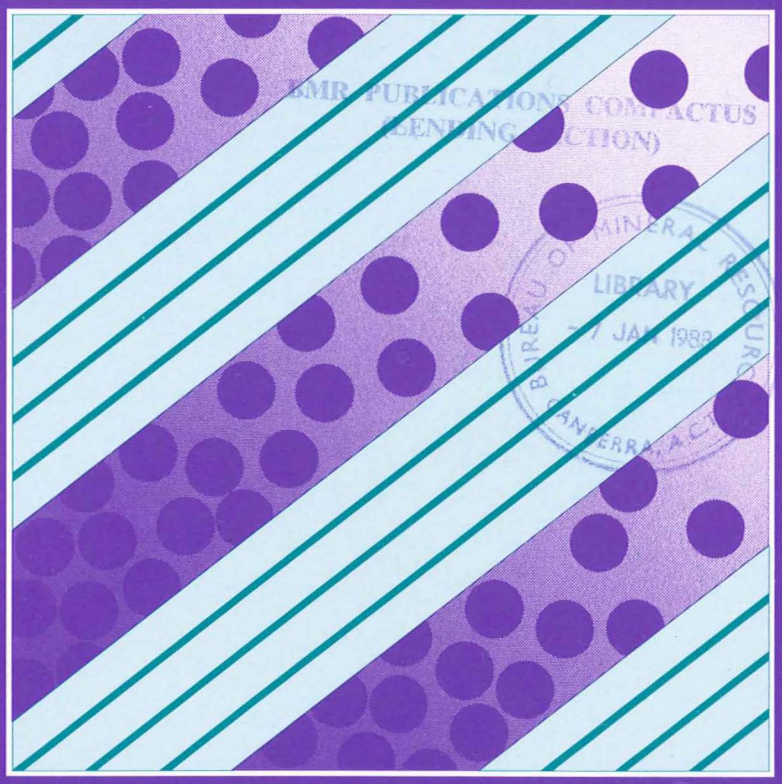
GROUNDWATER 6

Studies in Hydrogeology

NATIONAL GROUNDWATER DATA BASE INVENTORY 5 YEAR FORWARD PROGRAM VOLUME 1

AUSTRALIAN GROUNDWATER CONSULTANTS



BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

DIVISION OF CONTINENTAL GEOLOGY

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Division of Continental Geology Groundwater Series No. 6

NATIONAL GROUNDWATER DATA BASE INVENTORY 5 YEAR FORWARD PROGRAM

by

Australian Groundwater Consultants Pty Limited

VOLUME 1

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
DEPARTMENT OF PRIMARY RESOURCES & ENERGY

FOREWORD

This is one of the the new series of hydrogeological reports compiled by the Hydrogeology Group of the Bureau of Mineral Resources (BMR), Division of Continental Geology, from a study prepared by Australian Groundwater Consultants (AGC).

Arising from the support by the Department of Resources and Energy for a National Water Resources Inventory Program BMR retained AGC to devise a five year forward program of groundwater reconnaissance and exploration. Funding has been provided through the Federal Water Resources Assistance Program. In each State and Territory the consultants investigated with the relevant authorities the status of groundwater knowledge and local methods of groundwater data storage and retrieval; they attempted an assessment of the work required to provide sufficient information for the national inventory and recommended programs of work, with suggested priorities and details of required staffing, equipment, time schedules and costs.

This report is the outcome of the AGC study, which was completed in 1985.

Peter J. Cook
Chief, Division of
Continental Geology.

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AGC would like to thank the many people involved in some way in this study. In particular the directors are grateful for the discussions with Dr. P. Cook of the BMR and staff of the Hydrogeological Group.

We also wish to thank the fruitful discussions with staff from the various State authorities and organisations. Finally we wish to thank Mr. Mike Lee, Lyall Macoun & Joy Consulting Engineers (formerly with the Dept. of Resources & Energy) for his valuable contributions in discussions on the overall concepts of the program.

SUMMARY

STUDY BACKGROUND

The 1983 the Department of Resources & Energy philosophy of a National Water Resources Inventory Program was developed from recommendations made in the Water 2000 report (Jacobson et.al., 1983). That report concluded amongst other things:

- Groundwater resources data are inadequate in about three quarters of Australia's drainage basins.
- That there existed deficiencies in groundwater data collection, storage, analysis and dissemination.

and recommended that:

- National groundwater resource assessment be upgraded through increased Commonwealth funding.
- That the reconnaissance be focused on the remote, unknown areas of the continent, that is, the arid and semi-arid zones and northern Australia.
- That the analysis, and dissemination of groundwater data through publication be improved for national development planning.

Australian Groundwater Consultants were retained by the Bureau of Mineral resources on behalf of the Department of Resources & Energy to carry out a study to identify and develop a five year forward program of reconnaissance and exploration for the National Water Resources Inventory program. This study dealt only with groundwater as distinct from surface water resources.

The tasks addressed by the consultants were as follows:

- To provide a description of data coverage, distribution, density, storage and access throughout the States of Australia.

- Discuss similarities and differences of the data bases, and their suitability and reliability for providing data for national assessment.

- Suggest improvements to State data bases to provide the required data for the national inventory.

- Assess groundwater areas within each State and determine the reconnaissance and exploration needs for the national inventory data base.

- Set priorities for reconnaissance and exploration.
- Describe in detail the investigation programs and their objectives including program staffing, equipment requirements, time schedules and costs.

Interviews were conducted with the relevant State authorities knowledge of groundwater data in each State. In addition the

storage and retrieval systems currently used in each State were reviewed and summarised.

The response to the program philosophy was mixed, but the overall thrust of the program was considered to be beneficial.

State Data Bases

Review of the State data bases revealed that they all incorporate a large volume and coverage of groundwater data in retrievable form accessible throughout a variety of E.D.P. systems. The reliability of the data is variable both from source and in processing and much of the data has not been collated or interpreted on a regional scale except in relation to specific problem areas. Details of the various storage systems are presented in Appendices A-I(Vol.2).

Improvement and further development of these systems in some States are desirable in order to achieve more reliable and comprehensive data entry. In addition, comprehensive data output including an indication of the coverage of areas with processed data in map and report formats would be beneficial.

The assessment of the status of knowledge from the State data bases indicated that there are large areas of the continent where groundwater conditions are unknown, and unevaluated. Unevaluated areas occur where groundwater data are available and sufficient to assess the groundwater system but where these data have not been evaluated and/or collated. Conceptually known areas were also identified where the groundwater system is generally known but where there is insufficient information to determine its behaviour and development of site-specific potential.

Assessment and Evaluation of Groundwater Knowledge

Assessment of data available and classification of Australia's principal aquifer types (fractured rocks, large sedimentary basin and other sedimentary deposits) into unknown, unevaluated, conceptually known and design evaluated reveal large areas where data need to be collected, collated, interpreted and presented. It is recommended that this be done by the preparation of hydrogeological maps (see Appendix J, Volume 2) or hydrogeological data sheets. A hydrogeological data sheet is defined here as a map summarising available groundwater data but where there is insufficient information to enable interpretation of the data to be presented.

The areas identified and shown on Figures 3-1 to 3-19 in the main text are discussed in Section 3. Figure 1-1 summarises the proposed areas for investigation.

It has been argued that the recently completed Review 85 program achieves the objective of collation by a direct route, and that hydrogeological mapping is therefore unnecessary. However, the former is a broad scale groundwater resource assessment while the latter in its fully developed form deals with the flow-system

hydrodynamics including salinity/yield relationships of aquifer systems.

Collection, collation and publication of existing and new data in a consistent form will vastly improve the dissemination of data base information and the status of knowledge of the respective groundwater areas selected.

Most of the State Authorities accept the concept of the National reconnaissance program and co-operated to identify areas for inclusion in the classification schemes adopted for this study. To undertake the work programs however they will need to employ contract staff and supervisors or consultants to complete the requirement of hydrogeological maps and data production, including bore census, data collation, interpretation and drilling supervision.

Reconnaissance & Exploration Program

After discussions with the State authorities various 1:250,000 sheets were selected against justification criteria for inclusion in a five year program of evaluation which includes bore census, data collection, some drilling and testing to produce 1:250,000 hydrogeological maps and data sheet.

The areas for study, outlined in Chapter 4.0 of this report, were selected 1. to cover the more remote areas of the continent, or areas away from developed groundwater regions, and 2. to include regional areas where large amounts of data already exist which need to be collated to produce maps or data sheets of National importance.

Although the second objective tends to overlap somewhat with the proposed State/Commonwealth Hydrogeological Mapping, the areas selected from a State point of view, are mostly in low priority regions.

Drilling has been included in the program to obtain additional information in areas where virtually no data exist.

Priorities are presented for the five year program of National Groundwater resources assessment so that funding and program scheduling can be manipulated if required.

The proposed 5 year program will achieve the following:

- Improvement in the accessibility of interpreted hydrogeological data presently stored in raw form in various data bases.
- Improvement in the level of groundwater knowledge in the more remote areas of Australia leading to a better assessment of regional groundwater resources.
- Improved dissemination of hydrogeological information to interested groups.

The recommended 5 year programs for each state are as follows:

South Australia

1. Bore census and preparation of data sheets in Officer Basin.
2. Hydrogeological mapping of the fluviatile system in the northern areas of the State.
2. Drilling to check interpretations and to supplement bore census data.

TOTAL $1.4M

New South Wales

1. Hydrogeological mapping of Central Fractured Rock Province and Riverine Drainage Systems including the Murray Basin.

TOTAL $1.5M

Victoria

1. Preparation of hydrogeological maps for three 1:250,000 sheets, St. Arnaud, Ballarat and Hamilton.
2. Drilling of 3 deep bores in the Murray Basin to complement NSW work program and provide information on the deeper aquifers which are presently unkown.

TOTAL $0.4M

Queensland

1. Hydrogeological mapping of Central Eastern Section of Queensland plus supplementary drilling.
2. Georgina Basin Queensland.
3. Hydrogeological mapping of southwest Riverine Drainage systems.

TOTAL $1.4M

Western Australia

1. Hydrogeological data collection and mapping of Eastern Goldfields.
2. Hydrogeological data collection and mapping of Pilbara Region.
3. Drilling in the Canning Basin (2 deep bores plus 5 shallow bores).
4. Drilling in the Officer Basin (2 deep bores plus 5 shallow bores).

TOTAL $2.8M

Northern Territory

1. Hydrogeological data collection, collation and mapping of central, northern and southern region of State including large sedimentary basins (ie. Wiso, Daly, Georgina).

2. Drilling, testing of one deep hole in Georgina Basin.

TOTAL $2.0M

GRAND TOTAL $9.5M

It is proposed that the data and draft maps at 1:250,000 scale be entered into a graphics computer system to allow the flexibility required in map legend preparation, alterations and additions and integration into smaller scale maps as required. From the graphics system, individual maps will be able to be selected for publication. These would be available to the public and other interested groups.

The various phases of data collection and map production envisaged are as follows:

1. Bore census, compilation, production of draft 1:250,000 data sheets.
2. Hydrogeological interpretation. Production of maps and explanatory notes.
3. Editing, checking of draft maps, data sheets and notes.
4. Digitising into a graphics computer system.
5. Selection for publication.
6. Production of preliminary hydrogeological maps, data sheets.
7. Printing of final colour or black and white hydrogeological maps, data sheets and explanatory notes.

The options for map production include the BMR's undertaking the work through use of inhouse graphics terminal(s) and printing facilities but this would require that staffing be increased and facilities of map production be improved and extended.

Alternatively the States could undertake to carry out this work leaving the BMR to produce selected smaller scale maps of distinct hydrogeological units as required using the 1:250,000 data stored on the graphics system.

If the States are to undertake this role graphics terminals will need to be provided to each State organisation for their use. Estimated cost would be in the region of $1M plus contract staff to operate and check the system, and edit and check the data base.

Irrespective of which organisation controls map production the BMR should be involved in coordinating the order, time schedule and the standards of data collection and formatting for the maps in cooperation with the States.

A pilot program to determine more precisely the costing of each step is recommended.

This program should:

- Determine more precisely overall costing, staffing and logistic requirements for bore census, collection and collation of data.

- Determine computer graphic system and printing requirements

hydrogeological data sheets or maps consistent with the general aim of the program. Of particular importance are the continued exploration in the Murray Basin and new exploration in the Canning Basin, studies of the large sedimentary basins, the smaller Tertiary Basins and palaeochannel systems aquifers. Many of these regional studies could be carried out by the BMR Hydrogeological Group.

- If the Bureau of Mineral Resources acts as a collating body to edit and supervise preparation of the hydrogeological data sheets or maps that its staffing and facilities be increased accordingly.

- That specific research aspects flowing from the 5 year program be addressed by the BMR hydrogeological group (see Section 5.4.1 of this report).

- If the States act as the collating agency, that graphics computer system terminals be set up within the appropriate authority for use on the proposed program.

- If any State does not wish to participate in the 5 year forward program that the BMR be funded to carry out the program of work.

- That a pilot program be set up during 1985/86 to hydrogeologically map four selected areas. During this pilot program the collation, map production requirements and costs could be more closely assessed and adjustments made to the costing outlined in this proposal. In addition it will allow suitability of the proposed hydrogeological legends to be assessed more accurately.

- It is recommended that the States through the State/Commonwealth co-operative funding be encouraged to hydrogeologically map design evaluated or conceptually evaluated areas which would benefit from a larger scale presentation. Larger scales of 1:100,000, 1:50,000 or even 1:10,000 should be utilised where appropriate. This should ensure that groundwater data in the more intensive investigation areas are disseminated and available to the public in an interpreted form.

