |
| HCO3 | | NUMBER |
| CO3 | | NUMBER |
| CL | | NUMBER |
| SO4 | | NUMBER |
| CA | | NUMBER |
| MG | | NUMBER |
| NA | | NUMBER |
| K | | NUMBER |
| NO3 | | NUMBER |
| LABPH | | NUMBER(4,2) |
| LABEC | | NUMBER |
| TDSEVAP | | NUMBER(7) |
| TDSSUM | | NUMBER(7) |
| TOTALK | | NUMBER |
| COMM | | CHAR(100) |

```
SQL> select column_name, comments from user_col_comments where table_name = 'MAJION';
```

| COLUMN_NAME | COMMENTS |
|---|---|
| SAMPREF | SYSTEM GENERATED SAMPLE REFERENCE NUMBER, AS IN SAMPLE.SAMPREF |
| LABREF | SAMPLE REFERENCE NUMBER DESIGNATED BY ANALYTICAL LABORATORY |
| ANDATE | DATE OF COMPLETION OF ANALYSIS |
| DATEREL | CODE FOR RELIABILITY OF DATE FOR COMPLETION OF ANALYSIS, REFERENCING DATEREL.DATEREL |
| LAB | LABORATORY WHICH ANALYSED THE SAMPLE, REFERENCING LAB.LAB |
| HCO3 | BICARBONATE AS HCO3 IN MG/L |
| CO3 | CARBONATE AS CO3 IN MG/L |
| CL | DISSOLVED CHLORIDE AS CL IN MG/L |
| SO4 | DISSOLVED SULPHATE AS SO4 IN MG/L |
| CA | CALCIUM AS CA IN MG/L |
| MG | MAGNESIUM AS MG IN MG/L |
| NA | SODIUM AS NA IN MG/L |
| K | POTASSIUM AS K IN MG/L |
| NO3 | DISSOLVED NITRATE AS NO3 IN MG/L |
| LABPH | LABORATORY PH AT 25 DEGREES CELSIUS |
| LABEC | LABORATORY ELECTRICAL CONDUCTIVITY AT 25 DEGREES CELSIUS IN US/CM |
| TDSEVAP | TOTAL DISSOLVED SOLIDS BY EVAPORATION IN MG/L |
| TDSSUM | TOTAL DISSOLVED SOLIDS BY SUMMATION IN MG/L |
| TOTALK | TOTAL ALKALINITY AS CACO3 IN MG/L |
| COMM | COMMENTS ON MAJOR ION ANALYSES OF GROUNDWATER SAMPLE |

### 4.10) Table: MINION

The MINION table stores the minor ion chemistry for groundwater from particular aquifer intervals. Details on the origin of the water sample may be derived from table SAMPLE via the common field SAMPREF. The primary key is a composite of SAMPREF and LABREF, accommodating duplicate samples. Negative values are used for ion analyses less than the detection limit.

```
SQL> describe minion

 Name                           Null?    Type
 ------------------------------ -------- ----
 SAMPREF                        NOT NULL NUMBER(7)
 LABREF                                  CHAR(20)
 ANDATE                                  DATE
 DATEREL                                 CHAR(4)
 LAB                                     CHAR(20)
 SI                                      NUMBER
 FE                                      NUMBER
 MN                                      NUMBER
 F                                       NUMBER
 BR                                      NUMBER
 I                                       NUMBER
 AL                                      NUMBER
 B                                       NUMBER
 CU                                      NUMBER
 SR                                      NUMBER
 ZN                                      NUMBER
 LI                                      NUMBER
 PO4                                     NUMBER
 PB                                      NUMBER
 BA                                      NUMBER
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'MINION';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
SAMPREF      SYSTEM GENERATED SAMPLE REFERENCE, AS IN SAMPLE.SAMPREF
LABREF       SAMPLE REFERENCE NUMBER DESIGNATED BY ANALYTICAL LABORATORY
ANDATE       DATE OF COMPLETION OF ANALYSIS
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMPLETION OF ANALYSIS, REFERENCING DATEREL.DATEREL
LAB          LABORATORY WHICH ANALYSED THE SAMPLE, REFERENCING LAB.LAB
SI           DISSOLVED SILICA AS SI IN MG/L
FE           DISSOLVED IRON AS FE IN MG/L
MN           DISSOLVED MANGANESE AS MN IN MG/L
F            DISSOLVED FLUORIDE AS F IN MG/L
BR           DISSOLVED BROMIDE AS BR IN MG/L
I            DISSOLVED IODIDE AS I IN MG/L
AL           ALUMINIUM AS AL IN MG/L
B            BORON AS B IN MG/L
CU           COPPER AS CU IN MG/L
SR           STRONTIUM AS SR IN MG/L
ZN           ZINC AS ZN IN MG/L
LI           LITHIUM AS LI IN MG/L
PO4          DISSOLVED PHOSPHATE AS PO4 IN MG/L
PB           LEAD AS PB IN MG/L
BA           BARIUM AS BA IN MG/L
COMM         COMMENTS ON MINOR ION ANALYSIS OF GROUNDWATER SAMPLE
```

### 4.11) Table: ISOTOPE

The ISOTOPE table stores the isotope chemistry for groundwater from particular aquifer intervals. Details on the origin of the water sample may be derived from table SAMPLE via the common field SAMPREF. The primary key is a composite of SAMPREF and LABREF, which allows duplicate samples to be recorded.

```
SQL> describe isotope

 Name                           Null?    Type
 ------------------------------ -------- ----
 SAMPREF                        NOT NULL NUMBER(7)
 LABREF                                  CHAR(20)
 ANDATE                                  DATE
 DATEREL                                 CHAR(4)
 LAB                                     CHAR(20)
 DEUT                                    NUMBER(5,1)
 DEUTERR                                 NUMBER(5,1)
 O18                                     NUMBER(7,3)
 O18ERR                                  NUMBER(7,3)
 S35                                     NUMBER(5,1)
 S35ERR                                  NUMBER(5,1)
 C13                                     NUMBER(5,1)
 C13ERR                                  NUMBER(5,1)
 C14                                     NUMBER(5,1)
 C14ERR                                  NUMBER(5,1)
 CL36RAT                                 NUMBER(4)
 CL36ERR                                 NUMBER(4)
 CL36ATOM                                NUMBER(5)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'ISOTOPE';

COLUMN_NAME  COMMENTS
------------ --------------------------------------------------------------------------------
SAMPREF      SYSTEM GENERATED SAMPLE REFERENCE NUMBER AS IN SAMPLE.SAMPREF
LABREF       SAMPLE REFERENCE NUMBER DESIGNATED BY LABORATORY
ANDATE       COMPLETION DATE OF ANALYSIS
DATEREL      CODE FOR RELIABILITY OF DATE FOR COMPLETION OF ANALYSIS, REFERENCING DATEREL.DATEREL
LAB          LABORATORY WHICH ANALYSED SAMPLE, REFERENCING LAB.LAB
DEUT         DEUTERIUM PERCENTILE
DEUTERR      DEUTERIUM ERROR
O18          OXYGEN 18 PERCENTILE
O18ERR       OXYGEN 18 ERROR
S35          SULPHUR 35 PERCENTILE
S35ERR       SULPHUR 35 ERROR
C13          CARBON 13 PERCENTILE
C13ERR       CARBON 13 ERROR
C14          CARBON 14 PERCENTILE
C14ERR       CARBON 14 ERROR
CL36RAT      CHLORINE 36 RATIO X10E-15
CL36ERR      CHLORINE 36 ERROR X10E-15
CL36ATOM     CHLORINE 36 ATOMS X10E6/L
COMM         COMMENTS ON ISOTOPIC ANALYSIS OF GROUNDWATER SAMPLE
```

## 5) DETAILS OF LOOK UP TABLES

Look up tables are used in the MURBO database to store attribute abbreviations and definitions. The abbreviations are used in the data tables. This is particularly true for table GENERAL which stores location, elevation and construction details of boreholes. In most instances, identifiable single character codes have been used (eg. 'S' for 'STRATIGRAPHIC') as this aids recognition of correct coding during data entry and database query operations.

### 5.1) Table: STATE

The STATE look up table lists the abbreviations and names of the states that include parts of the Murray Basin within their borders; New South Wales, Victoria and South Australia. The field STATE.STATE is referenced for each borehole in table GENERAL by field STATE.

```
SQL> describe state

 Name                           Null?    Type
 ------------------------------ -------- ----
 STATE                          NOT NULL CHAR(1)
 NAME                                    CHAR(20)

SQL> select column_name, comments from user_col_comments where table_name = 'STATE';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
STATE           CODE FOR STATE, REFERENCED BY GENERAL.STATE
NAME            NAME OF STATE

SQL> select * from state order by state;

STATE  NAME
-----  --------------------
N      NEW SOUTH WALES
S      SOUTH AUSTRALIA
V      VICTORIA

3 records selected
```

### 5.2) Table: LOCREL

The LOCREL look up table holds codes for the methods used in determining the location of a borehole. The primary key LOCREL.LOCREL is referenced in table GENERAL by field LOCREL. This field gives an indication of the degree of accuracy to which spatial coordinates have been determined for boreholes.

```
SQL> describe locrel

 Name                           Null?    Type
 ------------------------------ -------- ----
 LOCREL                         NOT NULL CHAR(1)
 CLASS                                   CHAR(20)
 COMM                                    CHAR(50)

SQL> select column_name, comments from user_col_comments where table_name = 'LOCREL';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
LOCREL          CODE FOR METHOD OF DETERMINING BOREHOLE LOCATION, REFERENCED BY GENERAL.LOCREL
CLASS           METHOD OF DETERMINING LOCATION OF BOREHOLE
COMM            COMMENTS ON METHOD TO DETERMINE BOREHOLE LOCATION
```

```
SQL> select * from locrel order by locrel;

LOCREL  CLASS            COMM
------- ---------------- --------------------------------------------------
D       DIFFERENTIAL GPS DIFFERENTIAL GLOBAL POSITIONING SYSTEM
F       FIELD            ESTIMATED FROM FIELD OBSERVATIONS
G       GPS              STANDARD GLOBAL POSITIONING SYSTEM
M       MAP              ESTIMATED FROM A PUBLISHED MAP
N       NOT SURVEYED     METHOD OF ESTIMATION UNKNOWN
O       OWNER            ESTIMATED FROM OWNER RETURNS
S       SURVEYED         TRADITIONAL SURVEY TECHNIQUES

7 records selected
```

## 5.3) Table: DATEREL

The DATEREL look up table holds codes denoting the reliability attached to the date fields found in the data tables (eg. CONDATE in the GENERAL table). This field recognises that many dates for key events, such as completion of borehole construction or groundwater sampling, may be poorly known. If only the year is known, the middle of that year should be entered (ie 30-JUN-1956) and 'Y' entered in the DATEREL column. If the event occurred before that year, the same date should be entered as above but 'BY' entered in DATEREL. Likewise, if only the month of the year is known, the middle of the month should be entered (ie 15-AUG-1956) and 'M' entered in the DATEREL column.

```
SQL> describe daterel

 Name                           Null?    Type
 ------------------------------ -------- ----
 DATEREL                        NOT NULL CHAR(1)
 CLASS                                   CHAR(20)
 COMM                                    CHAR(50)

SQL> select column_name, comments from user_col_comments where table_name = 'LOCREL';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------
DATEREL         CODE FOR RELIABILITY OF DATE, REFERENCED IN TABLES GENERAL, POLLEN, FORAM, AQINT,
                SAMPLE, MAJION, MINION AND ISOTOPE
CLASS           DEGREE OF RELIABILITY ATTACHED TO DATE
COMM            COMMENTS ON DATE RELIABILITY CODE

SQL> select * from locrel order by locrel;

DATEREL  CLASS           COMM
-------- --------------- --------------------------------------------------
A        APPROXIMATE
B        BEFORE          BEFORE THIS DATE
E        ERROR           POSSIBLY IN ERROR
M        MONTH           ONLY MONTH AND YEAR KNOWN
P        POST            POST THIS DATE
Y        YEAR            ONLY YEAR KNOWN

6 records selected
```

## 5.4) Table: BORETYPE

The BORETYPE look up table holds codes for the principal purpose(s) of the borehole. Up to four BORETYPE.BORETYPE codes may be used for each borehole in table GENERAL within the field BORETYPE. This reflects the fact that a borehole may be ultimately used for a number of purposes eg 'HL' indicates both livestock and domestic usage.

```
SQL> describe boretype

 Name                           Null?    Type
 ------------------------------ -------- ----
 BORETYPE                       NOT NULL CHAR(1)
 CLASS                                   CHAR(25)
```

```
SQL> select column_name, comments from user_col_comments where table_name = 'BORETYPE';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
BORETYPE        CODE FOR PRINCIPAL PURPOSE OF BOREHOLE, REFERENCED BY GENERAL.BORETYPE
CLASS           PRINCIPAL PURPOSE OF BOREHOLE

SQL> select * from boretype order by boretype;

BORETYPE  CLASS
--------- ------------------------
A         IRRIGATION OR AGRICULTURE
C         COAL EXPLORATION
D         DRAINAGE DISPOSAL
E         ENGINEERING INVESTIGATION
F         INDUSTRIAL
G         GROUNDWATER EXPLORATION
H         DOMESTIC
I         GROUNDWATER INTERCEPTION
L         LIVESTOCK
M         MINERAL EXPLORATION
N         RECHARGE
O         OBSERVATION
P         PETROLEUM EXPLORATION
R         RAIL OR ROAD CONSTRUCTION
S         STRATIGRAPHIC
T         TOWN WATER
W         WASTE DISPOSAL

17 records selected.
```