- That the BMR takes on the role of supervision and management of the proposed 5 year forward program and that close liaison be established between BMR staff and the relevant State authorities.

and costs more precisely.
- Test the adequacy of hydrogeological legends proposed by the hydrogeological mapping sub-committee.
- Highlight likely problems that could be encountered during collation, compilation, digitising and the final printing process.

Total cost for the pilot study is estimated at $196,000.

Extended Investigation Program

As part of the recommended program some additional areas of work were seen as being desirable. This included some additional drilling in the Canning, Officer, Eucla Basins and a number of basins in Queensland. This program has a budget of about $3.0M.

Similarly it is recognised that further investigation drilling may be required in some areas arising from the five years program and a further $3.0M is recommended as a budget for this contingency.

Finally it is recommended that the BMR Groundwater Research Group should undertake integrated research programs related to the 5 year program. A budget of $2.0M is allocated for this over five years. Additional areas of research have been identified are outlined in Section 5.4.1 of this report.

The proposed 5 year forward program we believe is an essential aspect of the future investigation and developmentof Australia's vast groundwater resources. In the 5 years, a major step forward will be made in the dissemination of information on one of the nation's most vital natural resources.

RECOMMENDATIONS

- That the five year forward program be based on collection and collation of hydrogeological data in selected areas supplemented by some exploratory drilling.

- That the programs be undertaken by either the relevant State organisation staff or contract staff or consultants with results compiled either by the BMR or the States on a graphics computer system and to the final printing stage.

- That 1:250,000 sheets be used as the base for the program and that the legends used be those recommended by the AWRC hydrogeological mapping sub-committee. Explanatory notes should also be prepared with both the data sheets and the maps.

- That the hydrogeological mapping sub-committee strongly considers the adoption of an Australian Legend (for large scale mapping) where colour, and colour tones be used to distinguish salinity and probable yields respectively in preference to the modified I.A.H. approach which uses aquifer type as a basic parameter.

- That an expanded program consider extending the production of

DEPARTMENT OF RESOURCES & ENERGY
BUREAU OF MINERAL RESOURCES

NATIONAL DATA BASE INVENTORY
AND 5-YEAR FORWARD PROGRAM

1.0 INTRODUCTION

1.1 STUDY INITIATION

In 1983 the Department of Resources and Energy developed the philosophy of a new water resources program. The program philosophy was developed from recommendations made in the Water 2000 report compiled by hydrogeological staff of the Bureau of Mineral Resources for the Department of Resources & Energy. This report indicated that although the knowledge of Australian groundwater resources has increased considerably many parts of the continent still lack suitable data and inadequate groundwater information is available for many other parts. In addition the report indicated that access to available information is not easy and in general that analysis and dissemination of data are deficient.

In its conclusions the report emphasized the importance of groundwater as a national resource particularly in the arid to semi-arid regions and although many areas are being developed and stressed there are vast areas which remain untapped.

With respect to assessment the report concluded that:

". Groundwater resources data are inadequate for long term planning purposes in about three quarters of Australia's drainage basins.
. There are some deficiencies in methods of data collection and storage, and considerable deficiencies in data analysis and dissemination.
. The guidelines for Commonwealth assistance for groundwater data collection require revision in view of a national need for an upgraded and co-ordinated groundwater resources assessment program.
. Strengthening of Commonwealth assistance for assessment, and research related to assessment, of groundwater resources is essential."

The report made several recommendations, as follows:

"1.Assessment of national groundwater resources should be upgraded through a greatly increased level of Commonwealth Funding, and it should be co-ordinated by the Commonwealth.
2.The Commonwealth should direct more funding towards groundwater assessment activities of national significance related to broad-scale water resources planning, to ensure that there is-

- Reconnaissance and hydrogeological investigation of the arid and semi-arid zones, and northern Australia.
- Long term groundwater research and monitoring to identify and ameliorate large scale water quality problems.
- Systematic research and evaluation of the hydrogeology, and the quantity and quality of groundwater resources of the large sedimentary basins and fractured rock aquifers.
- Regional groundwater resource evaluation and modelling, especially in regions which are dependent on groundwater, or where increased demands are anticipated.

3. In the groundwater resources assessment program the importance of data analysis and the dissemination of information through publications must be recognised by the Commonwealth with the ultimate aim of maintaining a national groundwater resources inventory for national development planning.
4. Research related to the assessment of national groundwater resources should be greatly strengthened and co-ordinated by the Commonwealth, especially in the fields of hydrogeology, aquifer systems analysis, groundwater chemistry, and improved technology for the use of saline aquifers.
5. There should be increased analysis of stressed and polluted groundwater systems by the Commonwealth and States as well as by the users.

The subdivision of the new water resources program developed by the Department of Resources and Energy includes the following programs:

1. National Water Resources Inventory Program
   This program is to be carried out in order to provide a basic level of groundwater reconnaissance and exploration where such information does not presently exist. The program is to be funded entirely be the Commonwealth with the actual work being carried out where possible by State agencies on the Commonwealth's behalf.

2. Federal/State Co-operative Water Data Program
   The Federal/State co-operative program provides a vehicle for Commonwealth assistance to the States for surface water and groundwater data collection and analysis activities which relate to specific objectives of mutual Commonwealth and State interest. This program is to be funded by both the Commonwealth and the States on a dollar for dollar basis.

3. Australian Water Resources Council Collaborative Program
   This program includes a range of water resources data activities of mutual Commonwealth/State interest which do not involve the passing of Commonwealth funds to the States and which come within the ambit of Australian Water Resources Council.

In latter part of January 1985 Australian Groundwater Consultants were retained by the Bureau of Mineral resources on behalf of the Department of Resources & Energy to carry out a study to identify and develop a 5 year forward program of reconnaissance and exploration for the National Water Resources Inventory Program.

1.2 AIMS OF THE STUDY

The aims of the project undertaken by AGC were to study and evaluate the data bases of each State and to determine

1. the status of knowledge of groundwater data in Australia.
2. identify areas where there was little dissemination of information as well as to identify areas lacking in groundwater knowledge,
3. develop suitable investigation programs which would obtain and disseminate the required data, so that this knowledge could be substantially improved.

The tasks to be addressed by the consultants were as follows:

- To provide a description of data coverage, distribution, density, storage and access.
- Discuss similarities and differences of the data bases, and their suitability and reliability for providing data for national assessment.
- Suggest improvements to State data bases to provide the required data for the national inventory.
- Assess Groundwater Areas within each State and determine the reconnaissance and exploration needs for the national inventory data base.
- Set priorities for reconnaissance and exploration.
- Describe in detail the investigation programs and their objectives including program staffing, equipment requirements, time schedules and costs.

1.3 WORK PROGRAM

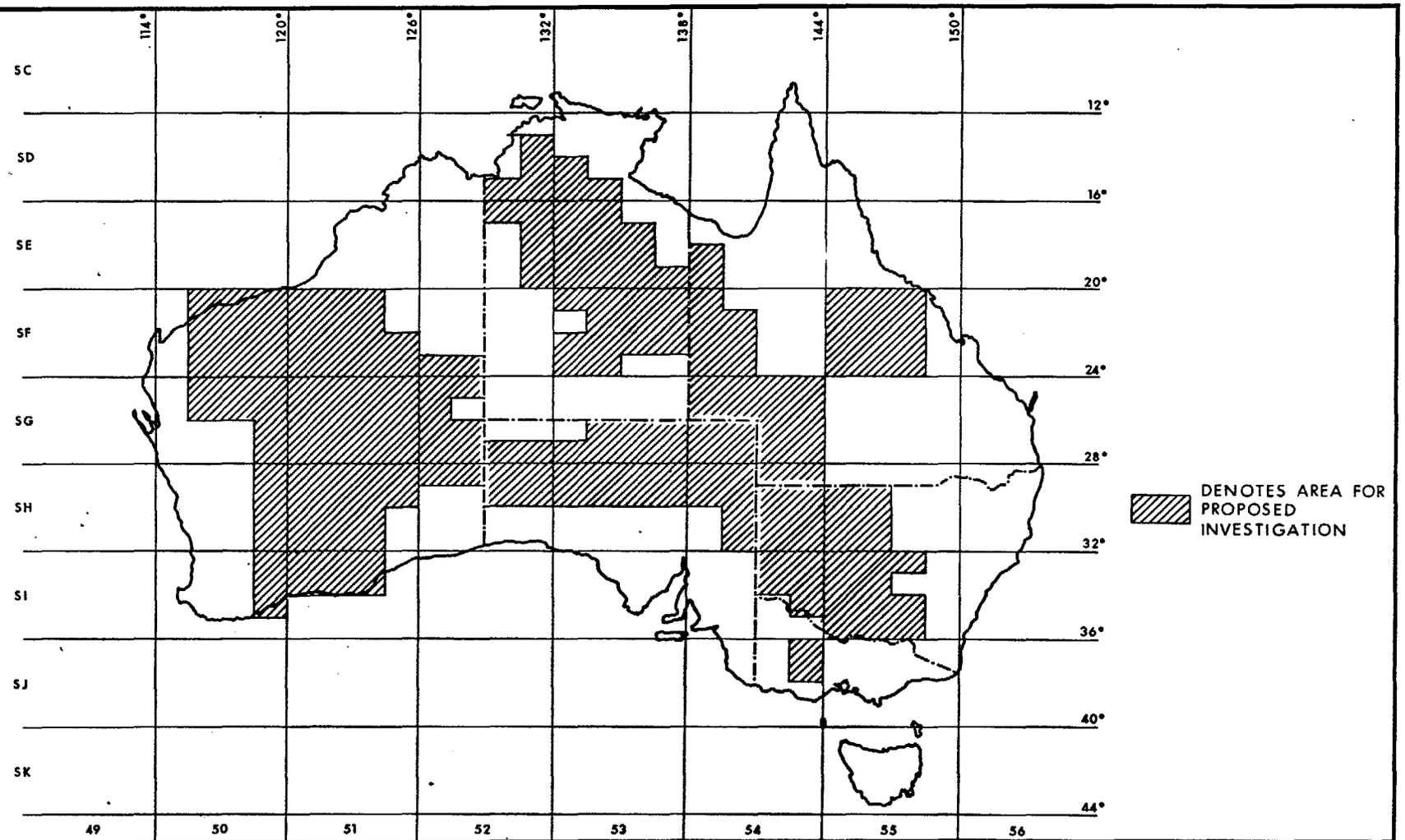
The work commenced with a visit by the AGC Project Director, F. Kalf and M. Lee Liaison Officer, Lyall Macoun & Joy to each major State authority in the respective States to outline the objectives of the program and to obtain detailed information on the respective data bases.

Additional organisations in some States responsible for collection and collation of groundwater data were also contacted and follow up work was carried out by the local AGC office in the respective States to obtain further details.

Each State organisation likely to attract Commonwealth funds was also asked to provide details of investigation programs which they considered could be included in the National Inventory Program.

Replies were received from most States and these were reviewed and assessed by the consultants.

From these submissions proposals were formulated by the consultants and further discussions held with the respective State authorities. In nearly all cases a general agreement was reached on the proposed program of work.



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BUREAU OF MINERAL RESOURCES

NATIONAL GROUNDWATER DATA BASE INVENTORY

PROPOSED AREAS FOR INVESTIGATION

FIG 1-1

1.4 ATTITUDES TO THE STUDY

During discussions held with various State authorities widely varying views on the need to investigate more remote areas were conveyed to use. To a large degree these views appear to be related somewhat to the background of the individuals within the organisation. For example those with engineering backgrounds tended to favour problem solving, with attention being given to design evaluated areas, whilst those with scientific backgrounds tended to favour broader scale investigation as an important adjunct both to problem solving and to concentrated efforts in design evaluated areas. It should be emphasised that this varied considerably from State to State.

All authorities recognised to varying degrees a need for the proposed reconnaissance program, although understandably all State efforts are presently concerned with the major areas of groundwater extraction, development and/or areas where there is an immediate need for further groundwater investigations.

Certain key personnel in the Queensland Water Resources Commission appear to favour more attention being given to developed areas with broad scale reconnaissance being seen as of less interest. The Queensland Water Resources Commission have indicated to us in fact that it may or may not accept the concept of the National Inventory Program and have indicated their preference for more direct funding to the States.

Whilst many could see the benefits of a National inventory Program there were mixed feelings about the role played by the BMR. Many of these views are privately held and not necessarily those of the respective State authorities. In most cases it is known that there is good co-operation between the BMR and staff of State authorities. Such co-operation is exemplified in the present study on the Murray Basin project. Some individuals resent the intrusion of the Commonwealth into the States groundwater investigation programs and in particular that staff from the State would need to be assigned to work programs proposed in a National Reconnaissance program. Most States argued that either additional or preferably contract staff would be required to carry out the work on a continuous basis.

Most individuals agreed that the BMR had an important role to play although it was suggested in one instance that the National Reconnaissance Program was simply designed to generate work for the hydrogeological group. Some distrusted the BMR motives, and were suspicious about the use of data (i.e. plagiarism) whilst others welcomed the idea as being an ideal opportunity to collate existing information particularly if the program was to produce hydrogeological maps and/or data sheets. AGC received comments from some individuals that such a program is well overdue and should have been undertaken some years ago.

It has been suggested that bore monitoring should be included in the Reconnaissance Program. Whilst such monitoring is an important aspect of groundwater management, we see that this activity should be the responsibility of the various State authorities.

2.0 STATE DATA BASES ASSESSMENT

2.1 GENERAL

The assessment of data bases in each state included a study of coverage, distribution, storage and access of the groundwater information.

Detailed information on the storage and access of information current for 1985 is provided in Appendix A in Volume II of this report. Each Appendix A section describes the storage and access of data in each respective State, and gives the method and examples of retrieval.

During the assessment stage of the data bases it was evident that some method of evaluating the availability or status of groundwater knowledge would be preferable to merely indicating the coverage, distribution and density of data. Many areas of the States have groundwater data available but often these raw data have not been assessed, interpreted or evaluated.

In some areas very few data are available and groundwater conditions are virtually unknown, whilst in other areas the opposite is true. Merely mapping areas of density does not necessarily distinguish the areas of groundwater resource and development. The system of categories developed allows the delineation of such areas in each State in terms of the status of knowledge of the groundwater system. The categories are titled from the lowest status of knowledge to the highest, that is unknown, unevaluated, conceptually evaluated and design evaluated. These categories have been applied for the three basic aquifer types identified in Australia, namely fractured rocks, large sedimentary basins and other sedimentary deposits.

The classification categories are described in detail in Section 3.0 of this report.

The application of the status of knowledge categories to different aquifer types showed that upgrading the category would not be possible for some aquifer types. To take account of these factors a set of criteria was developed incorporating the concept of need, cost, practicability and immediacy of benefits. These were used to test the programs of work against the status of knowledge classification of the resources derived from the State data bases. This rating system is defined in Section 3.

In general the coverage and distribution of groundwater data stored in State government files in Australia is determined by:

1. the extent to which the resource has been developed to meet community demands,
2. the extent to which legislation has made the return of information obligatory on developers,
3. the degree to which the authorities have undertaken programs to collect data by way of bore census or government

initiated investigation programs,

4. the degree to which groundwater data have been collected for mineral and energy resources, major industrial or civil engineering projects,
5. the extent to which the groundwater resources are likely to be developed and managed.

2.2 SIMILARITIES AND DIFFERENCES OF THE DATA BASES

The major similarities and differences of the data bases outlined in Appendices A-G (Volume II) almost entirely relate to the type of data stored, and the systems used to store and retrieve the data.

The assessment of all the data bases indicated that irrespective of the system used all have the ability to store the basic data items such as bore construction details and groundwater data such as depth to water, yield and so on. Normally investigation bores constructed by a particular authority have detailed data available on construction, lithology and other hydrogeological parameters whilst information available from private drillers is less detailed and therefore less reliable.

Electronic Data Processing (EDP) systems are operational in New South Wales, Queensland, South Australia and Victoria with the majority of the backlog of data entered on these systems. In Western Australia and Northern Territory the computer systems are still in the design stage, although operational.

The Tasmanian system became operational recently, but some backlog of bore data is still to be entered on the system.

Although the type of information stored is similar, the EDP data base systems are vastly different in the detail of information that can be recorded, the software of the operating systems and in the hardware on which the EDP systems are run.

Whether data are stored on a computer system or in paper form each authority has a different protocol for retrieving the information. In some authorities for example the data are readily available to the public, whereas in others the procedures are more complex and data are often confidential and require approval to be released.

Most authorities allow raw (or uninterpreted) data to be assessed although in many States the general policy is not to release interpreted data, which are classified in nearly all cases as confidential. This has been identified as being one of the reasons which is often responsible for lack of detailed documentation or data presentation of groundwater information.

Considering the vast areas to be covered, the vast amounts of data generated and the multiplicity of demands placed on limited numbers of groundwater hydrologists, a considerable amount of work has been done by the various State authorities including outstanding efforts by some individuals and groups both past and present. Many data sets however, still remain in their raw form. These include at least some of the data aquired in investigations

carried out on a general basis, particularly those projects funded by the Commonwealth.

There are however, a number of other reasons why data have not been compiled and presented and/or made available to the public. Some of those identified are:

- Concerns about possible plagiarism of data (i.e. by other professionals, consultants, scientific groups, etc.).
- Fear of incorrect interpretation being made by the public.
- Quest for 100% certainty in information and interpretation to counter possible errors being detected and individuals held responsible.
- Lack of faith in the usefulness of and market available for maps presenting more detailed groundwater data (i.e. large scale hydrogeological maps).
- Policy of allowing access to raw data but not to interpreted data.
- Territorial rights to data collected by the States.
- Uncertainty as to political sensitivity of data.
- Confidentiality of data.
- Lack of legisation to ensure data are recorded (i.e. bore licenses).

It should be pointed out that confidentiality of information is also common to groundwater data held by private groups such as mining companies and consultants. It could be argued that in these cases these organisations have their livelihood to consider and the disadvantage created through release should competitors obtain this information needs to be taken into consideration.

Whilst it could be argued that public authorities should have no such concerns, the additional reasons identified above explain in part the attitudes held by various authorities and individuals about the release of interpreted information.

2.3 SUITABILITY, RELIABILITY AND HYDROGEOLOGICAL MAPPING

The suitability and reliability of data relates largely to the quality, usefulness and accuracy of data collected in groundwater investigations.

There is a vast range of information collected as is apparent from a study of Appendices A-I in Volume II but the coverage and reliability is far from uniform.

The term reliability here refers to accuracy of information rather than the status of knowledge which is discussed later on in this report.

The consultants' experience in assessing reliability is that it is entirely variable and that it would be difficult to assign a reliability index to data collected by individual States. In most cases the reliability of data cannot be completely controlled. For example information obtained from for example drillers records which are collected by some States under conditions of the issue of a license is rarely checked at its

source and may be good or poor depending on the responsibility, care and training of the driller.

Information collected by the States as part of groundwater investigations is likely to be more reliable since some direct control is exercised by driller training and supervision over the collection and recording of information.

Data transferred to a EDP data base system is normally checked for gross errors before entry. In addition, the EDP systems normally have editing systems which flag data which do not fit within prescribed error criteria. Despite this, some errors are incorporated in EDP data bases during the processes of entering data.

Whilst the State data bases incorporate both error checks and efiting facilities into their systems, these are not consistent from one base to the next and as a result the reliability of data is variable.

Whilst we believe that every effort needs to be made to record accurate and reliable data, bad data will always be part of a data base and it therefore is important that those using the data are capable of making a value judgement on the data's reliability.

2.4 SUGGESTED IMPROVEMENTS OF STATE DATA BASES

2.4.1 Operational Improvements

The major improvements required in State Data Bases relate to the maintenance and improvement of high data entry standards and, in some States, the development of suitable E.D.P. systems to improve the value and ease of output of data to the users.

The improvement of data standards will involve training and education of the sources of data, including both government and private drillers. Where legislation exists, some policing of minimum standards of data coverage and accuracy should be undertaken. Up to date operating and description manuals should also be prepared on the system operations so that information on data access remains current. Such documents are lacking in some States.

AGC see no value in establishing a central, national data base of raw groundwater data. Apart from the "big brother" overtones, data collection, and analysis undertaken for example by the BMR should be done on an area or project-specific basis and an individual data base prepared for that particular area, by the BMR inhouse micro-computer data base package.

Data coverage agreements on a national basis through the AWRC Groundwater Committee could be valuable from some areas. For example in Victoria and W.A. authorities collect soil salinity data as a matter of course in some areas because salinisation has been perceived as a problem. Similar problems exist in other States but no such data have been collected. An agreement to

include soil salinity data from government drilling programs in any inland area where groundwater irrigation is proposed could be a valuable addition to the data base. Many other examples can be identified both for private and government data gatherers.

Dissemination of data should also be improved in some States. An index map, updated annually, showing the current areas of investigation and the areas covered or intended to be covered by past and future report and mapping programs should be made available to the public on a subscription basis. This would both assist the data users and perhaps attract the data, especially in areas where no legislative requirement exists to collect them directly. It should include all reports, whether internal (unpublished) or published. Similarly in some States the data bases should include reference to relevant reports, so that people using the system have access not only to raw data, but also to processed and interpreted data.

The States should be encouraged to submit all report information (published and unpublished) into the STREAMLINE data base system.

2.4.2 Hydrogeological Mapping

In assessing hydrogeological information and then making interpretations it is necessary to constantly assess and reassess existing data and where doubt exists to formulate an investigation program to resolve data inadequacies. This is presently done for site specific or problem areas, but is not done as a matter of course to improve or check existing data base information of a general nature.

This problem could be partly solved by collating existing data and presenting these data in some form of summary or map form such as a hydrogeological map or perhaps a data sheet. A hydrogeological data sheet is defined here as a map summarising available groundwater data but where there is insufficient information to enable interpretation of the data to be presented.

It should be noted that the detail presented in hydrogeological maps can also vary considerably depending on the data density, suitability and reliability of the data, the scale of presentation and the relative size of the hydrogeological unit and units depicted. Collation into a hydrogeological map forces those collecting the data to work with the data and thereby assess their value and reliability more carefully. It also aids considerably in disseminating interpreted data collected by the various groundwater authorities.

Whilst considerable effort in Australia has been expended by groundwater hydrologists in developing resource maps at small scales very little work has been done in the production of hydrogeological maps at larger scales. Some States have initiated hydrogeological mapping, although some commented that at present there was insufficient suitably qualified staff to continue to carry out this task. In addition such activity normally has a low priority, or in some authorities is not considered warranted.

The Victorian Department of Mines and Energy have produced an excellent full colour 1:100,000 hydrogeological map for the Western Port area in Victoria, whilst a similar coloured map has been produced by the Bureau of Mineral Resources for the A.C.T. region. In addition, draft maps have been attempted in Western Australia, Northern Territory and in New South Wales and Victoria. The Bendigo 1:250,000 map is presently being printed in Victoria.

Historically the reaction of most professional groundwater hydrologists to hydrogeological mapping has been at best lukewarm. In some cases the usefulness of hydrogeological mapping has been questioned, whilst some hydrogeologists see no benefit in the production of these maps. One reason is that this activity is considered by most to be of less importance than solving immediate and local groundwater problems. The usefulness of hydrogeological map is often inversely proportional to the groundwater hydrogeologist's familiarity with the area. Thus for those who have worked in an area for some time this approach is seen to be of limited benefit since the area has already been conceptually evaluated in the minds of these professionals compared to those unfamiliar with the area. It is to these latter group of persons that hydrogeological maps could provide the greatest benefit since they would allow a rapid overview of the hydrogeological conditions of the area.

In part, the problem of acceptance lies in what a hydrogeological map should show and whether it conveys useful information to the hydrogeologists. It is unlikely at present that two hydrogeologists could agree on their perceptions of what represents a good hydrogeological map.

In 1983 a hydrogeological legend was published following several meetings of the international committee (International Association of Hydrogeologists et.al, 1983).

This publication states that:

"The purpose of hydrogeological maps is to enable various areas to be distinguished according to their hydrological character in relation to the geology. They should indicate, on a topographic base, such items as the extent of the principal groundwater bodies, the scarcity of groundwater elsewhere, the known or possible occurrence of artesian basins, areas of saline groundwater and the potability of groundwater. They should also show, according to scale, information of a local character, such as the location of boreholes, wells and other works, contours of the potentiometric surface, the direction of groundwater flow, and variations in water quality.

In general any information leading to a better understanding of occurrence, movement, quantity and quality of groundwater, should be shown on hydrogeological maps, depending upon the scale adopted. The data normally presented relate to such matters as precipitation, evaporation, surface hydrology, geometric data on water-bearing formations, hydrochemistry and availability of water. In addition, sufficient geology should be shown to lead to a proper understanding of the hydrogeological conditions.

However, the geology should remain subdued and the hydrogeological features should be prominent".

The hydrogeological map is a means of presenting hydrogeological data in a meaningful way. Preparation of such a map forces the users of the data to collate and bring the information together. This step is essential for a conceptual understanding of groundwater conditions and flow systems particularly if this information is conveyed to other groundwater hydrologists or indeed to other interested groups.

As noted previously hydrogeologists instinctively develop conceptual understanding of a groundwater area either after extensive experience in that particular area or in long sessions of analysing raw data. Most often this conceptual understanding is rarely recorded in map form since once conceptualized the groundwater hydrologist most often goes on to the next step to solve a particular groundwater problem or perhaps to carry out modelling studies to determine groundwater reservoir performance.

It is important that conceptualisations of hydrogeological conditions across groundwater areas are recorded, even if such interpretations include uncertainties. Only by collating the data in this way can inadequacies be identified.

Usefulness of a hydrogeological map depends on the scale of mapping. Our assessment is that in order to allow a reasonable level of technical presentation the working scale should be no smaller that 1:250,000 but possibly 1:500,000 in regionally extensive basin aquifer systems.

The map scale of 1:250,000 is considered suitable for regional assessment since:

1. a full set of topographic maps exists.
2. Geological maps are available.
3. It is the minimum scale at which in most areas technical use can be made of information i.e. for target identification, initial investigation planning, etc.

AGC have reservations about the usefulness of 1:1,000,000 hydrogeological maps or smaller. Whilst this depends on the hydrogeological unit being treated, smaller scale maps are likely to lose the required detailed geological information required for proper interpretation.

Mapping at smaller scales can also be misleading except as noted above where the magnitude and uniformity of the basin or groundwater region is such that producing maps at 1:250,000 scale will present only portions of the system eg. Officer Basin, Canning Basin, Great Artesian Basin, etc and other large hydrogeological units.