### 5.5) Table: DRILLMETH

The DRILLMETH look up table holds codes for the drilling method(s) used during construction of the borehole.[15,17] The primary key DRILLMETH.DRILLMETH is referenced for each borehole by field DRILLMETH in table GENERAL. The single character codes may be concatenated in field GENERAL.DRILLMETH, the order representing the relative prominence of multiple drilling methods used (eg 'MD' for a rotary mud hole that has been cored for some critical zones).

```
SQL> describe drillmeth

 Name                           Null?    Type
 ------------------------------ -------- ----
 DRILLMETH                      NOT NULL CHAR(1)
 CLASS                                   CHAR(25)

SQL> select column_name, comments from user_col_comments where table_name = 'DRILLMETH';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
DRILLMETH       DRILLING METHOD CODE, REFERENCED BY GENERAL.DRILLMETH
CLASS           DRILLING METHOD USED DURING BOREHOLE CONSTRUCTION

SQL> select * from drillmeth order by drillmeth;

DRILLMETH  CLASS
---------- ------------------------
A          ROTARY AIR
C          CABLE TOOL
D          DIAMOND
F          DRIVEN
H          HAND DUG WELL
I          REVERSE CIRCULATION
J          JETTED
M          ROTARY MUD
P          ROTARY PERCUSSION
R          ROTARY
S          AUGER

11 records selected.
```

### 5.6) Table: STATUS

The STATUS look up table holds codes for the current condition of borehole. Combinations of the primary key STATUS.STATUS may be used in the field STATUS in table GENERAL eg. 'AN' for an abandoned, non flowing bore. This field is particularly useful in highlighting flowing bores.

```
SQL> describe status

 Name                           Null?    Type
 ------------------------------ -------- ----
 STATUS                         NOT NULL CHAR(1)
 CLASS                                   CHAR(50)

SQL> select column_name, comments from user_col_comments where table_name = 'STATUS';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
STATUS          CODE FOR CURRENT CONDITION OF BOREHOLE, REFERENCED BY GENERAL.STATUS
CLASS           BOREHOLE CONDITION CATEGORY

SQL> select * from status;

STATUS CLASS
------ --------------------------------------------------
A      ABANDONED, NOT OPERATIONAL
C      CEASED FLOWING
F      FLOWING
N      NON FLOWING
O      ORIGINALLY FLOWING, PRESENT STATE UNKNOWN
Q      NOT IN USE, BUT OPERATIONAL
R      RECONDITIONED
T      TEST HOLE, NEVER USED
U      CURRENTLY IN USE

9 records selected.
```

### 5.7) Table: SHEET100

The SHEET100 look up table holds details of the 1:100 000 mapsheet coverage over the Murray Basin. Field SHEET100.SHEET100 is referenced for each borehole by the 1:100 000 mapsheet number stored in field SHEET100 in table GENERAL.The column SHEET250 links the 1:100 000 mapsheet to its 1:250 000 mapsheet, stored in table SHEET250. The latitude, longitude and AMG coordinates for the southwest corner of the mapsheet are also stored. As each 1:100 000 mapsheet is 0.5 by 0.5 degree square, these attributes are sufficient to define constraints on the location of boreholes.

```
SQL> describe sheet100
 Name                           Null?    Type
 ------------------------------ -------- ----
 SHEET100                       NOT NULL NUMBER(4)
 SHEET250                                CHAR(7)
 NAME                                    CHAR(13)
 SOUTHLAT                                NUMBER(3,1)
 WESTLON                                 NUMBER(4,1)
 SWEAST                                  NUMBER(6)
 SWNORTH                                 NUMBER(7)

SQL> select column_name, comments from user_col_comments where table_name = 'SHEET100';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
SHEET100        REFERENCE NUMBER FOR 1:100 000 MAPSHEET, REFERENCED BY GENERAL.SHEET100
SHEET250        REFERENCE NUMBER OF ENCOMPASSING 1:250 000 MAPSHEET, REFERENCING SHEET250.SHEET250
NAME            NAME OF 1:100 000 MAPSHEET
SOUTHLAT        MOST SOUTHERLY LATITUDE OF 1:100 000 MAPSHEET IN DECIMAL DEGREES
WESTLON         MOST WESTERLY LONGITUDE OF 1:100 000 MAPSHEET IN DECIMAL DEGREES
SWEAST          AMG EASTING OF SOUTHWEST CORNER OF 1:100 000 MAPSHEET
SWNORTH         AMG NORTHING OF SOUTHWEST CORNER OF 1:100 000 MAPSHEET
```

```
SQL> select * from sheet100 order by name;
```

| SHEET100 | SHEET250 | NAME | SOUTHLAT | WESTLON | SWEAST | SWNORTH |
|---|---|---|---|---|---|---|
| 7226 | SI54-15 | ALBACUTYA | -36 | 141.5 | 545064 | 6015922 |
| 6932 | SI54-2 | ANABAMA | -33 | 140 | 406581 | 6348256 |
| 7430 | SI54-8 | ARUMPO | -34 | 142.5 | 638528 | 6236816 |
| 7733 | SI55-1 | BADEN PARK | -32.5 | 144 | 218126 | 6400161 |
| 7628 | SI54-12 | BALRANALD | -35 | 143.5 | 728154 | 6124087 |
| 7128 | SI54-11 | BELLBIRD | -35 | 141 | 500000 | 6126943 |
| 8026 | SI55-14 | BERRIGAN | -36 | 145.5 | 364803 | 6014997 |
| 7529 | SI54-12 | BIDURA | -34.5 | 143 | 683620 | 6180573 |
| 7426 | SI54-16 | BIRCHIP | -36 | 142.5 | 635196 | 6014997 |
| 7432 | SI54-4 | BONO | -33 | 142.5 | 640130 | 6347701 |
| 7532 | SI54-4 | BOOLABOOLKA | -33 | 143 | 686847 | 6346923 |
| 7830 | SI55-5 | BOOLIGAL | -34 | 144.5 | 269101 | 6235013 |
| 7132 | SI54-3 | BUCKALOW | -33 | 141 | 500000 | 6348700 |
| 7230 | SI54-7 | BUNNERUNGEE | -34 | 141.5 | 546174 | 6237718 |
| 8126 | SI55-14 | BURAJA | -36 | 146 | 409870 | 6015575 |
| 7025 | SJ54-2 | CANNAWIGARA | -36.5 | 140.5 | 455222 | 5960461 |
| 7031 | SI54-6 | CANOPUS | -33.5 | 140.5 | 453556 | 6293156 |
| 6731 | SI54-5 | CAROOMA | -33.5 | 139 | 314213 | 6291477 |
| 7525 | SJ54-4 | CHARLTON | -36.5 | 143 | 679121 | 5958717 |
| 7030 | SI54-6 | CHOWILLA | -34 | 140.5 | 453825 | 6237718 |
| 7726 | SI55-13 | COHUNA | -36 | 144 | 229577 | 6011874 |
| 8028 | SI55-10 | COLEAMBALLY | -35 | 145.5 | 363116 | 6125915 |
| 7927 | SI55-13 | CONARGO | -35.5 | 145 | 318601 | 6069654 |
| 7832 | SI55-1 | CONOBLE | -33 | 144.5 | 266429 | 6345924 |
| 7932 | SI55-1 | COOMBIE | -33 | 145 | 313152 | 6346923 |
| 6826 | SI54-14 | COONALPYN | -36 | 139.5 | 364803 | 6014997 |
| 7730 | SI55-5 | CULPATARO | -34 | 144 | 222907 | 6233772 |
| 7331 | SI54-7 | CUTHERO | -33.5 | 142 | 592887 | 6292820 |
| 7127 | SI54-15 | DANYO | -35.5 | 141 | 500000 | 6071493 |
| 7632 | SI54-4 | DARNICK | -33 | 143.5 | 733570 | 6345924 |
| 7425 | SJ54-4 | DONALD | -36.5 | 142.5 | 634337 | 5959531 |
| 8025 | SJ55-2 | DOOKIE | -36.5 | 145.5 | 365662 | 5959531 |
| 7728 | SI55-9 | DRY LAKE | -35 | 144 | 226200 | 6122829 |
| 7825 | SJ55-1 | ECHUCA | -36.5 | 144.5 | 276090 | 5957671 |
| 6729 | SI54-9 | EUDUNDA | -34.5 | 139 | 316379 | 6180573 |
| 8024 | SJ55-2 | EUROA | -37 | 145.5 | 366531 | 5904061 |
| 6730 | SI54-5 | FLORIETON | -34 | 139 | 315289 | 6236027 |
| 7124 | SJ54-3 | GOROKE | -37 | 141 | 500000 | 5905113 |
| 7929 | SI55-9 | GUNBAR | -34.5 | 145 | 316379 | 6180573 |
| 7630 | SI54-8 | HATFIELD | -34 | 143.5 | 730898 | 6235013 |
| 7828 | SI55-9 | HAY | -35 | 144.5 | 271845 | 6124087 |
| 7824 | SJ55-1 | HEATHCOTE | -37 | 144.5 | 277539 | 5902191 |
| 8031 | SI55-6 | HILLSTON | -33.5 | 145.5 | 360665 | 6292261 |
| 7326 | SI54-15 | HOPETOUN | -36 | 142 | 590129 | 6015575 |
| 7324 | SJ54-3 | HORSHAM | -37 | 142 | 588977 | 5904646 |
| 7732 | SI55-1 | IVANHOE | -33 | 144 | 219698 | 6344701 |
| 8027 | SI55-14 | JERILDERIE | -35.5 | 145.5 | 363954 | 6070458 |
| 7125 | SJ54-3 | KANIVA | -36.5 | 141 | 500000 | 5960578 |
| 6925 | SJ54-2 | KEITH | -36.5 | 140 | 410443 | 5960113 |
| 7626 | SI54-16 | KERANG | -36 | 143.5 | 725342 | 6013147 |
| 7731 | SI55-5 | KILFERA | -33.5 | 144 | 221292 | 6289238 |
| 6824 | SJ54-2 | KINGSTON | -37 | 139.5 | 366531 | 5904061 |
| 6830 | SI54-6 | KOOMOOLOO | -34 | 139.5 | 361471 | 6236816 |
| 8029 | SI55-10 | KOOROONGAL | -34.5 | 145.5 | 362288 | 6181368 |
| 7332 | SI54-3 | LAKE TANDOU | -33 | 142 | 593418 | 6348256 |
| 7130 | SI54-7 | LAKE VICTORIA | -34 | 141 | 500000 | 6237831 |
| 7526 | SI54-16 | LALBERT | -36 | 143 | 680267 | 6014188 |
| 6931 | SI54-6 | LILYDALE | -33.5 | 140 | 407112 | 6292820 |
| 7129 | SI54-11 | LINDSAY | -34.5 | 141 | 500000 | 6182389 |
| 6924 | SJ54-2 | LUCINDALE | -37 | 140 | 411022 | 5904646 |
| 7633 | SI54-4 | MANARA | -32.5 | 143.5 | 734880 | 6401374 |
| 7631 | SI54-8 | MANFRED | -33.5 | 143.5 | 732243 | 6290470 |
| 6728 | SI54-9 | MANNUM | -35 | 139 | 317483 | 6125116 |
| 6928 | SI54-10 | MANTUNG | -35 | 140 | 408746 | 6126486 |
| 7826 | SI55-13 | MATHOURA | -36 | 144.5 | 274657 | 6013147 |
| 7026 | SI54-14 | MCCALLUM | -36 | 140.5 | 454935 | 6015922 |
| 7333 | SI54-3 | MENINDEE | -32.5 | 142 | 593941 | 6403688 |
| 6726 | SI54-13 | MENINGIE | -36 | 139 | 319732 | 6014188 |
| 8030 | SI55-6 | MERRIWAGGA | -34 | 145.5 | 361471 | 6236816 |
| 7232 | SI54-3 | MIDDLE CAMP | -33 | 141.5 | 546708 | 6348589 |
| 7329 | SI54-11 | MILDURA | -34.5 | 142 | 591805 | 6181935 |
| 7725 | SJ55-1 | MITIAMO | -36.5 | 144 | 231297 | 5956391 |
| 6727 | SI54-13 | MOBILONG | -35.5 | 139 | 318601 | 6069654 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7928 | SI55-9 | MOGGUMBILL | -35 | 145 | 317483 | 6125116 |
| 6827 | SI54-14 | MOORLANDS | -35.5 | 139.5 | 363954 | 6070458 |
| 6929 | SI54-10 | MOOROOK | -34.5 | 140 | 408194 | 6181935 |
| 6829 | SI54-10 | MORGAN | -34.5 | 139.5 | 362288 | 6181368 |
| 7831 | SI55-5 | MOSSGEIL | -33.5 | 144.5 | 267756 | 6290470 |
| 7727 | SI55-13 | MOULAMEIN | -35.5 | 144 | 227878 | 6067353 |
| 7930 | SI55-5 | MUCKERUMBA | -34 | 145 | 315289 | 6236027 |
| 7531 | SI54-8 | MULURULU | -33.5 | 143 | 685786 | 6291477 |
| 6831 | SI54-6 | MURKABY | -33.5 | 139.5 | 360665 | 6292261 |
| 7924 | SJ55-1 | NAGAMBIE | -37 | 145 | 322037 | 5903243 |
| 7024 | SJ54-2 | NARACOORTE | -37 | 140.5 | 455511 | 5904996 |
| 7433 | SI54-4 | NARTOOKA | -32.5 | 142.5 | 640916 | 6403137 |
| 7224 | SJ54-3 | NATIMUK | -37 | 141.5 | 544488 | 5904996 |
| 7225 | SJ54-3 | NHILL | -36.5 | 141.5 | 544777 | 5960461 |
| 7328 | SI54-11 | NOWINGI | -35 | 142 | 591253 | 6126486 |
| 7527 | SI54-16 | NYAH | -35.5 | 143 | 681398 | 6069654 |
| 7032 | SI54-2 | OAKVALE | -33 | 140.5 | 453291 | 6348589 |
| 7829 | SI55-9 | ONE TREE | -34.5 | 144.5 | 270464 | 6179552 |
| 7327 | SI54-15 | OUYEN | -35.5 | 142 | 590694 | 6071033 |
| 7729 | SI55-9 | OXLEY | -34.5 | 144 | 224543 | 6178302 |
| 7629 | SI54-12 | PAIKA | -34.5 | 143.5 | 729535 | 6179552 |
| 7330 | SI54-7 | PARA | -34 | 142 | 592349 | 6237380 |
| 6930 | SI54-6 | PARCOOLA | -34 | 140 | 407650 | 6237380 |
| 6927 | SI54-14 | PARRAKIE | -35.5 | 140 | 409305 | 6071033 |
| 7028 | SI54-10 | PARUNA | -35 | 140.5 | 454373 | 6126829 |
| 7027 | SI54-14 | PINNAROO | -35.5 | 140.5 | 454653 | 6071378 |
| 7431 | SI54-8 | POONCARIE | -33.5 | 142.5 | 639334 | 6292261 |
| 7231 | SI54-7 | POPILTAH | -33.5 | 141.5 | 546443 | 6293156 |
| 7233 | SI54-3 | REDAN | -32.5 | 141.5 | 546970 | 6404018 |
| 7029 | SI54-10 | RENMARK | -34.5 | 140.5 | 454098 | 6182276 |
| 7428 | SI54-12 | ROBINVALE | -35 | 142.5 | 636883 | 6125915 |
| 7424 | SJ54-4 | RUPANYUP | -37 | 142.5 | 633468 | 5904061 |
| 6825 | SJ54-2 | SANTO | -36.5 | 139.5 | 365662 | 5959531 |
| 7131 | SI54-7 | SCOTIA | -33.5 | 141 | 500000 | 6293268 |
| 7925 | SJ55-1 | SHEPPARTON | -36.5 | 145 | 320878 | 5958717 |
| 7228 | SI54-11 | SUNSET | -35 | 141.5 | 545626 | 6126829 |
| 7627 | SI54-16 | SWAN HILL | -35.5 | 143.5 | 726757 | 6068619 |
| 6828 | SI54-10 | SWAN REACH | -35 | 139.5 | 363116 | 6125915 |
| 7533 | SI54-4 | TERYAWYNIA | -32.5 | 143 | 687895 | 6402366 |
| 7133 | SI54-3 | THACKARINGA | -32.5 | 141 | 500000 | 6404128 |
| 6926 | SI54-14 | TINTINARA | -36 | 140 | 409870 | 6015575 |
| 7926 | SI55-13 | TUPPAL | -36 | 145 | 319732 | 6014188 |
| 7530 | SI54-8 | TURLEE | -34 | 143 | 684710 | 6236027 |
| 7427 | SI54-16 | TYRELL | -35.5 | 142.5 | 636045 | 6070458 |
| 7227 | SI54-15 | UNDERBOOL | -35.5 | 141.5 | 545346 | 6071378 |
| 8127 | SI55-14 | URANA | -35.5 | 146 | 409305 | 6071033 |
| 7126 | SI54-15 | WALLOWA | -36 | 141 | 500000 | 6016037 |
| 7827 | SI55-13 | WANGANELLA | -35.5 | 144.5 | 273242 | 6068619 |
| 8125 | SJ55-2 | WANGARATTA | -36.5 | 146 | 410443 | 5960113 |
| 7325 | SJ54-3 | WARRACKNABEAL | -36.5 | 142 | 589556 | 5960113 |
| 7625 | SJ54-4 | WEDDERBURN | -36.5 | 143.5 | 723909 | 5957671 |
| 7528 | SI54-12 | WEIMBY | -35 | 143 | 682516 | 6125116 |
| 7229 | SI54-11 | WENTWORTH | -34.5 | 141.5 | 545901 | 6182276 |
| 7429 | SI54-12 | WILD DOG | -34.5 | 142.5 | 637711 | 6181368 |
| 7931 | SI55-5 | WILLANDRA | -33.5 | 145 | 314213 | 6291477 |
| 8128 | SI55-10 | YANCO | -35 | 146 | 408746 | 6126486 |
| 6832 | SI54-2 | YUNTA | -33 | 139.5 | 359869 | 6347701 |