It has been argued that the groundwater assessment undertaken to produce the maps and reports in the AWRC Review 85 program achieves the objective of collation but by a more direct route, and that hydrogeological mapping is therefore unnecessary. Others have criticised the Review 85 program suggesting that the

program does not get the professional attention it deserves in the collation. It has been reported that the work is often carried out under pressure, in haste, and with no attention to detail.

The consultants believe that the Review 85 exercise should be distinguished from hydrogeological mapping. The former is a broad scale groundwater resource assessment while the latter deals in its fully developed form with flow system hydrodynamics, such as water table contours, flow directions and magnitudes, salinity/yield relationships, aquifer parameters and so on. In other words, hydrogeological maps provide a more in-depth analysis of the dynamics of the flow system as well as providing resource information. Of course the usefulness of the map will depend to a large extent on the amount of data available.

AGC believe that hydrogeological mapping or at least the preparation of hydrogeological information maps would be the most cost-effective method of collating existing hydrogeological information, particularly data that have been collected as part of State/Federal Co-operative program. Many of these data presently exist only in raw form and some could be summarised as hydrogeological maps at large scales ie. 1:100,000 to 1:50,000 in design evaluated areas.

2.4.3 Reconnaissance & Investigation Program

For the present reconnaissance program we believe that collation of new and existing data should be carried out using 1:250,000 sheets as the basic collation unit.

Many map sheets are likely to have a paucity of data whilst others will have included in them a considerable amount of data. Where possible, an attempt should be made to interpret the data for presentation as a hydrogeological map.

Collection, collation and publication of existing and new data in some consistent form will greatly improve both the dissemination of data base information and improve the status of knowledge of the respective areas selected for hydrogeological compilation.

Objectives

The areas selected for study and which are outlined in Section 4.0 of this report have been selected with essentially two objectives in mind:

Firstly to cover the more remote areas of the continent, or areas which are largely away from the more local well-developed groundwater regions;

Secondly to include regional areas where a great deal of data already exists but which needs to be collated and where it would be possible to produce hydrogeolgical maps which would be of National importance.

Although the second objective tends to overlap somewhat with the proposed State/Commonwealth Hydrogeological Mapping program, the

areas selected in this program from a State point of view are mostly in low priority regions.

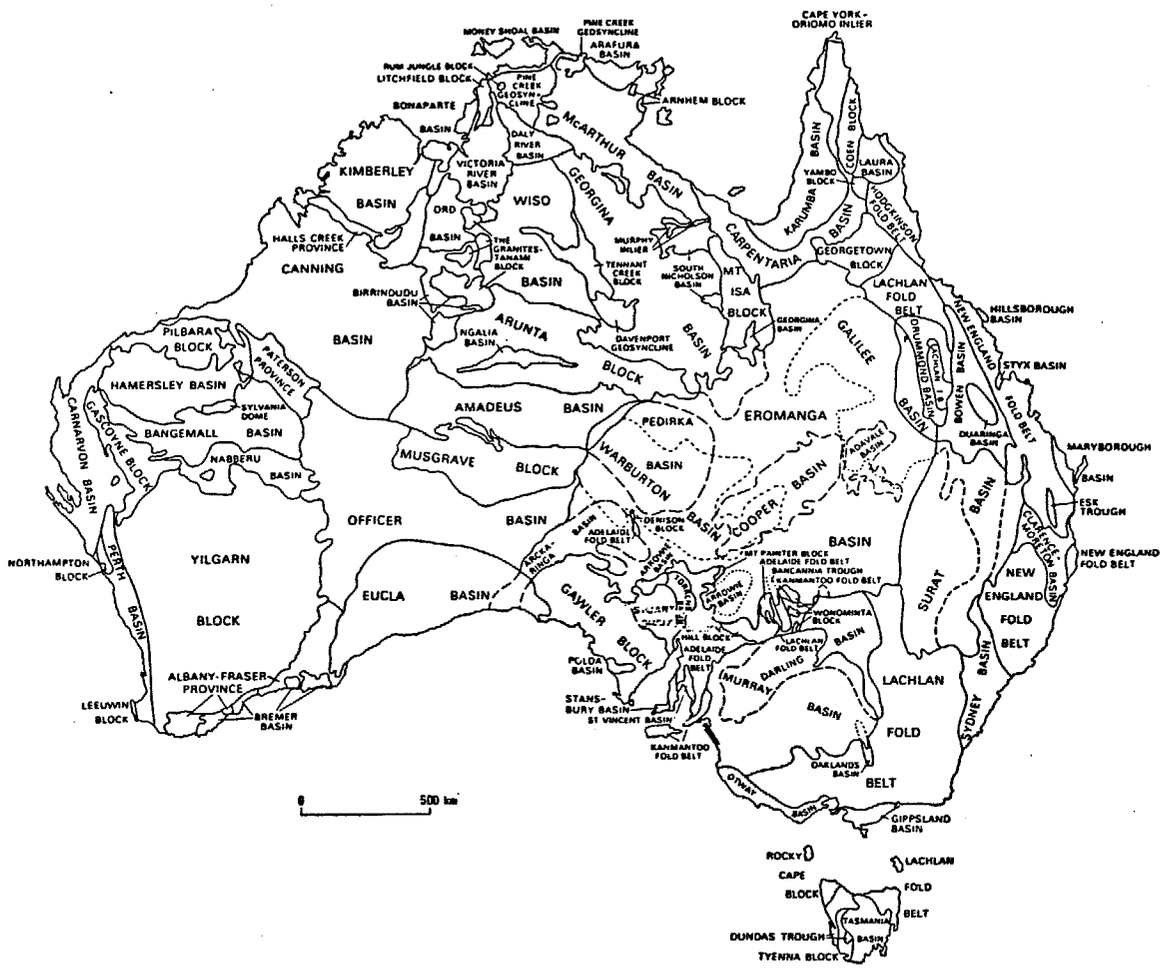
In addition to data collation on 1:250,000 sheets, part of the program would be devoted to exploratory drilling. This drilling has been selected to optimise the benefit to be derived and to gain significant information in areas which are at present unknown.

We believe the proposed 5 year program will achieve the following:

- Improvement in the accessibility of interpreted hydrogeological data presently stored in raw form in various data bases.
- Improvement in the level of groundwater knowledge in the more remote areas of Australia leading to a better assessment of regional groundwater resources.
- Improved dissemination of hydrogeological information to interested groups.

In addition to this program AGC have also suggested a more comprehensive program of investigation. It differs from the initial program only in its increased use of drilling to further elaborate groundwater knowledge and in some cases to extend the scope of the initial program.

The next chapter discusses the assessment and evaluation of groundwater knowledge throughout the continent. Figure 2-1 illustrates the major geological provinces which are referred to in this chapter.



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NATIONAL GROUNDWATER DATA BASE INVENTORY

AUSTRALIAN GEOLOGICAL PROVINCES

FIG 2-1

3.0 ASSESSMENT AND EVALUATION OF GROUNDWATER KNOWLEDGE

3.1 DEFINITION OF CATEGORIES AND CRITERIA

In assessing the availability or status of groundwater knowledge in each State it was found necessary to develop a rating system. Initially this rating system was designed to show the state of knowledge on a single map. Subsequently, this rating system was extended to cover groundwater occurrence in the following divisions:

- fractured rock aquifers
- large sedimentary basins (i.e. greater than about 15,000 km^2)
- other sedimentary deposits.

The rating categories have been defined as follows:

1. Unknown
   Those areas where insufficient groundwater data are available to assess the groundwater system.

2. Unevaluated
   Those areas where groundwater data are available and sufficient to assess the groundwater system but where these data have not been evaluated and/or collated.

3. Conceptually Known
   Those areas where the groundwater system is generally known but where there is insufficient information to determine the hydrodynamic behaviour or development of site-specific potential.

4. Design Evaluated
   Those areas where groundwater extraction systems can be designed or where the effects of development or hydrodynamics can be reasonably evaluated.

The categories outlined above were found to be beneficial in identifying the present status of groundwater knowledge in each State. However, the rating provided no information on the criteria or constraints which will determine whether some data would be useful or whether they would improve the groundwater knowledge in each State to the extent that a groundwater area could be shifted from a lower category to a higher category. The rating system also provided no information on the criteria or constraints which will determine whether some data would be useful or whether they would improve the groundwater knowledge substantially.

A series of criteria was therefore developed in order of priority which could be used to test the need or otherwise of improving the groundwater knowledge. These criteria in decreasing order of importance are as follows:

1. Need to upgrade the category.
2. Ability of investigation program to upgrade category (based on money available for program).
3. Benefits to be derived from improved data record.

4. Immediacy of benefits to be derived.
5. Potential for resolving hydrogeological or community problems.
6. Likelihood of results being different from what is already known.
7. Whether above tests apply at a national mapping level.

Whilst the category system is a useful concept, like most systems it is not perfect since it does not account for scale or the depth dimension.

Scale dependency occurs as a result of the size of the area classified. An example of this is the Great Artesian Basin. Whilst the basin, on a regional scale has been conceptually evaluated, certain areas of the basin could be classed as unknown to unevaluated, for example in the Simpson Desert area of South Australia and the Northern Territory.

Depth dependency can be demonstrated by an example in the Georgina Basin in the Northern Territory. This basin is conceptually evaluated to a depth of about 200 metres. Beyond this depth, geological evidence suggests that the groundwater potential is significant, yet it would be necessary to classify the strata beyond 200 m or so as unknown. In addition the categories do not indicate whether the information and data are readily available or in fact whether they have been disseminated. Often there is a high density of data with the design evaluated areas and they may be well known to a select number of groundwater hydrologists even though very few data have been published.

The proposed system has received favourable response from State agencies. In particular the criterion of a "need to know" was acknowledged as important since it was felt by some individuals that the original concept of simply filling in knowledge gaps could not be completely justified because of the lack of foreseeable future development. However, experience indicates that this development often comes sooner than expected, especially if the groundwater resources have been evaluated to some extent.

AGC can indicate several areas within Australia where no significant groundwater was thought to occur where now large quantities are extracted for industry and town supply (e.g. Pilbara, Eastern Goldfields of WA). It is therefore necessary to look well into the future as well as concentrating efforts into presently developed areas. This can be achieved only by proper planning and this in turn requires suitable detailed regional assessments.

Many aquifers considered to be remote today could in a short time become important sources of water as industry spreads throughout the continent and sources of groundwater are required to meet the demands.

3.3 DESCRIPTIONS OF STATUS OF GROUNDWATER KNOWLEDGE

In the following sections classification categories are described

within each State within three hydrogeological subdivisions designated as:

1. Fractured rocks.
2. Large sedimentary basins.
3. Other sedimentary deposits.

Definitions which have been used in other publications in the past have been found to be inadequate to describe the range of deposits and aquifer occurrences throughout Australia. Whilst the first two sub-divisions are self explanatory the third sub-division was selected to include many of the smaller basins which contain generally Tertiary to recent deposits but also other sediments (e.g. Permian and Triassic in South Australia). The sub-division also includes shallow unconsolidated sediments, surficial deposits, (i.e. calcretes), palaeochannels, river valley alluvial sediments, sand dunes and so on, without being specific about the depth or degree of consolidation of the aquifer material.

In the second category no strict classification of "large" can be given, however for the purpose of this report it includes those basins which are greater than about 15,000 km^2 in area which are not sub-basins of more major structures. A study of the regional hydrodynamics generally requires that these basins be treated as complete units.

Where possible the smaller basins have been marked under sub-division 3. However, there are likely to be many smaller basins which have been overlooked at the scale of presentation and some which are presently unknown.

Further discussion on map compilation and printing occurs in Section 5.0 of this report.

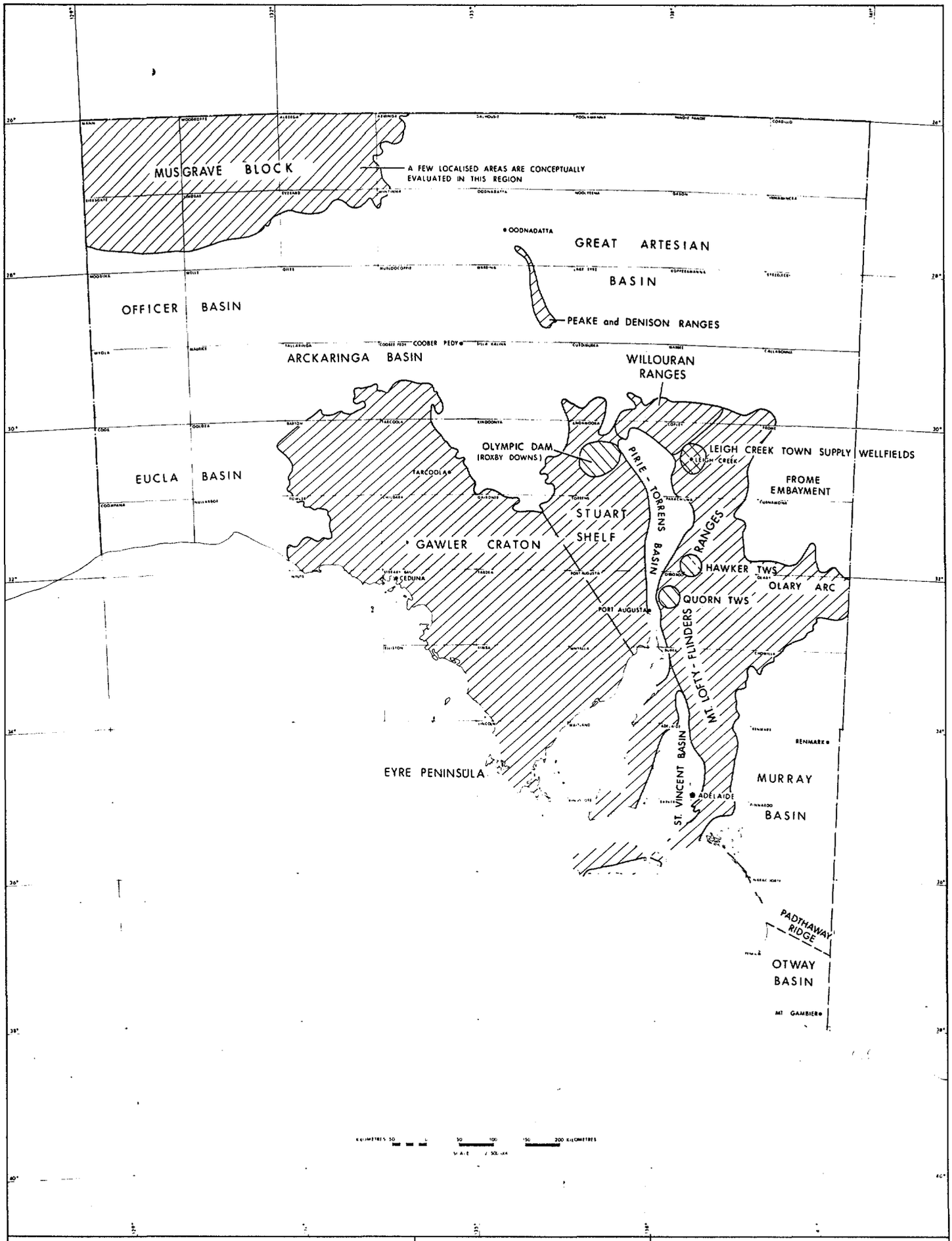
3.3.1 South Australia

3.3.1.1 Classification Categories

Fractured Rocks

Figure 3-1 shows the areas of South Australia within which groundwater occurs in fractured rock aquifers. They include rocks within the Adelaide Geosyncline and adjacent metamorphic provinces (Mount Lofty and Flinders Ranges and Olary Arc), the adjacent Stuart Shelf - Gawler Craton area, the Peake and Denison Ranges and the Musgrave Block in the extreme north-west of the State. Because the map scale is small the Willouran Ranges are included as a north-west extension of the Flinders Ranges.

There have been few detailed studies of groundwater in these aquifers anywhere in the State although the general hydrogeological conditions are known for most, if not all areas. Water well records of moderate to good quality are available for most areas even if recent census work has not been undertaken. The data density is highly variable, reflecting the distribution of water wells and, to some extent, the groundwater potential.


MUSGRAVE BLOCK
A FEW LOCALISED AREAS ARE CONCEPTUALLY EVALUATED IN THIS REGION
OODNADATTA
GREAT ARTESIAN BASIN
PEAKE and DENISON RANGES
OFFICER BASIN
COOBER PEDY
ARCKARINGA BASIN
WILLOURAN RANGES
OLYMPIC DAM (ROXBY DOWNS)
LEIGH CREEK TOWN SUPPLY WELLFIELDS
LEIGH CREEK
EUCLA BASIN
TARCOOLA
FROME EMBAYMENT
STUART SHELF
PIRIE - TORRENS BASIN
RANGES
GAWLER CRATON
HAWKER TWS
OLARY ARC
QUORN TWS
EDUNA
PORT AUGUSTA
MT. LOFTY - FLINDERS
EYRE PENINSULA
RENMARK
MURRAY BASIN
ST. VINCENT BASIN
ADELAIDE
PADTHAWAY RIDGE
OTWAY BASIN
MT GAMBIER
KILOMETRES 50 0 50 100 150 200 KILOMETRES
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
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SOUTH AUSTRALIA
FRACTURED ROCK AQUIFERS
FIG 3-1

FIG. 3_1

The only area which could be said to approach the design evaluated stage is around Leigh Creek in the northern Flinders Ranges where several aquifers have been investigated in detail for town water supply purposes. The rest of the area must be classified as unevaluated except for three conceptually known areas where water supply investigations have been undertaken (Olympic Dam, Quorn and Hawker). In addition there are several smaller areas which are not shown on the plan in northern parts of the State (Flinders Ranges and Musgrave Block) where detailed water supply investigations have been completed. Only in the central Mount Lofty Ranges near Adelaide is groundwater developed intensively,and there it is used for irrigation and warrants systematic investigation. Elsewhere developments are restricted to large numbers of small supplies for livestock and a few larger developments for townships, and for mining and tourist developments. Sufficient unevaluated data are available in most areas to produce hydrogeological data sheets at a scale of 1:250,000, although new bore census data would undoubtedly be beneficial. It is unlikely that complete hydrogeological maps could be produced for any of the 1:250,000 sheets apart from small areas where the maps include specific investigation areas such as Leigh Creek.

Large Sedimentary Basins

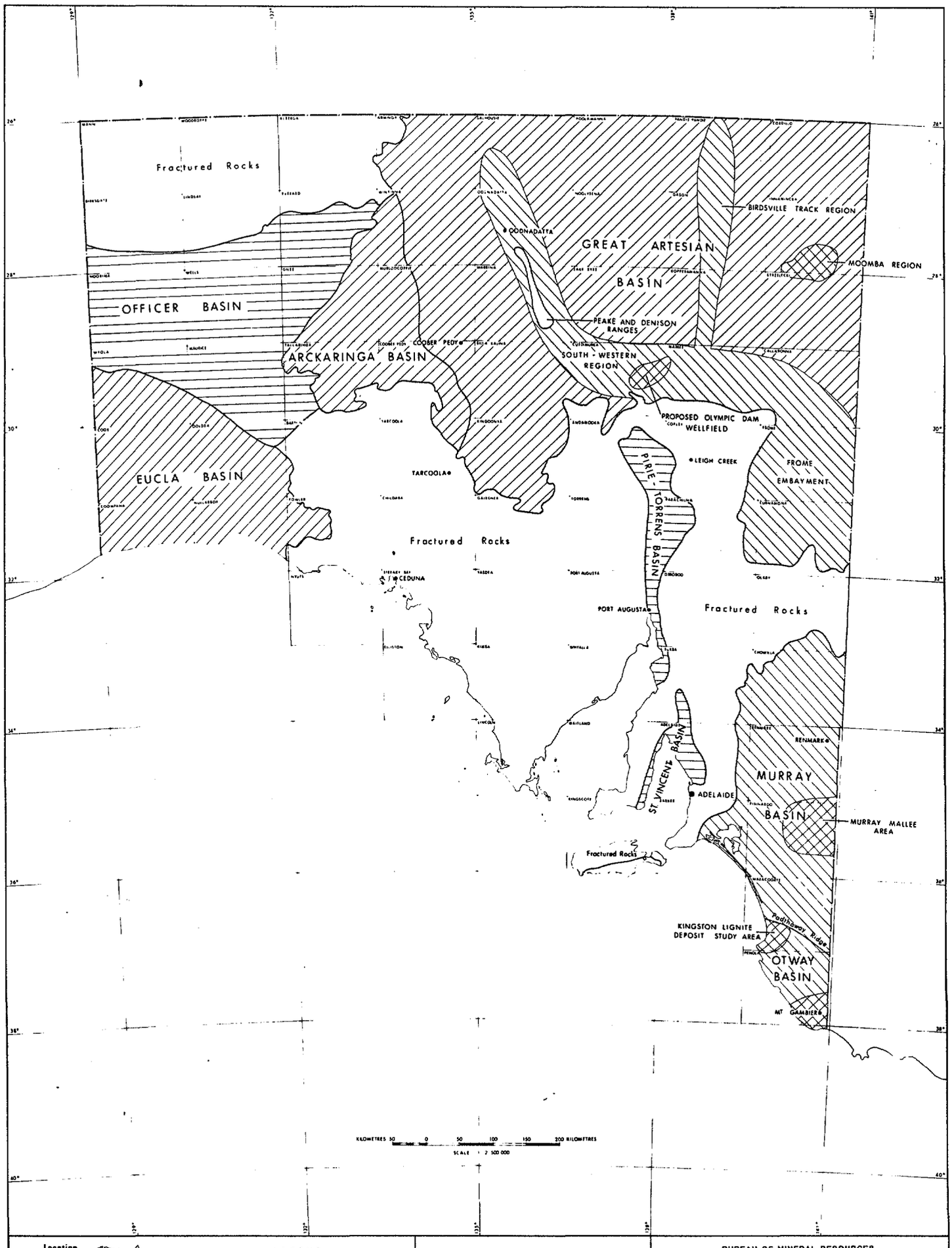
Figure 3-2 shows the large sedimentary basins in South Australia, and includes all which have recognised groundwater potential. The intensity of development and the status of knowledge of the basins varies considerably from practically no development (or hydrogeological data) in the Officer Basin to intensive development and detailed understanding in areas such as the Mount Gambier area of the Otway Basin.

As shown on Figure 3-2 the large basins cover a large proportion of South Australia. There are published reports describing groundwater occurrence, and sometimes hydrogeology, for all and also parts of the Great Artesian Basin and for the Pirie-Torrens, Murray and Otway Basins. The other basins (Eucla, Officer and Arckaringa) are sparsely developed and less documented. The information available is summarised, with most major references listed, in Shepherd, 1983. Other references are numerous and can readily be extracted from the SADME data base (see Appendix A).

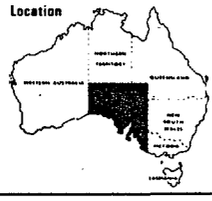
At some location in the State deep basins and troughs are known to underlie the upper sediments (to which most groundwater extraction is restricted). These are not well known hydrogeologically and have been omitted from Figure 3.2. Most are closed structurally and are likely to contain saline groundwater.

Great Artesian Basin

Although well known and covering a large part of the State, the basin is sparsely developed with approximately 200 bores most of which are sited around the southern and western margins and in one northerly-trending zone (Birdsville Track - Moomba area). Bore census data are mostly up to date in that part of the basin



Location



LEGEND

- UNKNOWN
- UNEVALUATED
- CONCEPTUALLY EVALUATED
- DESIGN EVALUATED

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SOUTH AUSTRALIA

LARGE SEDIMENTARY BASINS

FIG 3-2

FIG. 3_2

which has been developed although detailed records of some of the early artesian bores have been lost. Although the general hydrogeology of the basin is conceptually known, at the map scale presented much of the South Australian section is best classified as unevaluated because of the paucity of data. Exceptions are the conceptually known south and west marginal areas and the design evaluated wellfield areas for the Moomba gasfields and the Olympic Dam project, the latter of which might extract up to 33 ML/day.

The Cooper and Pedirka Basins, which underlie the Great Artesian Basin proper, have not been studied extensively hydrogeologically, and do not affect the hydrogeological classification of the area discussed here. As a result they have been omitted from Figure 3.2.

Frome Embayment

The Frome Embayment is partly underlain by the Great Artesian Basin Cretaceous sediments, and also includes a thick sequence of Tertiary and Quaternary deposits including important aquifers in a number of formations. Bore census work was done on this area in the mid sixties (Ker, 1963) and has been updated in recent years.

Arckaringa Basin

As shown in Figure 3.2 this is the western extension of a deeper basin which in part underlies the Great Artesian Basin aquifers.

Some bore census data are available but the area is sparsely developed and unevaluated. It is probable that 1:250,000 scale hydrogeological data sheets could be produced from existing data.

Eucla Basin

The Eucla Basin is sparsely developed, has little potential except for saline groundwater and there has not been a recent bore census. Sufficient information is available to classify the area as unevaluated rather than unknown, but it is doubtful whether a useful data map could be produced.

Officer Basin

The Officer Basin is remote and undeveloped, and no recent bore census data are available. Its hydrogeology is unknown within South Australia. there is not a high probability of its having major potential for good quality groundwater, although large resources of saline water may be available.

Murray Basin

The Murray Basin in South Australia has been well documented for many years. Although recent bore census reports are not available for the entire area, the general standard of records is moderate to good. The degree of hydrogeological evaluation means that the basin is best classified as conceptually known, although a substantial area of the Murray Mallee, east of Adelaide, may

soon be design evaluated.

An intensely developed local occurrence of low salinity groundwater, the Angas-Bremer irrigation area, has been design evaluated.

There is sufficient information to prepare 1:250,000 hydrogeological maps for most of the Basin within South Australia.

Otway Basin

The Otway Basin within South Australia is intensely developed over much of its area and the two main aquifers have been investigated over many years. Bore census data are available for most of the area and many evaluation and water supply reports have been prepared. The basin therefore can be classified as conceptually known, with two areas design evaluated (Mount Gambier area and Kingston Lignite Deposit study area). In addition detailed studies have been carried out at other localities. There is probably sufficient information to prepare hydrogeological maps for much, if not all of the area at a scale of 1:250,000 or larger if required. The locally important irrigation areas at Padthaway and Keith-Willalooka are classified as within "other sedimentary deposits", being derived from shallow sediments in the Padthaway Ridge area between the Otway and Murray Basins.

Pirie-Torrens Basin

This basin was studied in the 1950's and a report published which mainly describes the groundwater occurrence, and documents the bore census work which was carried out at that time. The basin is best classified as conceptually known, and probably has little potential for groundwater of even medium salinity except near a few sites of local recharge along its eastern margin.