130 rows selected

### 5.8) Table: SHEET250

The SHEET250 look up table holds descriptions of the 1:250 000 mapsheets intersecting the Murray Basin. The primary key SHEET250.SHEET250 is referenced as a foreign key field SHEET250 in table SHEET100, citing the appropriate 1:250 000 mapsheet number for each 1:100 000 mapsheet. This establishes the link to enable the querying of borehole data on the basis of 1:250 000 mapsheets. In turn, SHEET250.SHEET1000 references the primary key field SHEET1000 of table SHEET1000, linking the relevant 1:1 million mapsheet number.

```
SQL> describe sheet250

 Name                           Null?    Type
 ------------------------------ -------- ----
 SHEET250                       NOT NULL CHAR(7)
 NAME                                    CHAR(10)
 SHEET1000                               CHAR(4)

SQL> select column_name, comments from user_col_comments where table_name = 'SHEET250';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
SHEET250        REFERENCE NUMBER OF 1:250 000 MAPSHEET, REFERENCED BY SHEET100.SHEET250
NAME            NAME OF 1:250 000 MAPSHEET
SHEET1000       REFERENCE NUMBER OF ENCOMPASSING 1:1 MILLION MAPSHEET, REFERENCING SHEET1000.SHEET1000

SQL> select * from sheet250 order by name;

SHEET250  NAME       SHEET1000
--------- ---------- ----------
SI54-9    ADELAIDE   SI54
SI54-7    ANABRANCH  SI54
SI54-12   BALRANALD  SI54
SI54-13   BARKER     SI54
SJ55-1    BENDIGO    SJ55
SI55-5    BOOLIGAL   SI55
SI54-5    BURRA      SI54
SI55-6    CARGELLIGO SI55
SI54-6    CHOWILLA   SI54
SI55-13   DENILIQUIN SI55
SI55-9    HAY        SI55
SJ54-3    HORSHAM    SJ54
SI55-1    IVANHOE    SI55
SI55-14   JERILDERIE SI55
SI54-4    MANARA     SI54
SI54-3    MENINDEE   SI54
SI54-11   MILDURA    SI54
SJ54-2    NARACOORTE SJ54
SI55-10   NARRANDERA SI55
SI54-2    OLARY      SI54
SI54-15   OUYEN      SI54
SI54-14   PINNAROO   SI54
SI54-8    POONCARIE  SI54
SI54-10   RENMARK    SI54
SJ54-4    ST ARNAUD  SJ54
SI54-16   SWAN HILL  SI54
SJ55-2    WANGARATTA SJ55

27 records selected.
```

## 5.9) Table: SHEET1000

The SHEET1000 look up table lists the 1:1 million mapsheets intersecting the Murray Basin. The primary key SHEET1000, storing the 1:1 million mapsheet number, is referenced by field SHEET1000 in table SHEET250. This completes the hierarchical relationship between the tables storing details of mapsheets of various scales - SHEET100, SHEET250 and SHEET1000.

```
SQL> describe sheet1000

 Name                           Null?    Type
 ------------------------------ -------- ----
 SHEET1000                      NOT NULL CHAR(4)
 NAME                                    CHAR(10)

SQL> select column_name, comments from user_col_comments where table_name = 'SHEET1000';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
SHEET1000       1:1 MILLION MAPSHEET NUMBER, REFERENCED BY SHEET250.SHEET1000
NAME            NAME OF 1:1 MILLION MAPSHEET

SQL> select * from sheet1000 order by name;

SHEET1000  NAME
---------- ----------
SI54       ADELAIDE
SI55       CANBERRA
SJ54       HAMILTON
SJ55       MELBOURNE

4 records selected
```

## 5.10) Table: AGE

The AGE look up table holds codes representing subdivisions of geological time, ranging from eras to intervals of epochs. The primary key AGE is referenced in fields describing age ranges in tables POLLEN, FORAM and GEOL. The code is structured in an hierarchical sense - for instance, the code for an epoch has the relevant period and era encoded within it. This becomes particularly useful when querying a database containing age estimates of varying precision (eg. 'CZQ%' to encompass all subdivisions of the Quaternary). Estimates of the relevant time interval, determined by the fields MINIMA and MAXIMA, are based on AGSO documentation of the Australian Phanerozoic time scale.[1,3,11,12,19,25,26,27,28,29]

```
SQL> describe age

 Name                           Null?    Type
 ------------------------------ -------- ----
 AGE                            NOT NULL CHAR(5)
 CLASS                                   CHAR(25)
 ERA                                     CHAR(11)
 PERIOD                                  CHAR(13)
 EPOCH                                   CHAR(11)
 SUBEPOCH                                CHAR(7)
 MINIMA                                  NUMBER(7,3)
 MAXIMA                                  NUMBER(7,3)

SQL> select column_name, comments from user_col_comments where table_name = 'AGE';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
AGE             CODE FOR SUBDIVISION OF GEOLOGICAL AGE, REFERENCED IN TABLES GEOL,POLLEN AND FORAM
CLASS           GEOLOGICAL TIME PERIOD
ERA             GEOLOGICAL ERA
PERIOD          GEOLOGICAL PERIOD
EPOCH           GEOLOGICAL EPOCH
SUBEPOCH        SUBDIVISION OF GEOLOGICAL EPOCH
MINIMA          AGE OF TOP OF GEOLOGICAL TIME PERIOD IN MA
MAXIMA          AGE OF BASE OF GEOLOGICAL TIME PERIOD IN MA
```

```
SQL> select * from age;
```