Recent bore census data are limited, but hydrogeological data sheets could be produced at a scale of 1:250,000.

St. Vincent Basin

Most of the St. Vincent Basin is offshore, and groundwater use is restricted to strips along the eastern and western parts of the basin, which can be divided into five areas according to the degree of evaluation.

The north-eastern part of the basin and the western strip along Yorke Peninsula are little developed because of high salinity and are unevaluated. A data map could be prepared from bore census data, some of which is recent.

Beneath Adelaide and to the south, the Adelaide Plains and the small Noarlunga and Willunga Embayments have been broadly investigated to the conceptually known stage. The Noarlunga Embayment has little groundwater potential, however hydrogeological maps at a scale of 1:250,000 or larger could be

prepared for the Adelaide Plains and the Willunga Embayment. A current study of the Adelaide Plains area should raise it to the design evaluated stage in 1-2 years at the most.

The Northern Adelaide Plains area is intensively developed and has been design evaluated. A large scale hydrogeological map could be prepared.

Other Sedimentary Deposits

Groundwater occurs in a wide variety of sedimentary deposits in South Australia in addition to the major basins (Figure 3-3). They include smaller basins or areas of deposition, both marine and non-marine (such as the Barossa Valley, localised areas of deposits such as palaeochannels in the Frome Embayment and Eyre Penninsular, localised sedimentation within major basins (such as the Padthaway irrigation area) and various areas where local conditions have favoured groundwater recharge such as the so-called groundwater basins on Eyre Peninsula, where groundwater occurs in calcrete and Tertiary sands e.g. Robinson, Polda, Bramfield, Kappawanta Basins, etc.).

The consensus of opinion among hydrogeologists working in South Australia is that there are few examples of groundwater occurrence solely in surficial deposits, in contrast with previously published assessments. For example it is probable that most dug wells in the Flinders Ranges penetrate and derive their supplies from fractured rocks beneath alluvium which is only saturated at items of ephemeral surface flow.

Most of the sedimentary deposits which are not classified as major basins are of Tertiary to Recent age. Notable exceptions are several small Triassic basins in the Flinders Range, of which only Leigh Creek has known groundwater potential, and the restricted, but locally important area of near-surface Permian fluvioglacial sand south of Adelaide.

These deposits include several areas of intense groundwater development which have been investigated to the design evaluated stage, and for which detailed water well records are available. These areas are:

- Myponga and Hindmarsh Tiers Basins
- Barossa Valley
- Booborowie Valley
- Unley Wanilla and Unley South Basins
- Lincoln Basin
- Para Wurlie Basin
- Padthaway irrigation area
- Keith-Willalooka irrigation area
- Leigh Creek - main coal basin

The other areas are either little used and unevaluated or have been studied only in sufficient detail to be classified as conceptually evaluated, as shown in Figure 3-3. Those with good groundwater quality tend to have large amounts of data available and are developed; the others are generally used only for small


Fractured Rocks
OODNADATTA
Sedimentary Basins
COOBER PEDY
PROPOSED OLYMPIC DAM WELLFIELD
TRIASSIC COAL BASIN
LEIGH CREEK
TARCOOLA
Fractured Rocks
CEDUNA
WILLOCHRA BASIN
Fractured Rocks
PORT AUGUSTA
WALLOWAY BASIN
ROBINSON BASIN
COWELL BASIN
POLDA, BRAMFIELD, KAPPAWANTA, SHERINGA and TALIA BASINS
BOOBOROWIE VALLEY
CUMMINS BASIN
RENMARK
BAROSSA VALLEY
PARA WURLIE BASIN
UNLEY WANILLA and UNLEY SOUTH BASINS
ADELAIDE PLAINS
NORTHERN ADELAIDE PLAINS IRRIGATION AREA
ADELAIDE
LINCOLN BASIN
CARRIBIE BASIN
NOARLUNGA and WILLUNGA EMBAYMENTS
MYPONGA AND HINDMARSH TIERS BASIN
Fractured Rocks
SOUTHERN KANGAROO ISLAND
GENERAL AREA OF PERMIAN SAND AQUIFERS (UNEVALUATED)
KEITH-WILLALOOKA IRRIGATION AREA
PADTHAWAY IRRIGATION AREA
MT GAMBIER
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1:2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
SOUTH AUSTRALIA
OTHER SEDIMENTARY DEPOSITS
FIG. 3-3

FIG. 3_3

stock supplies and have correspondingly small amounts of data on file. An exception is the Leigh Creek coal basin which is being studied in detail for mine dewatering but which contains saline groundwater.

Similarly to Queensland little information is available on shallow groundwater in the Great Artesian Basin area. It may occur in shallow alluvium, Tertiary palaeochannels (fluviatile systems) and in fractured, silicified zones of the Bulldog Shale, which is the main confining bed to the artesian aquifer system. In general these aquifers must be classified as unknown, although a small area within the south-east of the basin in the southern Frome Embayment could be regarded as unevaluated with respect to Tertiary palaeochannels. The status of any other shallow groundwater in northern areas of the State is also unknown.

3.3.2 New South Wales

3.3.2.1 Classification Categories

Fractured Rocks

Fractured rocks in NSW occupy a large area over the State. The areas include the New England area to the north-east, the central and southern Tablelands to the south-east, the western slopes and plains and the West Darling area (see Figure 3-4).

Practically all of the areas in the State shown at this scale are unevaluated except in the ACT where the BMR have produced a 1:100,000 hydrogeological map of the region, and in the southern parts of the State where groundwater conditions are largely unknown due to paucity of data in the highlands.

In addition, the Mount Canobolas basalt area has been investigated and is conceptually known although no published reports are available on this area.

At present no detailed reports or maps are available on the fractured rock areas although broad scale assessments and small scale groundwater resource maps are available (AWRC 1975 and WRC 1984).

High bore data density occurs in the fractured rock areas in the central and southern Tablelands and parts of the western slopes and plains (see also WRC 1971). Many of these data exist as raw data and have not been evaluated. There is a need to present these data in map form either as larger scale hydrogeological maps or hydrogeological data sheets. By collating existing data, large areas could be conceptually evaluated without the need for a detailed drilling program.

Large Sedimentary Basins

In New South Wales the sedimentary basins include the Great Artesian Basin, Sydney, Oxley and Clarence Moreton Basins.

Although the Great Artesian Basin as a hydrogeological unit could

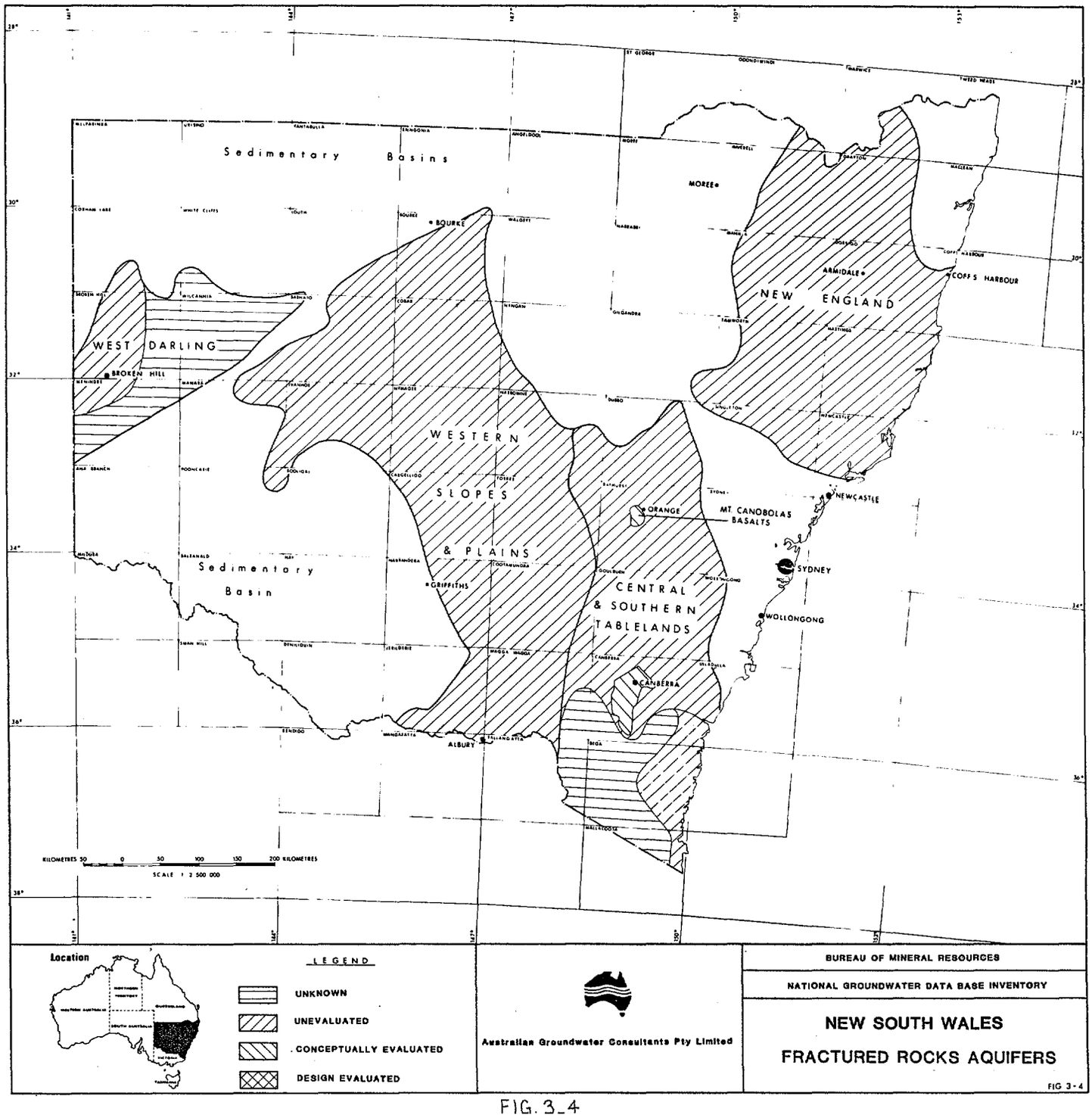

Sedimentary Basins
MOREE
BOURKE
ARMIDALE
COFFS HARBOUR
NEW ENGLAND
WEST DARLING
BROKEN HILL
WESTERN SLOPES & PLAINS
ORANGE
MT. CANOBOLAS BASALTS
NEWCASTLE
SYDNEY
WOLLONGONG
CENTRAL & SOUTHERN TABLELANDS
CANBERRA
GRIFFITHS
ALBURY
Sedimentary Basin
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1 : 2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
NEW SOUTH WALES
FRACTURED ROCKS AQUIFERS
FIG 3-4

FIG. 3_4

be considered to be conceptually evaluated (Habermehl 1980), on the scale presented in Figure 3-5 only the south-eastern lobe of the Basin could be so designated. A major portion of the western part of the Basin in NSW, South Australia (see Section 3.2.1) and in Queensland (see Section 3.2.4) remains unevaluated either because of paucity or incomplete evaluation of data.

Bore data existing in the Sydney Basin are few except in localised regions in the southern part of the basin where large yields of water are obtained from friable sandstones.

The area around Gerringong where large yields are obtained has been conceptually evaluated (Kalf 1970). The coal-bearing area of the Upper Hunter Valley has also been conceptually evaluated (Williamson 1958 and AGC 1983).

Although the New South Wales Geological Survey commenced a study on the Sydney Basin in the late sixties no final report was produced.

Both the Oxley Basin and Clarence Moreton Basins are unevaluated. Low yielding poor quality water is obtained in Clarence Moreton and only scattered data are available.

The hydrogeology of the Murray Basin is presently being studied by the BMR and a hydrogeological map which summarises available information is being produced. On a regional scale the Basin is presently unevaluated although the present work should bring this up to the conceptually evaluated state. Many regions on a larger scale are unknown, particularly the hydrogeology of the deeper strata.

The Lower Lachlan River Valley and Murrumbidgee valley sediments are discussed in the next section.

Other Sedimentary Deposits

These deposits occur mainly as valley infill and wind blown sandy sediments along the coastal, border and inland drainage valleys which form the most important groundwater resource in the State. Considerable investigation work has been expended on delineating these valley systems in NSW. Much of the initial work was conducted by Williamson and others (see Water Resources Commission 1984 and references therein).

A considerable amount of data has been collected and groundwater resource reports have been produced (WRC 1968-1975, WRC 1971 and WRC 1984). These reports discuss groundwater occurrence in drainage basins using a "broad brush" approach and include groundwater resource maps at small scales.

More detailed internal reports are available for some of these valleys with the remaining data available on internal files. Numerous internal reports are available on the geophysical investigations carried out in the State as part of the groundwater investigations.