| AGE | CLASS | ERA | PERIOD | EPOCH | SUBEPOCH | MINIMA | MAXIMA |
|---|---|---|---|---|---|---|---|
| CZ | CAINOZOIC | CAINOZOIC | | | | 0 | 66.4 |
| CZQ | QUATERNARY | CAINOZOIC | QUATERNARY | | | 0 | 1.64 |
| CZQH | RECENT | CAINOZOIC | QUATERNARY | RECENT | | 0 | .015 |
| CZQP | PLEISTOCENE | CAINOZOIC | QUATERNARY | PLEISTOCENE | | .015 | 1.64 |
| CZQPe | EARLY PLEISTOCENE | CAINOZOIC | QUATERNARY | PLEISTOCENE | EARLY | .7 | 1.64 |
| CZQPl | LATE PLEISTOCENE | CAINOZOIC | QUATERNARY | PLEISTOCENE | LATE | .015 | .7 |
| CZT | TERTIARY | CAINOZOIC | TERTIARY | | | 1.64 | 66.4 |
| CZTA | PALEOCENE | CAINOZOIC | TERTIARY | PALEOCENE | | 58 | 66.4 |
| CZTAe | EARLY PALEOCENE | CAINOZOIC | TERTIARY | PALEOCENE | EARLY | 62.5 | 66.4 |
| CZTAl | LATE PALEOCENE | CAINOZOIC | TERTIARY | PALEOCENE | LATE | 58 | 62.5 |
| CZTE | EOCENE | CAINOZOIC | TERTIARY | EOCENE | | 36.5 | 58 |
| CZTEe | EARLY EOCENE | CAINOZOIC | TERTIARY | EOCENE | EARLY | 52 | 58 |
| CZTEm | MIDDLE EOCENE | CAINOZOIC | TERTIARY | EOCENE | MIDDLE | 40.4 | 52 |
| CZTEl | LATE EOCENE | CAINOZOIC | TERTIARY | EOCENE | LATE | 36.5 | 40.4 |
| CZTO | OLIGOCENE | CAINOZOIC | TERTIARY | OLIGOCENE | | 24 | 36.5 |
| CZTOe | EARLY OLIGOCENE | CAINOZOIC | TERTIARY | OLIGOCENE | EARLY | 30 | 36.5 |
| CZTOl | LATE OLIGOCENE | CAINOZOIC | TERTIARY | OLIGOCENE | LATE | 24 | 30 |
| CZTM | MIOCENE | CAINOZOIC | TERTIARY | MIOCENE | | 5.2 | 24 |
| CZTMe | EARLY MIOCENE | CAINOZOIC | TERTIARY | MIOCENE | EARLY | 16.6 | 24 |
| CZTMm | MIDDLE MIOCENE | CAINOZOIC | TERTIARY | MIOCENE | MIDDLE | 10.6 | 16.6 |
| CZTMl | LATE MIOCENE | CAINOZOIC | TERTIARY | MIOCENE | LATE | 5.2 | 10.6 |
| CZTP | PLIOCENE | CAINOZOIC | TERTIARY | PLIOCENE | | 1.64 | 5.2 |
| CZTPe | EARLY PLIOCENE | CAINOZOIC | TERTIARY | PLIOCENE | EARLY | 3.4 | 5.2 |
| CZTPl | LATE PLIOCENE | CAINOZOIC | TERTIARY | PLIOCENE | LATE | 1.64 | 3.4 |
| MZ | MESOZOIC | MESOZOIC | | | | 66.4 | 250 |
| MZK | CRETACEOUS | MESOZOIC | CRETACEOUS | | | 66.4 | 130 |
| MZKe | EARLY CRETACEOUS | MESOZOIC | CRETACEOUS | EARLY | | 95 | 130 |
| MZKeb | ALBIAN | MESOZOIC | CRETACEOUS | EARLY | ALBIAN | 95 | 107 |
| MZKep | APTIAN | MESOZOIC | CRETACEOUS | EARLY | APTIAN | 107 | 115 |
| MZKl | LATE CRETACEOUS | MESOZOIC | CRETACEOUS | LATE | | 66.4 | 95 |
| MZJ | JURASSIC | MESOZOIC | JURASSIC | | | 130 | 204 |
| MZJe | EARLY JURASSIC | MESOZOIC | JURASSIC | EARLY | | 181 | 204 |
| MZJm | MIDDLE JURASSIC | MESOZOIC | JURASSIC | MIDDLE | | 150 | 181 |
| MZJl | LATE JURASSIC | MESOZOIC | JURASSIC | LATE | | 130 | 150 |
| MZR | TRIASSIC | MESOZOIC | TRIASSIC | | | 204 | 250 |
| MZRe | EARLY TRIASSIC | MESOZOIC | TRIASSIC | EARLY | | 243 | 250 |
| MZRm | MIDDLE TRIASSIC | MESOZOIC | TRIASSIC | MIDDLE | | 231 | 243 |
| MZRl | LATE TRIASSIC | MESOZOIC | TRIASSIC | LATE | | 204 | 231 |
| PZ | PALEOZOIC | PALEOZOIC | | | | 250 | 580 |
| PZP | PERMIAN | PALEOZOIC | PERMIAN | | | 250 | 295 |
| PZPe | EARLY PERMIAN | PALEOZOIC | PERMIAN | EARLY | | 270 | 295 |
| PZPl | LATE PERMIAN | PALEOZOIC | PERMIAN | LATE | | 250 | 270 |
| PZC | CARBONIFEROUS | PALEOZOIC | CARBONIFEROUS | | | 295 | 354 |
| PZCe | EARLY CARBONIFEROUS | PALEOZOIC | CARBONIFEROUS | EARLY | | 326 | 354 |
| PZCl | LATE CARBONIFEROUS | PALEOZOIC | CARBONIFEROUS | LATE | | 295 | 326 |
| PZD | DEVONIAN | PALEOZOIC | DEVONIAN | | | 354 | 408 |
| PZDe | EARLY DEVONIAN | PALEOZOIC | DEVONIAN | EARLY | | 387 | 408 |
| PZDm | MIDDLE DEVONIAN | PALEOZOIC | DEVONIAN | MIDDLE | | 370 | 387 |
| PZDl | LATE DEVONIAN | PALEOZOIC | DEVONIAN | LATE | | 354 | 370 |
| PZS | SILURIAN | PALEOZOIC | SILURIAN | | | 408 | 434 |
| PZSe | EARLY SILURIAN | PALEOZOIC | SILURIAN | EARLY | | 420 | 434 |
| PZSl | LATE SILURIAN | PALEOZOIC | SILURIAN | LATE | | 408 | 420 |
| PZO | ORDOVICIAN | PALEOZOIC | ORDOVICIAN | | | 434 | 500 |
| PZOe | EARLY ORDOVICIAN | PALEOZOIC | ORDOVICIAN | EARLY | | 458 | 500 |
| PZOl | LATE ORDOVICIAN | PALEOZOIC | ORDOVICIAN | LATE | | 434 | 458 |
| PZE | CAMBRIAN | PALEOZOIC | CAMBRIAN | | | 500 | 580 |
| PZEe | EARLY CAMBRIAN | PALEOZOIC | CAMBRIAN | EARLY | | 549 | 580 |
| PZEm | MIDDLE CAMBRIAN | PALEOZOIC | CAMBRIAN | MIDDLE | | 522 | 549 |
| PZEl | LATE CAMBRIAN | PALEOZOIC | CAMBRIAN | LATE | | 500 | 522 |
| PE | PRECAMBRIAN | PRECAMBRIAN | | | | 580 | 3800 |
| PR | PROTEROZOIC | PROTEROZOIC | | | | 580 | 2300 |
| PRL | LATE PROTEROZOIC | PROTEROZOIC | LATE | | | 580 | 1400 |
| PRM | MIDDLE PROTEROZOIC | PROTEROZOIC | MIDDLE | | | 1400 | 1800 |
| PRE | EARLY PROTEROZOIC | PROTEROZOIC | EARLY | | | 1800 | 2300 |
| AR | ARCHAEAN | ARCHAEAN | | | | 2300 | 3800 |

65 records selected.

### 5.11) Table: GEOL

The GEOL look up table holds codes for geological units within the Murray Basin, with an emphasis on the Cainozoic stratigraphy. The field UNIT is the primary key, referenced by corresponding UNIT fields in tables STRAT, AQINT, POLLEN, FORAM, SWL and SAMPLE. This allows the querying of these tables on the basis of regional stratigraphy. Wherever possible established abbreviations for the Cainozoic stratigraphy have been used, which tend to have age criteria useful during data query encoded within them. For example, TQs denotes Pliocene to Quaternary Shepparton Formation. Attributes for each unit including lithology, estimated age range, depositional environment and geomorphological expression have been derived from published AGSO maps and bulletins.[7,8,9,10,21] The STRATLEX field cites the identification number used for stratigraphic names held in the STRATLEX Australian stratigraphic lexicon. Details such as status, rank, province, age range and type section location are available for over 8000 stratigraphic names.[4]

```
SQL> describe geol

 Name                           Null?    Type
 ------------------------------ -------- ----
 UNIT                           NOT NULL CHAR(4)
 GEOL                                    CHAR(100)
 MAJLITH                                 CHAR(250)
 MINLITH                                 CHAR(200)
 MINAGE                                  CHAR(6)
 MAXAGE                                  CHAR(6)
 DEPENV                                  CHAR(200)
 GEOMORPH                                CHAR(200)
 STRATLEX                                NUMBER(5)

SQL> select column_name, comments from user_col_comments where table_name = 'GEOL';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
UNIT            CODE FOR GEOLOGICAL UNIT REFERENCED BY UNIT FIELD IN TABLES POLLEN,FORAM,STRAT,AQINT,SWL
                AND SAMPLE
GEOL            NAME OF GEOLOGICAL UNIT
MAJLITH         MAJOR LITHOLOGIES COMPRISING GEOLOGICAL UNIT
MINLITH         MINOR LITHOLOGIES COMPRISING GEOLOGICAL UNIT
MINAGE          CODE FOR MINIMUM GEOLOGICAL AGE OF UNIT, REFERENCING AGE.AGE
MAXAGE          CODE FOR MAXIMUM GEOLOGICAL AGE OF UNIT, REFERENCING AGE.AGE
DEPENV          DEPOSITIONAL ENVIRONMENT OF GEOLOGICAL UNIT
GEOMORPH        GEOMORPHIC EXPRESSION OF GEOLOGICAL UNIT
STRATLEX        FOREIGN KEY CITING UNIQUE IDENTIFIER FOR STRATLEX AUSTRALIAN STRATIGRAPHIC LEXICON
```

A full listing of the GEOL table is provided in Appendix A.

### 5.12) Table: CONFID

The CONFID look up table holds codes rating the level of confidence placed on palynological or foraminiferal interpretations. The code column CONFID corresponds to the column of the same name in tables POLLEN and FORAM. The rating is based on the sample medium (ie core or cuttings) and the presence of diagnostic spores, pollen, microplankton or forams.

```
SQL> describe confid

 Name                           Null?    Type
 ------------------------------ -------- ----
 CONFID                         NOT NULL NUMBER(1,0)
 CLASS                                   CHAR(15)
 COMM                                    CHAR(100)
```

```
SQL> select column_name, comments from user_col_comments where table_name = 'CONFID';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
CONFID          CODE FOR LEVEL OF CONFIDENCE IN INTERPRETATION,REFERENCING POLLEN.CONFID AND
                FORAM.CONFID
CLASS           LEVEL OF CONFIDENCE IN INTERPRETATION
COMM            COMMENTS ON CRITERIA USED FOR CONFIDENCE LEVEL

SQL> select * from confid order by confid;

CONFID  CLASS       COMM
------  ----------- ------------------------------------------------------
4       EXCELLENT   SWC OR CORE WITH ZONE SPECIES OF SPORES AND POLLEN,
                    MICROPLANKTON AND FORAMS
3       GOOD        SWC OR CORE WITH ZONE SPECIES OF SPORES OR POLLEN,
                    MICROPLANKTON OR FORAMS
2       POOR        SWC OR CORE WITH NON-DIAGNOSTIC SPORES AND POLLEN,
                    NON-DIAGNOSTIC MICROPLANKTON AND FORAMS
1       FAIR        CUTTINGS WITH ZONE SPECIES OF EITHER SPORES OR POLLEN,
                    MICROPLANKTON OR FORAMS
0       NO          CUTTINGS WITH NON-DIAGNOSTIC SPORES OR POLLEN,
                    NON-DIAGNOSTIC MICROPLANKTON OR FORAMS

5 records selected
```

### 5.13) Table: YIELD

The YIELD look up table holds codes indicating the amount of pollen or forams retrieved from the palynological or foraminiferal sample, respectively. The YIELD column references the YIELD column in table POLLEN and FORAM.

```
SQL> describe yield

 Name                           Null?    Type
 ------------------------------ -------- ----
 YIELD                          NOT NULL NUMBER(1,0)
 CLASS                                   CHAR(15)

SQL> select column_name, comments from user_col_comments where table_name = 'YIELD';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
YIELD           CODE FOR ESTIMATE OF POLLEN OR FORAM YIELD, REFERENCING POLLEN.YIELD AND FORAM.YIELD
CLASS           ESTIMATE OF POLLEN OR FORAM YIELD

SQL> select * from yield order by yield;

YIELD    CLASS
-------- ------------------------
0        VERY LOW
1        LOW
2        MEDIUM
3        HIGH
4        VERY HIGH

5 records selected
```

### 5.14) Table: INTTYPE

The INTTYPE look up table holds codes for the construction type of the borehole intake eg. slotted casing, well screen or open hole. The primary key INTTYPE links with field INTTYPE in table AQINT. The latter field may be a concatenation of INTTYPE.INTTYPE codes, the order representing borehole construction radially outwards (eg 'WG' represents a well screen surrounded by gravel pack). The field also caters for water cuts encountered during drilling but not ultimately used in the final supply. These tend to be sealed by cement lining (A), casing (C), timber (T) or simply back filled (B).

```
SQL> describe inttype

 Name                           Null?    Type
 ------------------------------ -------- ----
 INTTYPE                        NOT NULL CHAR(1)
 CLASS                                   CHAR(25)

SQL> select column_name, comments from user_col_comments where table_name = 'INTTYPE';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
INTTYPE         CODE FOR CONSTRUCTION TYPE OF BOREHOLE INTAKE, REFERENCED BY AQINT.INTTYPE
CLASS           CONSTRUCTION TYPE OF BOREHOLE INTAKE

SQL> select * from inttype order by inttype;

INTTYPE  CLASS
-------- ------------------------
A        CEMENT LINING
B        BACK FILLED
C        CASING
G        GRAVEL PACK
L        LOUVRED
M        MESH OR GAUZE
O        OPEN HOLE
P        PERFORATED CASING
R        PREPACKED SCREEN
S        SLOTTED CASING
T        TIMBER LINING
W        WELL SCREEN

 12 records selected.
```

## 5.15) Table: QUALSALT

The QUALSALT look up table holds codes for qualitative estimates of water salinity of a particular aquifer. This accommodates the common taste test during drilling for groundwater. The primary field QUALSALT references the field QUALSALT in table AQINT. The codes make up a numerical range of 1-8, representing salinity classes from fresh to very salty.[16] The number datatype allows the numerical grouping of various classes during data query ( eg. <4 for water potentially suitable for all stock).

```
SQL> describe qualsalt

 Name                           Null?    Type
 ------------------------------ -------- ----
 QUALSALT                       NOT NULL NUMBER(1)
 CLASS                                   CHAR(15)

SQL> select column_name, comments from user_col_comments where table_name = 'QUALSALT';

COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
QUALSALT        CODE FOR QUALITATIVE ESTIMATE OF GROUNDWATER SALINITY, REFERENCED BY AQINT.QUALSALT
CLASS           DESCRIPTION OF QUALITATIVE ESTIMATE OF SALINITY

SQL> select * from qualsalt order by qualsalt;

  QUALSALT  CLASS
---------- ---------------
         1 FRESH
         2 VERY GOOD
         3 GOOD
         4 GOOD STOCK
         5 STOCK
         6 MARGINAL STOCK
         7 SALTY
         8 VERY SALTY

8 records selected.
```