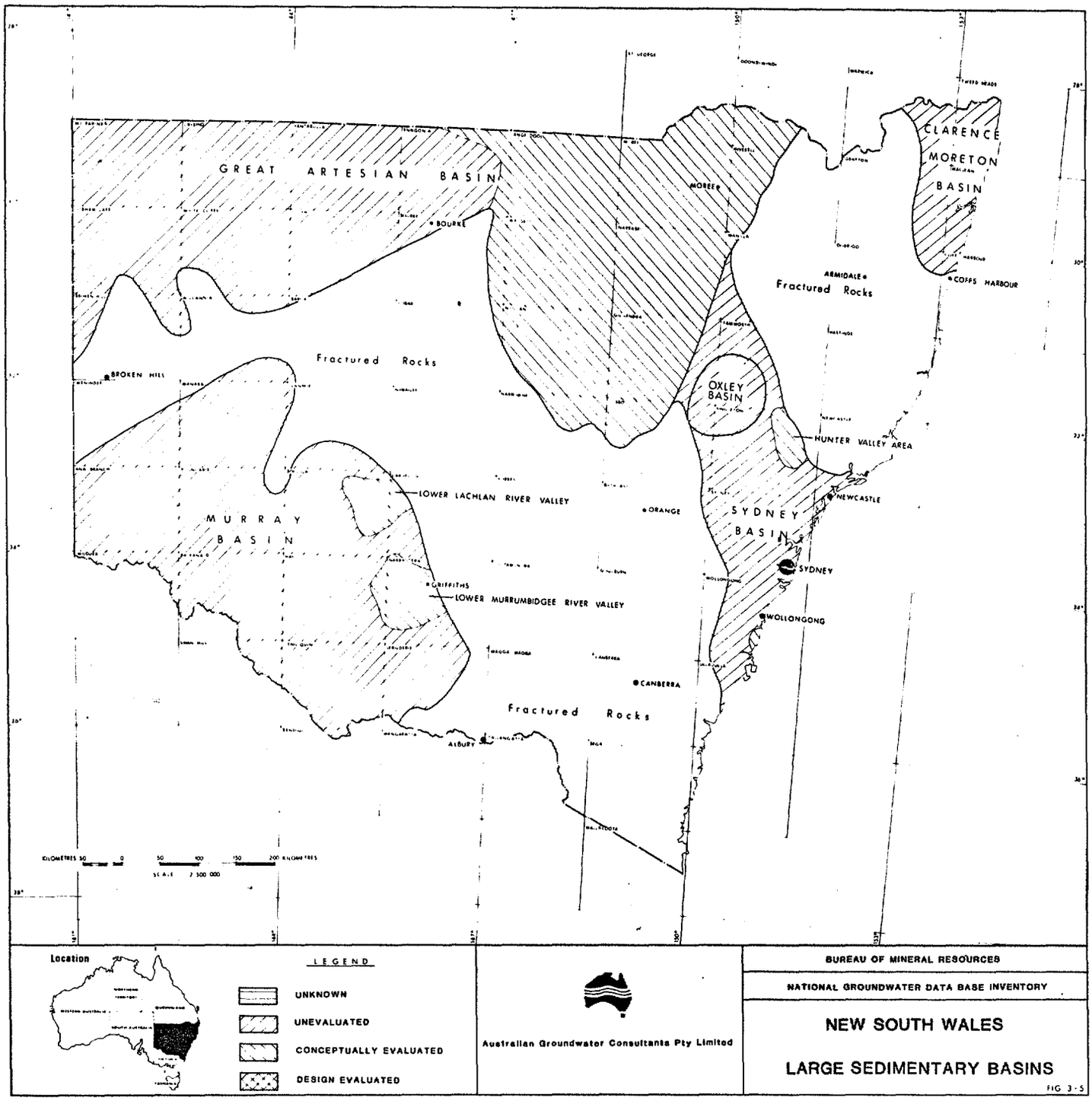

GREAT ARTESIAN BASIN
BOURKE
MOREE
CLARENCE MORETON BASIN
COFFS HARBOUR
ARMIDALE
Fractured Rocks
Fractured Rocks
BROKEN HILL
OXLEY BASIN
HUNTER VALLEY AREA
NEWCASTLE
LOWER LACHLAN RIVER VALLEY
ORANGE
MURRAY BASIN
SYDNEY BASIN
SYDNEY
GRIFFITHS
LOWER MURRUMBIDGEE RIVER VALLEY
WOLLONGONG
CANBERRA
Fractured Rocks
ALBURY
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1:3 000 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
NEW SOUTH WALES
LARGE SEDIMENTARY BASINS
FIG 3-5

FIG. 3_5

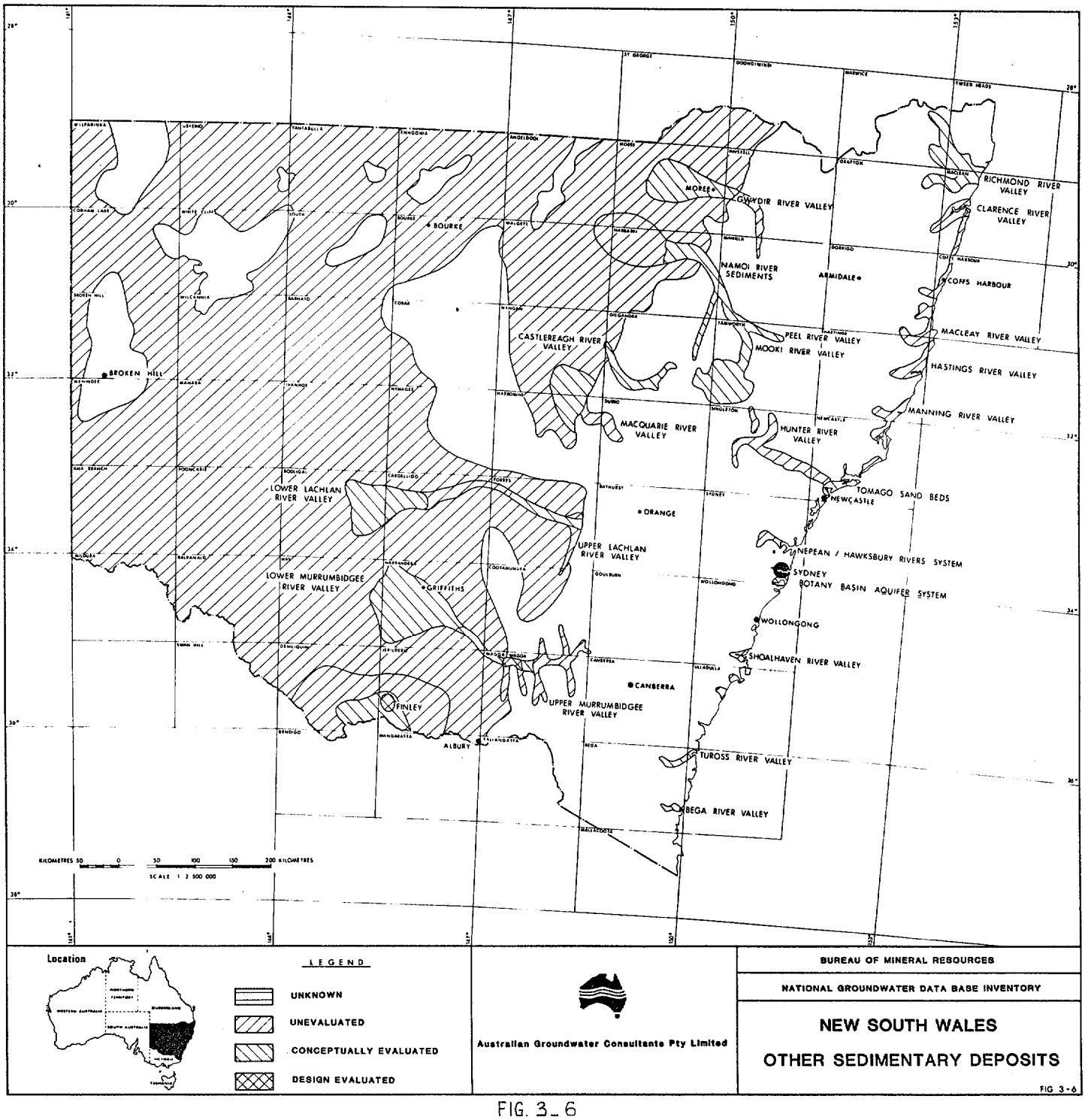

RICHMOND RIVER VALLEY
CLARENCE RIVER VALLEY
MOREE
GWYDIR RIVER VALLEY
BOURKE
NAMOI RIVER SEDIMENTS
ARMIDALE
COFFS HARBOUR
CASTLEREAGH RIVER VALLEY
PEEL RIVER VALLEY
MOOKI RIVER VALLEY
MACLEAY RIVER VALLEY
BROKEN HILL
HASTINGS RIVER VALLEY
MANNING RIVER VALLEY
MACQUARIE RIVER VALLEY
HUNTER RIVER VALLEY
LOWER LACHLAN RIVER VALLEY
TOMAGO SAND BEDS
NEWCASTLE
ORANGE
UPPER LACHLAN RIVER VALLEY
NEPEAN / HAWKSBURY RIVERS SYSTEM
SYDNEY
BOTANY BASIN AQUIFER SYSTEM
LOWER MURRUMBIDGEE RIVER VALLEY
GRIFFITHS
WOLLONGONG
SHOALHAVEN RIVER VALLEY
CANBERRA
FINLEY
UPPER MURRUMBIDGEE RIVER VALLEY
ALBURY
TUROSS RIVER VALLEY
BEGA RIVER VALLEY
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1 : 2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
NEW SOUTH WALES
OTHER SEDIMENTARY DEPOSITS
FIG 3-6

FIG. 3_6

A considerable amount of data exists on the Namoi Valley, Lachlan and Murrumbidgee systems, much of which could be presented at a suitable scale as hydrogeological maps. For the Namoi Valley system for example this could be achieved at a scale of 1:50,000 or 1:10,000 for certain sections of the valley.

The Botany Basin aquifer system, although consisting of largely unconsolidated to semi-concolidated sediments is conceptually known.

3.3.3 Victoria

3.3.1.1 Classification Categories

Fractured Rocks

Figure 3-7 shows the fractured rock aquifer areas of Victoria. They include the Lower Cretaceous mudstone, siltstone, shales and arkoses of the Otway Basin and west Gippsland which form the Merino Plateau, the Otway Ranges and Barraload Hills. They also include extensive outcrops of Tertiary basalts of western Victoria (Newer Volcanics) and of west Gippsland (Older Volcanics).

Groundwater from these rocks is used for stock watering where rainfall and surface water supplies are unreliable and occasionally are used for irrigation of intensive horticulture (Kinglake Plateau) where water quality permits. Very few areas have been investigated in detail for groundwater potential.

The Lower Cretaceous sediments are unknown since they have poor groundwater potential and as a result few holes have been drilled in them.

The fractured Palaeozoic rocks are used extensively only in isolated areas. They include areas around Melbourne and to the north-west around Castlemaine and Daylesford. The data have not been brought together however and the aquifers remain unevaluated.

The Tertiary volcanics represent stratified aquifers which have secondary permeability in fractures and also vesicles in the Newer Volcanics.

The Lower Tertiary basalt or Older Volcanics are mainly exposed in West Gippsland around the South Gippsland Hills.

The Newer Volcanics occur in a number of flows at most locations with often distinct breaks between periods of major flows. Groundwater production potential and salinity can vary between upper and lower units of any sequence of the basalt flows. Numerous stock water supplies have been developed in the Newer Volcanics and in some areas, irrigation is practised from bores in these aquifers, but mostly the records and hence the aquifers remain unevaluated.

To the south-west of Melbourne to Werribee specific evaluations undertaken by the Melbourne and Metropolitan Board of Works for