### 5.16) Table: ATTYPE

The ATTYPE look up table holds codes for the type of aquifer test undertaken on the borehole. The primary field ATTYPE references the field by the same name in the table AQINT. Up to four ATTYPE codes can be recorded in this field in table AQINT eg. 'QR' for a constant discharge test followed by a recovery test.

```
SQL> describe attype

 Name                           Null?    Type
 ------------------------------ -------- ----
 ATTYPE                         NOT NULL CHAR(1)
 CLASS                                   CHAR(25)
 COMM                                    CHAR(50)

SQL> select column_name, comments from user_col_comments where table_name = 'ATTYPE';

 COLUMN_NAME     COMMENTS
 --------------- --------------------------------------------------------------------------------
 ATTYPE          CODE FOR TYPE OF AQUIFER TEST, REFERENCED BY AQINT.ATTYPE
 CLASS           TYPE OF AQUIFER TEST
 COMM            COMMENTS ON AQUIFER TEST TYPE

SQL> select * from attype order by attype;

ATTYPE    CLASS                COMM
--------- -------------------  ----------------------
D         CONSTANT DRAWDOWN    FLOW RECESSION WITH VARIABLE DISCHARGE
P         PRELIMINARY          RANGE OF DISCHARGE RATES OVER SHORT TIME PERIOD
Q         CONSTANT DISCHARGE   DISCHARGE RATE MAINTAINED CONSTANT
R         RECOVERY             DRAWDOWN MONITORED AFTER DISCHARGE CEASES
S         STEP DRAWDOWN        DISCHARGE RATES CHANGED IN STAGES

5 records selected
```

### 5.17) Table: ATEQUIP

The ATEQUIP look up table holds codes for the equipment used during the aquifer test undertaken on the borehole. The primary field ATEQUIP references the field by the same name in the table AQINT.

```
SQL> describe atequip

 Name                           Null?    Type
 ------------------------------ -------- ----
 ATEQUIP                        NOT NULL CHAR(1)
 CLASS                                   CHAR(25)

SQL> select column_name, comments from user_col_comments where table_name = 'ATEQUIP';

 COLUMN_NAME     COMMENTS
 --------------- --------------------------------------------------------------------------------
 ATEQUIP         CODE FOR TYPE OF AQUIFER TEST EQUIPMENT, REFERENCED BY AQINT.ATEQUIP
 CLASS           TYPE OF AQUIFER TEST EQUIPMENT

SQL> select * from atequip order by atequip;

ATEQUIP   CLASS
--------- --------------
A         AIR LIFT
B         BAILER
C         CYLINDER PUMP
G         CENTRIFUGAL PUMP
J         JET PUMP
P         UNSPECIFIED PUMP
S         SUBMERSIBLE PUMP
T         TURBINE PUMP

8 records selected
```

## 5.18) Table: SAMPMETH

The SAMPMETH look up table holds codes for methods of groundwater sampling. The primary key SAMPMETH is referenced by the SAMPMETH field in table SAMPLE.

```
SQL> describe sampmeth

 Name                           Null?    Type
 ------------------------------ -------- ----
 SAMPMETH                       NOT NULL CHAR(1)
 CLASS                                   CHAR(20)

SQL> select column_name, comments from user_col_comments where table_name = 'SAMPMETH';

 COLUMN_NAME     COMMENTS
 --------------- --------------------------------------------------------------------------------
 SAMPMETH        CODE FOR METHOD OF GROUNDWATER SAMPLING, REFERENCING SAMPLE.SAMPMETH
 CLASS           METHOD OF GROUNDWATER SAMPLING

SQL> select * from sampmeth order by sampmeth;

SAMPMETH  CLASS
--------- ---------------
A         AIR LIFT
B         BAILER
F         FLOWING BORE
P         PUMP
T         TANK OR TROUGH

5 records selected
```

## 5.19) Table: LAB

The LAB look up table holds abbreviations, names and addresses for the laboratories or individuals that have undertaken analysis of palynology, forams or water chemistry. The primary key LAB is referenced by a LAB field in the tables POLLEN, FORAM, MAJION, MINION and ISOTOPE. The table is dynamic with new records added with the advent of new analyses.

```
SQL> describe lab

 Name                           Null?    Type
 ------------------------------ -------- ----
 LAB                            NOT NULL CHAR(20)
 NAME                                    CHAR(100)
 ADDRESS                                 CHAR(100)
 COMM                                    CHAR(100)

SQL> select column_name, comments from user_col_comments where table_name = 'LAB';
COLUMN_NAME     COMMENTS
--------------- --------------------------------------------------------------------------------
LAB             ABBREVIATION FOR LAB OR SPECIALIST REFERENCING LAB FIELD IN TABLES POLLEN, FORAM,
                MAJION,MINION AND ISOTOPE
NAME            NAME OF LABORATORY OR SPECIALIST
ADDRESS         ADDRESS OF LABORATORY OR SPECIALIST
COMM            COMMENTS ON LABORATORY OR SPECIALIST

 SQL> select lab, name, address from lab;
LAB      NAME                                               ADDRESS
-------- -------------------------------------------------- ----------------------------------------
BALME    B E BALME
EVANS    P R EVANS                                          BUREAU OF MINERAL RESOURCES, GPO BOX 378
                                                            CANBERRA 2061
MACPHAIL M K MACPHAIL                                       20 ABBEY ST GLADESVILLE NSW 2111
MCMINN   A MCMINN                                           GEOLOGICAL SURVEY OF NEW SOUTH WALES GPO 536
                                                            ST LEONARDS NSW 2065
BMREGG   GROUNDWATER ANALYTICAL CHEMISTRY LAB               BUREAU OF MINERAL RESOURCES, GPO BOX 378
                                                            CANBERRA 2061
CSIRO    CSIRO ANALYTICAL CHEMISTRY SERVICE                 CSIRO DIVISION OF ENERGY CHEMISTRY PMG 7
                                                            SUTHERLAND NSW 2232
NSWDWR   NEW SOUTH WALES DEPARTMENT OF WATER RESOURCES      GPO 3720 PARRAMATTA NSW 2124
VICSTATE VICTORIAN STATE LABORATORY
8 rows selected.
```

## 6) DATA VALIDATION

Several SQL*Plus command files have been compiled to be used as validation routines for the MURBO data tables. The files are based on similar programs designed by Andrew Tucker for the GABMOD borehole database.[6] Various aspects of the data structure and content are investigated including;

- referential integrity; the correct linking of data tables based on appropriate primary keys
- that data maintains common sense relationships
- the use of correct codes as defined by the look up tables
- a general statistical analysis of number datatypes to highlight potentially spurious values.

Bounding minima and maxima may be defined for each field in file min_max.sql.

It should be recognised that the use of these validation routines does not guarantee an error free database. Lengthy character fields such as those describing general comments, lithology and depositional environment have not been analysed. The recognition of extremely high or low numerical values is dependant on the appropriate definition of maxima and minima in min_max.sql. Alternatively a data value may fall within the arbitrary acceptable limits but may still be in error. Invalid data may enter a database through incorrect measurement, data entry errors, corruption during data transfer or inappropriate database manipulation routines. Graphical displays, such as borehole location plots or contours, may also highlight erroneous data.

### 6.1) Validation of table GENERAL:

Program **chkgen.sql** checks that;

- the UNO identifier is not null or non-unique
- the BOREID primary key is not null or non-unique
- the STATE, SHEET100, LOCREL, DATEREL, BORETYPE, STATUS and DRILLMETH fields have codes as defined by the look up tables
- the LATs and LONs are between the minimum and maximum for the SHEET100 specified
- the EASTs and NORTHS are between the minimum and maximum for the SHEET100 specified
- the AMGZONE is appropriate for the SHEET100 specified
- the ELEVNS, ELEVTOC, TOTDEPTH and CONDATE fields are within acceptable limits as defined in min_max.sql
- the top of casing is not below the natural surface
- the LITHLOG field contains either 'Y' or 'N' or null

### 6.2) Validation of table GEOPHYS:

Program **chkgeop.sql** checks that;

- the BOREID primary key is not null or non-unique
- each BOREID recorded is represented in table GENERAL
- the remaining fields flagging the existence or otherwise of geophysical logs contains either 'Y' or 'N' or null

### 6.3) Validation of table POLLEN:

Program **chkpoll.sql** checks that;

- the LABREF, LAB composite primary key is not null or non-unique
- the BOREID field is not null and is represented in table GENERAL
- the UNIT, PREFAGE, MINAGE and MAXAGE fields have codes as recorded in the GEOL and AGE look up tables
- the ANDATE, SAMPTOP, SAMPBASE, MYRTNOTH, FLEMNOTH and MAWGYM fields are within acceptable limits as defined in min_max.sql
- the top and base of sample corresponds to the borehole stratigraphy
- the ANDATE is not before the date of construction, CONDATE
- the LAB, CONFID, YIELD and DATEREL fields contain valid codes

### 6.4) Validation of table FORAM:

Program **chkform.sql** checks that;

- the LABREF, LAB composite primary key is not null or non-unique
- the BOREID field is not null and is represented in table GENERAL
- the UNIT, PREFAGE, MINAGE and MAXAGE fields have codes as recorded in the GEOL and AGE look up tables
- the ANDATE, SAMPTOP, SAMPBASE and PLANKBEN fields are within acceptable limits as defined in min_max.sql
- the top and base of sample corresponds to the borehole stratigraphy
- the ANDATE is not before the date of construction, CONDATE
- the LAB, CONFID, YIELD and DATEREL fields contain valid codes

### 6.5) Validation of table STRAT:

Program **chkstrat.sql** checks that;

- the composite primary key of BOREID, UNIT and UNITTOP is unique
- the BOREID field is represented in table GENERAL and is not null
- the UNIT field have codes as recorded in look up table GEOL
- the UNITTOP, THICK and SATTHICK fields are within acceptable limits as defined in min_max.sql
- the top and base of the unit is between the surface and base of hole
- SATTHICK is not greater than THICK
- PERCSAND is between 0 and 100

### 6.6) Validation of table AQINT:

Program **chkaqint.sql** checks that;

- the composite primary key of BOREID, UNIT and INTTOP is unique
- the composite primary key describes an aquifer interval within the bounds of the borehole stratigraphy as defined in data table STRAT
- the BOREID field is represented in table GENERAL and is not null
- the aquifer interval corresponds to borehole stratigraphy
- ATDATE is not earlier than CONDATE
- the UNIT, INTTYPE, QUALSALT and DATEREL fields have codes as defined in appropriate look up tables
- the INTTOP, INTBASE, INTRAD, KH, KV, S, ATDATE, ATDUR, ATSWL, ATDRAW and ATQ fields are within acceptable limits as defined in min_max.sql
- INTBASE is deeper than INTTOP
- the aquifer interval is between the top and base of the borehole

### 6.7) Validation of table SWL:

Program **chkswl.sql** checks that;

- the composite primary key of BOREID, UNIT and INTTOP is unique
- the composite primary key corresponds to a record in the AQINT table
- the BOREID field is represented in table GENERAL and is not null
- the UNIT and DATEREL fields have valid codes
- the INTTOP, MEASDATE, SWLTOC, SWLNS and RWL fields are within acceptable limits as defined in min_max.sql
- MEASDATE is not earlier than the date of construction, CONDATE

### 6.8) Validation of table SAMPLE:

Program **chksamp.sql** checks that;

- the primary key SAMPREF is not null or non-unique
- the composite foreign key of BOREID, UNIT and INTTOP corresponds to an aquifer interval recorded in table AQINT
- the BOREID field is represented in table GENERAL and is not null
- the UNIT, SAMPMETH and DATEREL fields have valid codes
- the INTTOP, SAMPDATE, FLDPH, FLDEH, FLDT, FLDEC, FLDDO fields are within acceptable limits as defined in min_max.sql
- SAMPDATE is not earlier than the date of construction, CONDATE

### 6.9) Validation of table MAJION:

Program **chkmaj.sql** checks that;

- the composite primary key of SAMPREF and LABREF is unique
- SAMPREF corresponds to a record in table SAMPLE and is not null
- the ANDATE field, major ion analyses and laboratory measurements are within acceptable limits as defined in min_max.sql
- ANDATE is not earlier than the date of sampling, SAMPDATE
- the DATEREL field has valid codes

### 6.10) Validation of table MINION:

Program **chkmin.sql** checks that;

- the composite primary key of SAMPREF and LABREF is unique
- SAMPREF corresponds to a record in table SAMPLE and is not null
- the ANDATE field and minor ion analyses are within acceptable limits as defined in min_max.sql
- ANDATE is not earlier than the date of sampling, SAMPDATE
- the DATEREL field has valid codes

### 6.11) Validation of table ISOTOPE:

Program **chkiso.sql** checks that;

- the composite primary key of SAMPREF and LABREF is unique
- SAMPREF corresponds to a record in table SAMPLE and is not null
- the ANDATE field and isotopic analyses are within acceptable limits as defined in min_max.sql
- ANDATE is not earlier than the date of sampling, SAMPDATE
- the DATEREL field has valid codes

## 7) ACKNOWLEDGMENTS

MURBO was founded on a database structure initially devised for the Murray Basin Hydrogeology Project by Richard Cooper, Ray Evans, Jim Kellett and others. Sonja Lenz, Rod Ryburn and Andrew Tucker provided advise on database structure. The manuscript was reviewed by Ray Evans, Jim Kellett and Andrew Tucker (AGSO) as well as state representatives including Steve Barnett (SADME), Greg Hoxley (RWC) and Lucy Lytton and Don Woolley (NSW DWR).

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## APPENDIX A: DETAILS OF GEOLOGICAL UNIT CODES STORED IN TABLE GEOL

*UNIT: COs*
GEOL: CAMBRIAN ORDOVICIAN SEDIMENTS
MAJLITH:
MINLITH:
MINAGE: PZA
MAXAGE: PZO
DEPENV: SHALLOW-MARINE TO NON-MARINE
GEOMORPH: LOCALLY EXPOSED IN SCOPES RANGE IN NORTHWEST MARGIN AND GLENELG AREA IN SOUTHWEST MARGIN

*UNIT: CZ*
GEOL: UNDIFFERENTIATED CAINOZOIC
MAJLITH:
MINLITH:
MINAGE: CZQH
MAXAGE: CZTAe
DEPENV:
GEOMORPH:

*UNIT: DCls*
GEOL: DEVONIAN TO LOWER CARBONIFEROUS SEDIMENTS INCLUDING MULGA DOWNS GROUP EQUIVALENTS
MAJLITH: YELLOW RED COARSE SANDSTONE, CONGLOMERATE, SILTSTONE
MINLITH: RED SHALE
MINAGE: PZCe
MAXAGE: PZDe
DEPENV: FLUVIO-LACUSTRINE
GEOMORPH: THICK BLOCK-FAULTED BROADLY WARPED SEQUENCES IN CONCEALED INFRABASINS

*UNIT: Em*
GEOL: CAMBRIAN METAMORPHICS
MAJLITH: METASEDIMENTS, SCHIST AND GNEISS
MINLITH:
MINAGE: PZE
MAXAGE: PZE
DEPENV: SHALLOW-MARINE TO PROXIMAL-DISTAL DEEP-SEA FAN ENVIRONMENTS
GEOMORPH: KANMANTOO FOLD BELT AT WESTERN MARGIN

*UNIT: EOm*
GEOL: CAMBRIAN ORDOVICIAN METAMORPHICS
MAJLITH: METAMORPHOSED SLATE, GREYWACKE, QUARTZOSE TURBIDITES
MINLITH:
MINAGE : PZO
MAXAGE: PZE
DEPENV: DEEP-MARINE INCLUDING SUBMARINE FANS
GEOMORPH: STAWELL AND BENDIGO BELTS AT SOUTHERN MARGIN

*UNIT: Ev*
GEOL: CAMBRIAN VOLCANICS
MAJLITH: BASIC AND ANDESITIC VOLCANICS, SERPENTINITE, DOLERITE, GABBRO
MINLITH: CHERT, VOLCANICLASTIC SEDIMENTS, SHALE
MINAGE: PZE
MAXAGE: PZE
DEPENV:
GEOMORPH: STAVELY, LAKE WINTLOW,HEATHCOTE AND MOUNT WELLINGTON BELTS AT SOUTHERN MARGIN

*UNIT: Kl*
GEOL: LOWER CRETACEOUS SEDIMENTS INCLUDING MONASH FORMATION AND MILLEWA GROUP EQUIVALENTS
MAJLITH: PALE GREY WEAKLY CEMENTED SANDSTONE, GLAUCONITIC MUDSTONE, GREEN-GREY CHLORITIC VOLCANOLITHIC SILTSTONE
MINLITH: MUDSTONE, COAL, CONGLOMERATE
MINAGE: MZKe
MAXAGE: MZKe
DEPENV: FLUVIATILE AND SHALLOW-MARINE
GEOMORPH: UNCERTAIN CONCEALED EXTENT, INTERSECTED IN LINEAR INFRABASINS

*UNIT: MZ*
GEOL: UNDIFFERENTIATED MESOZOIC
MAJLITH:
MINLITH:
MINAGE: MZKl
MAXAGE: MZRe
DEPENV:
GEOMORPH:

*UNIT: Og*
GEOL: ORDOVICIAN GRANITOIDS
MAJLITH:
MINLITH:
MINAGE: PZO
MAXAGE: PZO
DEPENV:
GEOMORPH:

*UNIT: Om*
GEOL: ORDOVICIAN METAMORPHICS
MAJLITH: TURBIDITIC METASEDIMENTS, SLATE, QUARTZITE AND GNEISS
MINLITH:
MINAGE: PZO
MAXAGE: PZO
DEPENV:
GEOMORPH: HOWQUA, TABBERABBERA AND WAGGA-OMEO BELTS AT SOUTHERN AND EASTERN MARGINS

*UNIT: PZ*
GEOL: UNDIFFERENTIATED PALEOZOIC
MAJLITH:
MINLITH:
MINAGE: PZPl
MAXAGE: PZEe
DEPENV:
GEOMORPH:

*UNIT: PRs*
GEOL: PROTEROZOIC SEDIMENTS INCLUDING ADELAIDEAN
MAJLITH: WEAKLY METAMORPHOSED CLASTICS, CARBONATES, EVAPORITES AND TILLITES
MINLITH:
MINAGE: PRL
MAXAGE: PRL
DEPENV: FLUVIO-DELTAIC, LAGOONAL, SHALLOW-MARINE
GEOMORPH: ADELAIDE FOLD BELT AT WESTERN MARGIN

*UNIT: P1*
GEOL: LOWER PERMIAN SEDIMENTS INCLUDING URANA FORMATION EQUIVALENTS
MAJLITH: DIAMICTITE
MINLITH: MUDSTONE, POORLY SORTED SILTY SANDSTONE, SANDY CONGLOMERATE
MINAGE: PZPe
MAXAGE: PZCl
DEPENV: GLACIO-MARINE, POSSIBLE SUB-GLACIAL TILLITE
GEOMORPH: PRESENT IN CONCEALED LINEAR INFRABASINS

*UNIT: Pu*
GEOL: UPPER PERMIAN SEDIMENTS INCLUDING COORABIN COAL MEASURES
MAJLITH: OFF-WHITE CLAYEY COARSE SAND, GREY DARK BROWN CARBONACEOUS CLAYS, COAL
MINLITH: CONGLOMERATE, SILT
MINAGE: PZPl
MAXAGE: PZPl
DEPENV: FLUVIAL, MEANDERING STREAM CHANNEL FLOOD PLAIN ENVIRONMENT
GEOMORPH: UNKNOWN CONCEALED EXTENT, THIN SHEET OVER OVENS GRABEN

*UNIT: pE*
GEOL: UNDIFFERENTIATED PRECAMBRIAN
MAJLITH: BASEMENT MIGMATITE, QUARTZO-FELSPATHIC METASEDIMENTARY AND BASIC GNEISSES
MINLITH: GRANITOIDS, BASIC AND ULTRABASIC INTRUSIVES
MINAGE: PE
MAXAGE: PE
DEPENV:
GEOMORPH: BROKEN HILL AND WILLYAMA HIGH-GRADE METAMORPHIC BASEMENT BLOCKS AT NORTHWEST MARGIN

*UNIT: Q*
GEOL: UNDIFFERENTIATED QUATERNARY
MAJLITH:
MINLITH:
MINAGE: CZQH
MAXAGE: CZQPe
DEPENV:
GEOMORPH:

*UNIT: Qa*

GEOL: COONAMBIDGAL FORMATION
MAJLITH: UNCONSOLIDATED GREY BROWN MICACEOUS SILTY CLAY, SILT, POLYMICTIC SAND, GRAVEL
MINLITH:
MINAGE: CZQH
MAXAGE: CZQPl
DEPENV: FLUVIAL, FLUVIO-LACUSTRINE, CHANNEL AND FLOODPLAIN ENVIRONMENTS OF EXISTING RIVERS
GEOMORPH: NARROW MEANDER BELTS, ANASTOMISED DISTRIBUTARIES AND CONFINED FLOODPLAINS INCISED WITHIN OLDER FLUVIAL, AEOLIAN LANDSCAPES AND IN TRIBUTARY HIGHLAND VALLEYS

*UNIT: Qad*

GEOL: QUATERNARY SOURCE-BORDERING DUNE DEPOSITS
MAJLITH: UNCONSOLIDATED LOCALLY MOBILE PALE ORANGE YELLOW SILICEOUS SAND MINLITH: LOCAL ABUNDANT MICACEOUS AND LITHIC GRAINS
MINAGE: CZQH
MAXAGE: CZQPl
DEPENV: FLUVIAL DERIVED SOURCE BORDERING AEOLIAN DUNE
GEOMORPH: ELLIPTICAL MOUNDS AND ELONGATE HUMMOCKY DUNE COMPLEXES ADJACENT TO ACTIVE AND FORMER RIVER CHANNELS

*UNIT: Qca*

GEOL: BAKARA CALCRETE RIPON CALCRETE AND OTHER CALCRETE DEPOSITS
MAJLITH: STRONGLY CEMENTED PALE GREY MASSIVE SHEET CALCRETE, CALCRETE RUBBLE, FRIABLE WHITE CREAM RHYZOLITIC AND NODULAR CALCRETE
MINLITH:
MINAGE: CZQH
MAXAGE: CZQPe
DEPENV: PEDOGENIC GROUNDWATER LACUSTRINE AND BIOGENIC ENVIRONMENTS OF DIAGENESIS
GEOMORPH: LOCAL MASSIVE RESISTANT SHEETS

*UNIT: Qcl*

GEOL: PADTHAWAY FORMATION
MAJLITH: UNCONSOLIDATED SAND, SILT, SANDY VARIEGATED CLAY, PEAT, CALCAREOUS CLAY, FRESHWATER LIMESTONE
MINLITH:
MINAGE: CZQPl
MAXAGE: CZQPl
DEPENV: LACUSTRO-LAGOONAL, SWAMP, MINOR LUNETTE AND LOCALLY COLLUVIAL ENVIRONMENTS BETWEEN STRANDED BEACH RIDGES
GEOMORPH: WIDESPREAD LOW-LYING COASTAL PLAINS AND WETLANDS WITH MINOR LUNETTES

*UNIT: Qdb*

GEOL: BUNYIP SAND
MAJLITH: UNCONSOLIDATED LOCALLY MOBILE PALE RED-BROWN QUARTZ SAND
MINLITH: CALCAREOUS RHIZOLITHS
MINAGE: CZQH
MAXAGE: CZQH
DEPENV: FLUVIAL DERIVED SOURCE BORDERING AEOLIAN DUNE
GEOMORPH: ELONGATE DUNEFIELDS EAST OF RIVER MURRAY IN SOUTH AUSTRALIA

*UNIT: Qdl*

GEOL: UNDIFFERENTIATED QUATERNARY LACUSTRINE-DERIVED AEOLIAN LUNETTE DEPOSITS
MAJLITH: POORLY CONSOLIDATED BROWN RED YELLOW GREY SILICEOUS SAND, SILTY CLAY, CLAY PELLET AGGREGATES, GYPSEOUS CLAY PELLETS, PALE GREY GYPSITE
MINLITH: RED CALCAREOUS AND GYPSEOUS PALEOSOLS WITH CALCRETE GLAEBULES, RHIZOLITHS, WHITE MOBILE WELL-SORTED QUARTZ SAND
MINAGE: CZQH
MAXAGE: CZQPl
DEPENV: AEOLIAN DUNE ENVIRONMENT ADJACENT TO DEFLATED LAKE FLOORS AND SHORES
GEOMORPH: SINGLE AND MULTIPLE LUNETTES (CRESCENTIC TRANSVERSE DUNES) CONCAVE TO WEST LOCATED ON EASTERN SIDE OF LAKE BASINS LOCALLY FLANKED BY BLOWOUT DUNES OF MOBILE WHITE SAND

*UNIT: Qdm*

GEOL: MOLINEAUX-LOWAN SANDS
MAJLITH: UNCONSOLIDATED LOCALLY MOBILE YELLOW GREY PALE ORANGE WELL SORTED MEDIUM TO FINE FROSTED QUARTZ SAND
MINLITH: MARINE-DERIVED AEOLINITE, CALCAREOUS FILAMENTAL RHIZOLITHS, CALCRETE GLAEBULES, IRON-CEMENTED PISOLITHS
MINAGE: CZQH
MAXAGE: CZQPl
DEPENV: AEOLIAN DUNE
GEOMORPH: IRREGULAR TO SUB-PARABOLIC LOCALLY LINEAR SHARP CRESTED DENSELY PACKED DUNES WITH NARROW INTERDUNE CORRIDORS AND MINOR SAND PLAINS, EXTENSIVE EASTERLY TRENDING TONGUE-LIKE DUNEFIELDS

*UNIT: Qdp*

| | |
|---|---|
| GEOL: | UNNAMED QUATERNARY AEOLIAN SAND PLAIN UNIT |
| MAJLITH: | UNCONSOLIDATED RED BROWN CLAYEY MEDIUM-FINE GRAINED SILICEOUS SAND, CLAY PELLET AGGREGATES |
| MINLITH: | LOAMY SOILS, IRON AND CARBONATE CEMENTED NODULES GRADING TO CALCRETE HARDPANS |
| MINAGE: | CZQH |
| MAXAGE: | CZQPl |
| DEPENV: | AEOLIAN SAND SHEET AND ASSOCIATED LACUSTRINE AND CLAYPAN ENVIRONMENTS |
| GEOMORPH: | EXTENSIVE FLAT TO GENTLY UNDULATING PLAINS LOCALLY WITH NUMEROUS FLUVIO-LACUSTRINE DEPRESSIONS INCLUDES AEOLIAN-MODIFIED SAND PLAINS ADJACENT TO RIVERS AND LAKES |

*UNIT: Qdu*

| | |
|---|---|
| GEOL: | UNNAMED QUATERNARY AEOLIAN DUNE DEPOSITS |
| MAJLITH: | UNCONSOLIDATED LOCALLY MOBILE RED-BROWN PALE ORANGE MEDIUM TO FINE GRAINED SILICEOUS SAND |
| MINLITH: | HUMIC DEBRIS; FRAGMENTED CALCAREOUS AND GYPSEOUS FILAMENTAL RHIZOLITHS |
| MINAGE: | CZQH |
| MAXAGE: | CZQPl |
| DEPENV: | AEOLIAN DUNE |
| GEOMORPH: | SHARP CRESTED IRREGULAR TO SUB-PARABOLIC LOCALLY LINEAR DUNES WITH NARROW INTERDUNE DEPRESSIONS,ELONGATE EASTERLY TRENDING DUNEFIELDS |

*UNIT: Qdw*

| | |
|---|---|
| GEOL: | WOORINEN FORMATION |
| MAJLITH: | UNCONSOLIDATED RED-BROWN SILICEOUS MEDIUM TO FINE GRAINED SILTY SAND, RED CALCAREOUS SILTY CLAY,SANDY CLAY, CLAY PELLET AGGREGATES |
| MINLITH: | HUMIC DEBRIS, FRAGMENTED CALCAREOUS TAP ROOT AND FILAMENTAL RHIZOLITHS, RED CALCAREOUS PALAEOSOLS WITH GYPSIFEROUS AND CARBONATE GLAEBULES GRADING TO CEMENTED CALCRETE HARDPANS |
| MINAGE: | CZQH |
| MAXAGE: | CZQPl |
| DEPENV: | AEOLIAN DUNE AND SWALE |
| GEOMORPH: | EXTENSIVE DUNEFIELDS OF DISCONTINUOUS EAST-WEST ORIENTED DUNES WITH SUBDUED CRESTS AND FLANKS SEPARATED BY BROAD SWALES AND SAND PLAINS |

*UNIT: Qfr*

| | |
|---|---|
| GEOL: | POORAKA FORMATION AND OTHER COLLUVIAL AND RESIDUAL DEPOSITS |
| MAJLITH: | UNCONSOLIDATED RED-BROWN POORLY-SORTED CLAYEY SAND, GRAVEL, CONGLOMERATE, BRECCIA |
| MINLITH: | CALCRETE INTERCALATIONS AND CAPPINGS, LOCAL FERRUGINISED SILICIFIED MATRIX |
| MINAGE: | CZQH |
| MAXAGE: | CZQPe |
| DEPENV: | COLLUVIAL SHEET WASH, ALLUVIAL FAN AND RESIDUAL LAG ENVIRONMENTS |
| GEOMORPH: | EXTENSIVE COALESCED LOW ANGLE FANS, HIGH ANGLE TALUS CONES AND SCREE SLOPES |

*UNIT: Qhe*

| | |
|---|---|
| GEOL: | SEMAPHORE SAND |
| MAJLITH: | UNCONSOLIDATED LOCALLY MOBILE WHITE CALCAREOUS FOSSILIFEROUS QUARTZ SAND |
| MINLITH: | HUMIC DEBRIS, CALCAREOUS RHIZOLITHS |
| MINAGE: | CZQH |
| MAXAGE: | CZQH |
| DEPENV: | COASTAL BEACH AND ASSOCIATED AEOLIAN DUNE |
| GEOMORPH: | PRESENT-DAY COASTAL BEACH AND DUNE COMPLEXES |

*UNIT: Qhl*

| | |
|---|---|
| GEOL: | UNNAMED HOLOCENE LAGOONAL CARBONATE DEPOSITS |
| MAJLITH: | UNCONSOLIDATED TO WEAKLY LITHIFIED FOSSILIFEROUS MICRITIC AND DOLOMITIC MUD, DOLOMITE |
| MINLITH: | QUARTZ SAND, CLAY, SHELL DETRITUS, CALCAREOUS ALGAL BIOLITHITE |
| MINAGE: | CZQH |
| MAXAGE: | CZQH |
| DEPENV: | RESTRICTED BRACKISH TO MARINE LAGOONAL |
| GEOMORPH: | LOCALLY EXPOSED AROUND MARGINS OF THE COORONG AND OTHER COASTAL LAKE COMPLEXES |

*UNIT: Qho*

| | |
|---|---|
| GEOL: | ST KILDA FORMATION |
| MAJLITH: | UNCONSOLIDATED MUD,SILT,SAND, SHELL DEBRIS |
| MINLITH: | EPHEMERAL SALT CRUSTS OF GYPSUM,HALITE |
| MINAGE: | CZQH |
| MAXAGE: | CZQH |
| DEPENV: | ESTUARINE,COASTAL LAKE AND SWAMP |
| GEOMORPH: | LITTORAL LAKE COMPLEXES,PARTLY EMERGENT ESTUARINE FLATS AND SALINAS |

*UNIT: Ql*

| | |
|---|---|
| GEOL: | UNDIFFERENTIATED QUATERNARY LACUSTRINE DEPOSITS |
| MAJLITH: | FRIABLE TO PLASTIC FINELY LAMINATED GREY CLAY, SILTY CLAY, HUMIC CLAY, GREY PALAEOSOLS |
| MINLITH: | MEDIUM TO FINE SAND |
| MINAGE: | CZQH |
| MAXAGE: | CZQPl |
| DEPENV: | LACUSTRINE AND ASSOCIATED STRANDLINE ENVIRONMENTS |
| GEOMORPH: | FLOODPLAIN LAKES AND SWAMPS, INTERDUNE DEFLATION HOLLOWS AND COASTAL LAKE COMPLEXES |

*UNIT: Qly*

| | |
|---|---|
| GEOL: | YAMBA FORMATION |
| MAJLITH: | FRIABLE PALE GREY GYPSITE, GYPSIFEROUS CLAY, GREY PELLETAL GYPSUM-QUARTZ AGGREGATES, BLACK SULPHIDE-RICH MUD, EPHEMERAL SALT CRUSTS OF GYPSUM HALITE BISCHOFITE THENARDITE MIRABILITE |
| MINLITH: | GREY CLAY WITH CRYSTALLINE GYPSUM MUSH, MOUNDS AND SHEETS OF FERRICRETE, CALCRETE AND SILCRETE CEMENTED QUARTZ SAND |
| MINAGE: | CZQH |
| MAXAGE: | CZQPl |
| DEPENV: | LACUSTRINE, EVAPORITIC AND AEOLIAN ENVIRONMENTS OF EPHEMERALLY ACTIVE PLAYAS MAINTAINED BY GROUNDWATER DISCHARGE AND DEFLATION OF LAKE FLOORS |
| GEOMORPH: | AEOLIAN-MODIFIED GYPSITE FLATS, ACTIVE SALINAS AS IRREGULARLY SHAPED LAKE COMPLEXES ENTRENCHED WITHIN RELICT PEDESTALS OF FORMER LAKE FLOORS |

*UNIT: Qpb*

| | |
|---|---|
| GEOL: | BRIDGEWATER FORMATION |
| MAJLITH: | POORLY CONSOLIDATED PALE YELLOW PINKISH-BROWN FINE TO COARSE FOSSILIFEROUS CALCAREOUS SAND,CALCARENITE |
| MINLITH: | CALCRETE CAPPING |
| MINAGE: | CZQPl |
| MAXAGE: | CZQPl |
| DEPENV: | COASTAL BEACH AND ASSOCIATED AEOLIAN DUNE |
| GEOMORPH: | STRANDED SERIES OF ELONGATE BEACH RIDGES SUBPARALLEL TO PRESENT COASTLINE |

*UNIT: Qpc*

| | |
|---|---|
| GEOL: | BLANCHETOWN CLAY BUNGUNNIA LIMESTONE |
| MAJLITH: | POORLY CONSOLIDATED TO FRIABLE WELL LAMINATED GREENISH-GREY RED-BROWN SILTY SANDY CALCAREOUS AND GYPSIFEROUS CLAY, WELL-CEMENTED FLAGGY DOLOMITIC LIMESTONE |
| MINLITH: | QUARTZ SAND, OSTRACOD SAND |
| MINAGE: | CZQPe |
| MAXAGE: | CZQPe |
| DEPENV: | PREDOMINATELY FRESHWATER LACUSTRINE, LOCALLY SALINE LACUSTRINE AND FLUVIAL ENVIRONMENTS |
| GEOMORPH: | MAINLY CONCEALED, LOCALLY EXPOSED IN RIVER CLIFFS AND LAKE MARGINS |

*UNIT: Qpl*

| | |
|---|---|
| GEOL: | COOMANDOOK FORMATION |
| MAJLITH: | PARTLY LITHIFIED GREY CREAM FOSSILIFEROUS MEDIUM-GRAINED QUARTZ SAND, CALCAREOUS SAND CALCARENITE, SANDY CLAY, CONTAINING LITHIC CLASTS AND SKELETAL DEBRIS DERIVED FROM OLDER LIMESTONES |
| MINLITH: | |
| MINAGE: | CZQPe |
| MAXAGE: | CZQPe |
| DEPENV: | SHALLOW MARINE |
| GEOMORPH: | ENTIRELY CONCEALED |

*UNIT: Qpu*

| | |
|---|---|
| GEOL: | UNNAMED PLEISTOCENE MARGINAL MARINE AND LAGOONAL UNIT |
| MAJLITH: | WELL CEMENTED PALE GREY FINE GRAINED DOLOMITIC ALGAL BOUNDSTONE WITH INTRACLASTS OF SANDSTONE, CALCARENITE, DOLOMITE |
| MINLITH: | SHEET CALCRETE CAPPING |
| MINAGE: | CZQPe |
| MAXAGE: | CZQPe |
| DEPENV: | MARGINAL-MARINE, LACUSTRO-LAGOONAL |
| GEOMORPH: | FLAT COASTAL PLAIN |

*UNIT: SDg*

| | |
|---|---|
| GEOL: | SILURIAN DEVONIAN GRANITOIDS |
| MAJLITH: | |
| MINLITH: | |
| MINAGE: | PZD |
| MAXAGE: | PZS |
| DEPENV: | |
| GEOMORPH: | |

*UNIT: SDls*

| | |
|---|---|
| GEOL: | SILURIAN TO LOWER DEVONIAN SEDIMENTS INCLUDING WINDUCK GROUP EQUIVALENTS |
| MAJLITH: | MARINE SILTSTONE, SHALE, LAMINATED QUARTZ SANDSTONE CONTAINING SHELLY FAUNAS |
| MINLITH: | |
| MINAGE: | PZDe |
| MAXAGE: | PZS |
| DEPENV: | MARINE, DEEP WATER TURBIDITES TO REGRESSIVE SHALLOW-MARINE SHELF |
| GEOMORPH: | THICK BLOCK-FAULTED BROADLY WARPED SEQUENCES IN CONCEALED INFRABASINS |

*UNIT: T*

| | |
|---|---|
| GEOL: | UNDIFFERENTIATED TERTIARY |
| MAJLITH: | |
| MINLITH: | |
| MINAGE: | CZTPl |
| MAXAGE: | CZTAe |
| DEPENV: | |
| GEOMORPH: | |

*UNIT: TQl*

| | |
|---|---|
| GEOL: | UNDIFFERENTIATED DURICRUST |
| MAJLITH: | RED MASSIVE TO PISOLITIC FERRUGINOUS SUBSOIL, MOTTLED CLAY, WHITE KAOLINITIC CLAY |
| MINLITH: | |
| MINAGE: | CZQ |
| MAXAGE: | CZTl |
| DEPENV: | COMPOSITE LATERITIC DURICRUST DEVELOPED OVER ELEVATED SURFACES IN DEEP CHEMICAL WEATHERING ENVIRONMENTS |
| GEOMORPH: | RESIDUAL FLAT TO GENTLY UNDULATING SURFACES, LOCALLY DEEPLY DISSECTED TO FORM STEEP-SIDED REMNANTS |

*UNIT: TQs*

| | |
|---|---|
| GEOL: | SHEPPARTON FORMATION |
| MAJLITH: | UNCONSOLIDATED TO POORLY CONSOLIDATED MOTTLED VARIEGATED CLAY, SILTY CLAY |
| MINLITH: | POLYMICTIC COARSE TO FINE SAND, GRAVEL, RED-BROWN PALAEOSOLS |
| MINAGE: | CZQ |
| MAXAGE: | CZTP |
| DEPENV: | FLUVIO-LACUSTRINE, FLOODPLAIN, CHANNEL AND LEVEE ENVIRONMENTS, MINOR AEOLIAN |
| GEOMORPH: | EXTENSIVE FLAT ALLUVIAL FLOODPLAINS TRAVERSED BY REMNANT TRACES OF INACTIVE MEANDERING PALAEOCHANNELS |

*UNIT: TQv*

| | |
|---|---|
| GEOL: | NEWER VOLCANICS |
| MAJLITH: | BASALTIC LAVA, AGGLOMERATE, SCORIA, TUFF |
| MINLITH: | VOLCANICLASTIC SEDIMENTS |
| MINAGE: | CZQ |
| MAXAGE: | CZT |
| DEPENV: | WIDESPREAD SUB-AERIAL VOLCANIC |
| GEOMORPH: | EXTENSIVE LAVA AND PYROCLASTIC FIELDS CONTAINING NUMEROUS SMALL REMNANT CONES PLUGS MAARS, ISOLATED SCORIACEOUS CONES PLUGS AND FLOWS |

*UNIT: TRm*

| | |
|---|---|
| GEOL: | MID TRIASSIC SEDIMENTS INCLUDING JERILDERIE FORMATION |
| MAJLITH: | WHITE QUARTZOSE SANDSTONE, PEBBLE CONGLOMERATE, MUDSTONE |
| MINLITH: | |
| MINAGE: | MZRm |
| MAXAGE: | MZRm |
| DEPENV: | FLUVIAL CHANNEL AND FLOOD PLAIN |
| GEOMORPH: | UNCERTAIN CONCEALED EXTENT, FORMS FLAT SHEET OVER OVENS GRABEN |

*UNIT: Ta*

| | |
|---|---|
| GEOL: | HIGHLAND TERTIARY SEDIMENTS |
| MAJLITH: | UNCONSOLIDATED TO LOCALLY FERRUGINISED SILICIFIED POORLY SORTED PEBBLE TO BOULDER CONGLOMERATE, GRANULAR TO FINE SAND |
| MINLITH: | SILT, CLAY, KAOLIN |
| MINAGE: | CZTPl |
| MAXAGE: | CZTAe |
| DEPENV: | HIGH LEVEL RESIDUAL, VALLEY FILL, ALLUVIAL AND COLLUVIAL |
| GEOMORPH: | EROSIONAL REMNANTS EXPOSED IN HIGHLAND VALLEYS AND STRANDED INTERFLUVES |

*UNIT: Teb*

| | |
|---|---|
| GEOL: | BUCCLEUCH BEDS |
| MAJLITH: | POORLY CONSOLIDATED GREY-BROWN CARBONACEOUS CLAY, FRIABLE CARBONACEOUS SAND, HIGHLY FOSSILIFEROUS WHITE BRYOZOAL LIMESTONE |
| MINLITH: | GREEN-GREY GLAUCONITIC CALCAREOUS CLAY (MARL) |
| MINAGE: | CZTOe |
| MAXAGE: | CZTEl |
| DEPENV: | SHALLOW-MARINE |
| GEOMORPH: | ENTIRELY CONCEALED |

*UNIT: Teo*

GEOL: OLNEY FORMATION
MAJLITH: UNCONSOLIDATED TO POORLY CONSOLIDATED DARK BROWN GREY BLACK CARBONACEOUS, SAND, SILT, CLAY, BROWN COAL, PEAT, COMMONLY MICACEOUS PYRITIC FERRUGINISED
MINLITH: POORLY SORTED FINE TO MEDIUM QUARTZ SAND, POLYMICTIC SAND, SANDY DOLOMITE
MINAGE: CZTMm
MAXAGE: CZTE
DEPENV: FLUVIO-LACUSTRINE, MEANDERING CHANNEL, FLOODPLAIN AND SWAMP, SOME DELTAIC, PARALIC
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Ter*

GEOL: RENMARK GROUP
MAJLITH: OLNEY FORMATION-WARINA SAND COMPOSITE, MEDIUM TO COARSE QUARTZ SAND, DARK BROWN GREY BLACK CARBONACEOUS SAND, SILT, CLAY, BROWN COAL, PEAT
MINLITH:
MINAGE: CZTM
MAXAGE: CZTA
DEPENV: FLUVIO-LACUSTRINE
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Ter1*

GEOL: LOWER RENMARK GROUP
MAJLITH: UNCONSOLIDATED TO POORLY CONSOLIDATED BLUE-GREY DARK BROWN BLACK LIGNEOUS SANDS AND SILTS
MINLITH:
MINAGE: CZTOe
MAXAGE: CZTEm
DEPENV: FLUVIAL, FLUVIO-LACUSTRINE
GEOMORPH: RESTRICTED TO BASIN TROUGHS, ENTIRELY CONCEALED

*UNIT: Ter2*

GEOL: MIDDLE RENMARK GROUP
MAJLITH: UNCONSOLIDATED TO POORLY CONSOLIDATED DARK GREY BLUE BLACK CARBONACEOUS COMMONLY PYRITIC AND LIGNEOUS CLAY,SILTY SAND
MINLITH:
MINAGE: CZTMm
MAXAGE: CZTO
DEPENV: FLUVIO-LACUSTRINE, PARALIC TO MARGINAL MARINE
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Ter3*

GEOL: UPPER RENMARK GROUP
MAJLITH: UNCONSOLIDATED TO POORLY CONSOLIDATED BROWN-GREY CARBONACEOUS MEDIUM TO FINE SAND, MICACEOUS AND PYRITIC SILT, FERRUGINISED UPPER SURFACE
MINLITH:
MINAGE: CZTMm
MAXAGE: CZTMm
DEPENV: FLUVIO-LACUSTRINE
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Tew*

GEOL: WARINA SAND
MAJLITH: UNCONSOLIDATED LOOSE TO FRIABLE GREY BROWN POORLY TO WELL SORTED MEDIUM TO COARSE QUARTZ SAND
MINLITH: FINE SAND, SILT, CLAY, CARBONACEOUS CLAY
MINAGE: CZTEe
MAXAGE: CZTA
DEPENV: FLUVIAL
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Tmg*

GEOL: GEERA CLAY
MAJLITH: POORLY CONSOLIDATED PLASTIC TO FRIABLE BLACK GREY DARK GREEN COMMONLY GLAUCONITIC FOSSILIFEROUS CALCAREOUS CARBONACEOUS CLAY, SILT
MINLITH: SAND, SANDY DOLOMITE
MINAGE: CZTMm
MAXAGE: CZTOl
DEPENV: SHALLOW AND MARGINAL MARINE, INTERDISTRIBUTARY BAY, LAGOONAL AND TIDAL FLAT
GEOMORPH: ENTIRELY CONCEALED

*UNIT: Tml*

GEOL: MURRAY GROUP LIMESTONES

MAJLITH: CONSOLIDATED WELL BEDDED PALE GREY YELLOW WHITE CREAM COARSE TO MEDIUM HIGHLY FOSSILIFEROUS SKELETAL CALCARENITE, CALCAREOUS CEMENTED QUARTZ SANDSTONE, BIOCLASTIC LIMESTONE

MINLITH: WEAKLY CONSOLIDATED CALCAREOUS CLAY (MARL)

MINAGE: CZTMm

MAXAGE: CZTOl

DEPENV: SHALLOW-MARINE PLATFORM

GEOMORPH: FORMS CLIFFS OF MURRAY RIVER GORGE, MINOR KARSTIFIED OUTCROPS, MAINLY CONCEALED

*UNIT: Tmw*

GEOL: WINNAMBOOL FORMATION

MAJLITH: POORLY CONSOLIDATED FRIABLE TO PLASTIC GREY BLUE-GREY PALE GREEN GLAUCONITIC HIGHLY FOSSILIFEROUS CALCAREOUS CLAY (MARL), ABUNDANT AND DIVERSE FAUNAS

MINLITH: SKELETAL CALCISILTITE, CALCARENITE, DENSE MICRITIC LIMESTONE

MINAGE: CZTMm

MAXAGE: CZTOl

DEPENV: RESTRICTED MARINE PLATFORM AND LAGOONAL

GEOMORPH: ENTIRELY CONCEALED

*UNIT: Toc*

GEOL: COMPTON CONGLOMERATE

MAJLITH: PARTLY CEMENTED MEDIUM TO COARSE IRONSTONE AND QUARTZ PEBBLE CONGLOMERATE, DARK BROWN HUMIC CLAY, GREEN GLAUCONITIC CLAY, RED CLAY WITH PEBBLE CLASTS, YELLOW BROWN GREY POORLY FOSSILIFEROUS CALCAREOUS SANDSTONE AND MARL

MINLITH:

MINAGE: CZTO

MAXAGE: CZTO

DEPENV: COMPOSITE UNIT DEPOSITED IN SUB-AERIAL RESIDUAL AND ASSOCIATED TRANSGRESSIVE SHALLOW MARINE ENVIRONMENTS

GEOMORPH: PATCHY SUBSURFACE DISTRIBUTION, ENTIRELY CONCEALED

*UNIT: Toe*

GEOL: ETTRICK FORMATION

MAJLITH: WEAKLY LITHIFIED GREY GREEN GLAUCONITIC HIGHLY FOSSILIFEROUS CALCAREOUS CLAY (MARL), SILT, SANDY SKELETAL CLAY

MINLITH: SKELETAL CALCARENITE TOWARDS TOP, FOSSILIFEROUS QUARTZ SAND, CARBONACEOUS CLAY

MINAGE: CZTMe

MAXAGE: CZTO

DEPENV: SHALLOW-MARINE, RESTRICTED PLATFORM TO LAGOONAL

GEOMORPH: ENTIRELY CONCEALED

*UNIT: Tpa*

GEOL: PLIOCENE SANDS

MAJLITH:

MINLITH:

MINAGE: CZTP

MAXAGE: CZTMl

DEPENV:

GEOMORPH:

*UNIT: Tpb*

GEOL: BOOKPURNONG BEDS

MAJLITH: POORLY CONSOLIDATED TO PLASTIC BROWN GREENISH-GREY CALCAREOUS HIGHLY FOSSILIFEROUS, GLAUCONITIC MICACEOUS CLAY (MARL), SILT, SAND, CHARACTERISTIC MOLLUSCAN MACROFOSSILS

MINLITH:

MINAGE: CZTP

MAXAGE: CZTMl

DEPENV: SHALLOW-MARINE SHELF

GEOMORPH: MAINLY CONCEALED

*UNIT: Tpc*

GEOL: CALIVIL FORMATION

MAJLITH: POORLY CONSOLIDATED PALE GREY POORLY SORTED COARSE TO GRANULAR QUARTZ SAND, CONGLOMERATE WITH WHITE KAOLINITIC MATRIX,KAOLIN, DARK BROWN FERRUGINIZED GREY PYRITIC SAND

MINLITH: CARBONACEOUS CLAY AND SILT

MINAGE: CZTPe

MAXAGE: CZTMl

DEPENV: SAND SHEET DEPOSITED IN VALLEY FILL,ALLUVIAL FAN, FLUVIO-LACUSTRINE AND BRAIDED CHANNEL ENVIRONMENTS

GEOMORPH: MAINLY CONCEALED

*UNIT: Tpn*

GEOL: NORWEST BEND FORMATION
MAJLITH: PARTLY CEMENTED PALE GREY BROWN YELLOW COQUINOID LIMESTONE WITH FOSSILIFEROUS QUARTZ SAND MATRIX, CHARACTERISTIC OYSTER BEDS
MINLITH:
MINAGE: CZTP
MAXAGE: CZTP
DEPENV: ESTUARINE
GEOMORPH: EXPOSED IN CLIFFS OF RIVER MURRAY GORGE, ELSEWHERE CONCEALED

*UNIT: Tps*

GEOL: UNDIFFERENTIATED LOXTON-PARILLA SANDS
MAJLITH: UNCONSOLIDATED TO WEAKLY CEMENTED YELLOW-BROWN FINE TO COARSE WELL-SORTED QUARTZ SAND, SANDSTONE, INTERSTITIAL WHITE KAOLINITIC OR GIBBSITE CLAY MATRIX TOWARDS TOP
MINLITH: CLAY, SILT, PEBBLY CONGLOMERATE, FINE TO COARSE SHELLY SANDSTONE, POORLY SORTED MICACEOUS QUARTZ SAND AND GRAVEL, MARINE SHELL, SANDY PISOLITIC FERRUGINOUS DURICRUST
MINAGE: CZTP
MAXAGE: CZTMl
DEPENV: COMPOSITE SAND SHEET DEPOSITED IN STRAND PLAIN AND FLUVIAL ENVIRONMENTS
GEOMORPH: TOPOGRAPHICALLY PROMINENT SUB-PARALLEL STRANDED BEACH RIDGES, ESTUARINE AND FLUVIAL COMPONENTS EXPOSED IN RIVER MURRAY CLIFFS, MAINLY CONCEALED

*UNIT: Tv*

GEOL: OLDER VOLCANICS
MAJLITH: BASALTIC LAVA, AGGLOMERATE, TUFF
MINLITH: VOLCANICLASTIC SEDIMENTS
MINAGE: CZTM
MAXAGE: CZTA
DEPENV: SUB-AERIAL VOLCANIC
GEOMORPH: NUMEROUS SMALL BUT WIDESPREAD VALLEY FLOWS AND HILL TOP CAPPINGS IN HIGHLAND AREAS

*UNIT: Ub*

GEOL: UNDIFFERENTIATED BASEMENT
MAJLITH:
MINLITH:
MINAGE:
MAXAGE:
DEPENV:
GEOMORPH:

*UNIT: Ubg*

GEOL: UNDIFFERENTIATED BASEMENT GRANITE
MAJLITH:
MINLITH:
MINAGE:
MAXAGE:
DEPENV:
GEOMORPH:

*UNIT: Ubm*

GEOL: UNDIFFERENTIATED BASEMENT METAMORPHICS
MAJLITH:
MINLITH:
MINAGE:
MAXAGE:
DEPENV:
GEOMORPH:

*UNIT: Ubs*

GEOL: UNDIFFERENTIATED BASEMENT SEDIMENTS
MAJLITH:
MINLITH:
MINAGE:
MAXAGE:
DEPENV:
GEOMORPH:

*UNIT: Ubv*

GEOL: UNDIFFERENTIATED BASEMENT VOLCANICS
MAJLITH:
MINLITH:
MINAGE:
MAXAGE:
DEPENV:
GEOMORPH:

67 records selected.