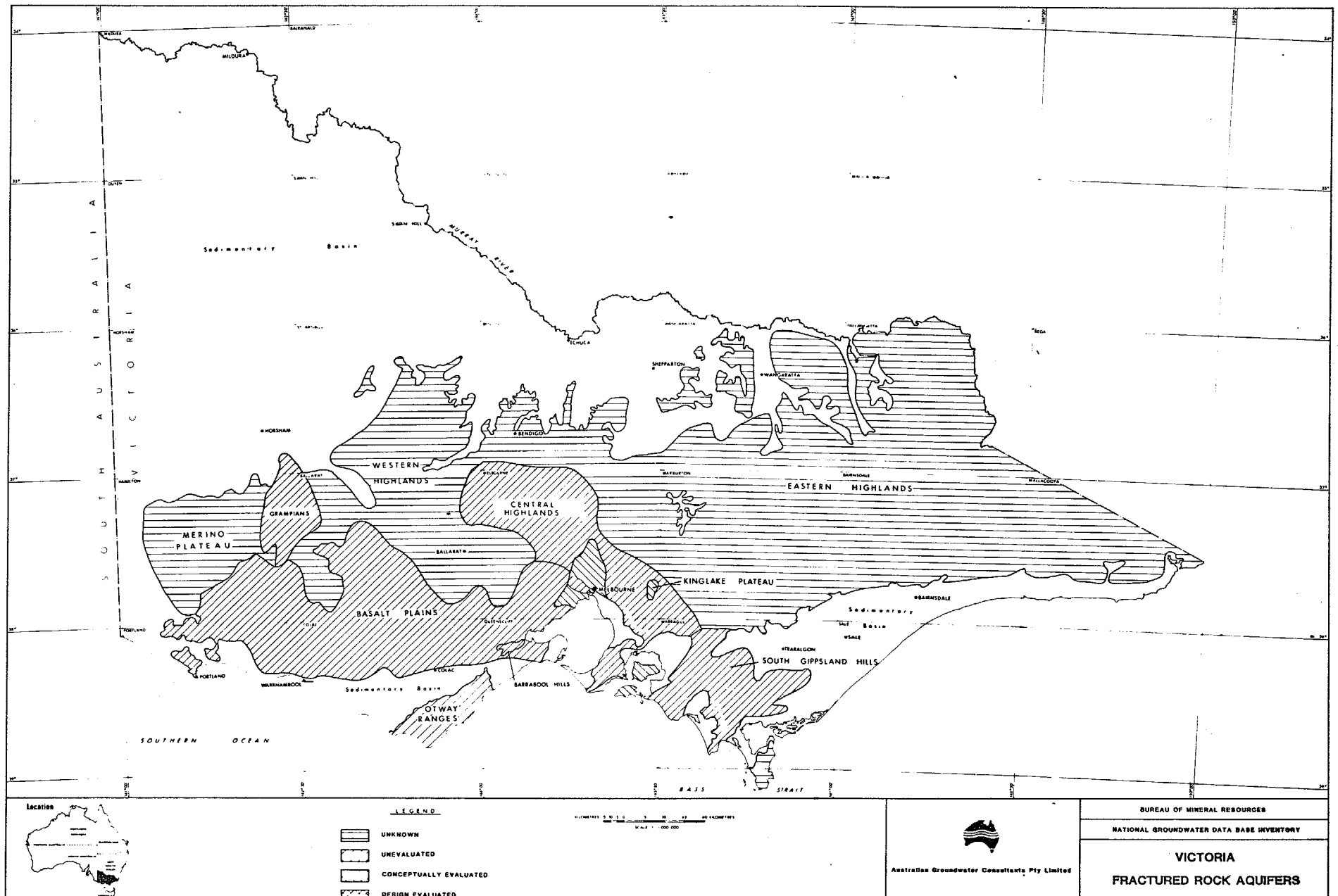

SOUTH AUSTRALIA
VICTORIA
MILDURA
Sedimentary Basin
MURRAY RIVER
SHEPPARTON
WANGARATTA
HORSHAM
BENDIGO
WESTERN HIGHLANDS
EASTERN HIGHLANDS
CENTRAL HIGHLANDS
GRAMPIANS
MERINO PLATEAU
BALLARAT
KINGLAKE PLATEAU
MELBOURNE
BASALT PLAINS
BAIRNSDALE
Sedimentary Basin
SALE
TRARALGON
SOUTH GIPPSLAND HILLS
PORTLAND
WARRNAMBOOL
COLAC
BARRABOOL HILLS
OTWAY RANGES
SOUTHERN OCEAN
BASS STRAIT
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
VICTORIA
FRACTURED ROCK AQUIFERS
FIG. 3-7

FIG. 3_7

outfall sewer location and design have produced a study which is design evaluated while on the Kinglake Plateau intensive drilling for horticultural water supplies has rendered these areas conceptually evaluated.

Future developments of groundwater from the fractured rocks will probably follow the patterns already established. In the Eastern Highlands interest will only centre around mining ventures and highland tourist developments and in these areas the present sparse record will need to be supplemented by specific data gathering which would be necessary even if hydrogeological maps were available.

In the Central Highlands through to South Gippsland Hills evaluation of the bore data record in association with structural geological analysis could lead to a conceptual evaluation of the aquifers which is likely to direct future water resources development for agricultural and town water supply purposes. This applies equally to the Western Highlands and Grampian areas.

The basalt-plains of western Victoria warrant upgrading of their status to conceptually evaluated to better direct stock, dosmestic and urban water supply development.

The critical areas for upgrading of status include the St. Arnaud and Ballarat 1:250,000 sheets followed by the Hamilton, Portland and Colac sheet areas in the future.

Large Sedimentary Basins

Figure 3-8 shows the sedimentary basins of Victoria all of which have recognised groundwater potential. All the basins include several aquifer horizons which have different groundwater potential and water quality characterisitics.

Murray Basin

The marine and non-marine aquifers of the Murray Basin underlie most of north western and northern Victoria. The work of Lawrence (1975) and Macumber (in press) with Tickell (in press) has defined the aquifers and the basin must be mostly considered to be conceptually evaluated. In addition the co-operative "Border Zone" study currently being undertaken between the South Australian Department of Mines & Energy and the Victorian Department of Minerals and Energy will further elucidate the hydrogeology of this basin.

The non-marine sections of the basin underlying the Riverine Plains sedimentary deposit aquifers are already considered conceptually evaluated. Some design evaluated areas exist around Lake Tyrell and over the Duddo Limestone around Murrayville where drilling for brines and investigation for a town water supply respectively have defined broad areas.

The Renmark Group sandstones which form the basal aquifers of the basin cannot be said to be known in enough areas to be considered conceptually evaluated at least in the western and northern parts of the basin in Victoria.

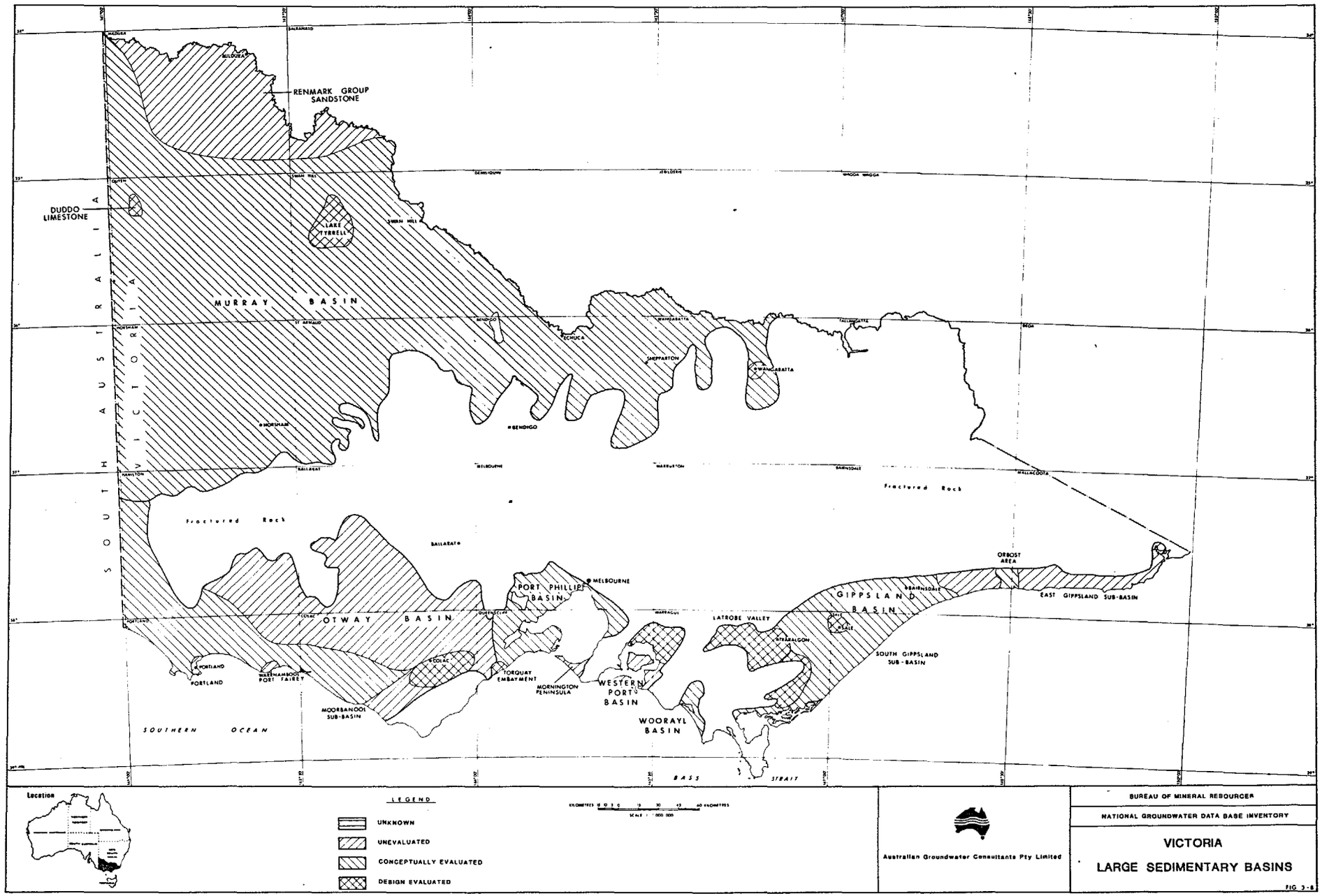

RENMARK GROUP SANDSTONE
DUDDO LIMESTONE
LAKE TYRRELL
MURRAY BASIN
SOUTH AUSTRALIA
VICTORIA
Fractured Rock
Fractured Rock
BENDIGO
SHEPPARTON
SWAN HILL
HORSHAM
BALLARAT
MELBOURNE
PORT PHILLIP BASIN
OTWAY BASIN
COLAC
TORQUAY EMBAYMENT
MORNINGTON PENINSULA
WESTERN PORT BASIN
WOORAYL BASIN
MOORABOOL SUB-BASIN
PORTLAND
WARRNAMBOOL
PORT FAIRY
LATROBE VALLEY
TRARALGON
SALE
GIPPSLAND BASIN
BAIRNSDALE
ORBOST AREA
EAST GIPPSLAND SUB-BASIN
SOUTH GIPPSLAND SUB-BASIN
SOUTHERN OCEAN
BASS STRAIT
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
VICTORIA
LARGE SEDIMENTARY BASINS
FIG. 3-8

FIG. 3_8

In general sufficient information exists to produce 1:250,000 hydrogeological maps of the principal aquifers of the Murray Basin and in the eastern area maps at 1:100,000 scale area already in production. The Mildura and Balranald sheets however remain unevaluated, and further work is warranted in this dry part of the State both to assess the water supply potential and value of the aquifers and to evaluate the hydrodynamics of the system. Some work on the latter is already being undertaken by the Rural Water Commission of Victoria.

Otway Basin

The southern margins of the Otway Basin are being investigated by the Department of Minerals and Energy for water supply potential for town and irrigation purposes. Specific hydraulic testing has been undertaken in the sand and limestone aquifers of the region along the southwestern margin close to the Otway Ranges. Assessments of recharge, underflow and discharge in this area have been made (Blake 1980, Leonard and Lakey 1983).

In general the basin is conceptually evaluated and except in areas of structural complexity further work on the existing data base could upgrade this southern margin to design evaluated.

The northern margin of the basin is overlain by Newer Volcanics and the lack of demand for better water supplies and the cost of deep drilling has resulted in few bores penetrating to bedrock. The numbers of bores in the record are however substantial and if consolidated and evaluated should be adequate to upgrade the status of this sector of the basin to conceptually evaluated.

This task should be included with the evaluation of the fractured rocks proposed from the Ballarat 1:250,000 sheet. When the Hamilton sheet is similarly completed, it will allow the Otway Basin to be considered conceptually evaluated around the margins.

Port Phillip Basin

The Port Phillip Basin has been extensively drilled by government and semi-government agencies, by industry, by rural developers and by the urban population of Melbourne and the Mornington Peninsula. The western half of the basin is currently unevaluated but certainly has an adequate data base for upgrading to design evaluated classification over much of the area. The eastern half of the basin is shallow and underlies the south-eastern suburbs of Melbourne and is intensively developed for recreation, garden watering and to a lesser extent, for industrial supply.

The Port Phillip Basin and the nearby Torquay Embayment should be upgraded in status to design evaluated classification and produced at 1:100,000 or at 1:50,000 for suburban areas. These maps would be of great value to industry and urban dewellers in assessing the potential sources of water relevant to their requirements, even though much of the water is brackish at least in the western half.

Western Port Basin

Western Port Basin has been heavily developed for horticultural irrigation and town water supply. It has been studied with respect to the possibility of salt water intrusion by a number of investigations over the last twenty years (Jenkins 1962, Rivera 1975, Lakey & Tickell 1980). The northern portion of the basin is design evaluated and a hydrogeological map has already been produced at 1:100,000 (Figure J-3).

The southern portion of the Basin is largely undeveloped owing to the availability of surface water. The area could be upgraded to conceptually evaluated which would permit the whole of the Queenscliff 1:250,000 sheet to be produced as a hydrogeological map.

Woorayl Basin

The Woorayl Basin is a small highly faulted basin which includes Lower Tertiary sands and basalts (Older Volcanics) and some shallow coastal deposits all of which yield low salinity waters. Sufficient bore and investigation drilling data are available for it to be considered conceptually evaluated, but it is doubtful whether the structural complexity will ever allow it to be upgraded to design evaluated unless very much more field investigation and survey work is performed.

Gippsland Basin

Considerable drilling has been carried out in the Gippsland Basin for coal and hydrocarbon deposits and more recently for the evaluation of water resources associated with coal. Groundwaters are used by industry for town supply and for irrigation. Major dewatering operations are associated with the Latrobe Valley lignite mines. (Brumley, Barton, Holdgate & Reid 1981 and Evans 1983).

The Latrobe Valley and South Gippsland sub-basins are considered design evaluated with the data from coal project investigations and specific investigations of the DME. Thompson (1981) has described the hydrodynamics of these basins, but as yet no hydrogeological maps have been produced.

Within the central portion of the Gippsland Basin, the Sale area is design evaluated with respect to the shallower aquifer (Barsdale Formation) but deeper drilling has not been undertaken and the remainder of the sections of the basin is conceptually evaluated only.

The East Gippsland sub-basin is largely unevaluated except for an area close to the township of Orbost where some government drilling has been carried out. There is a low density of bores due to the availability of surface waters. Production of data sheets or hydrogeological maps at 1:250,000 would be a valuable contribution in this area.

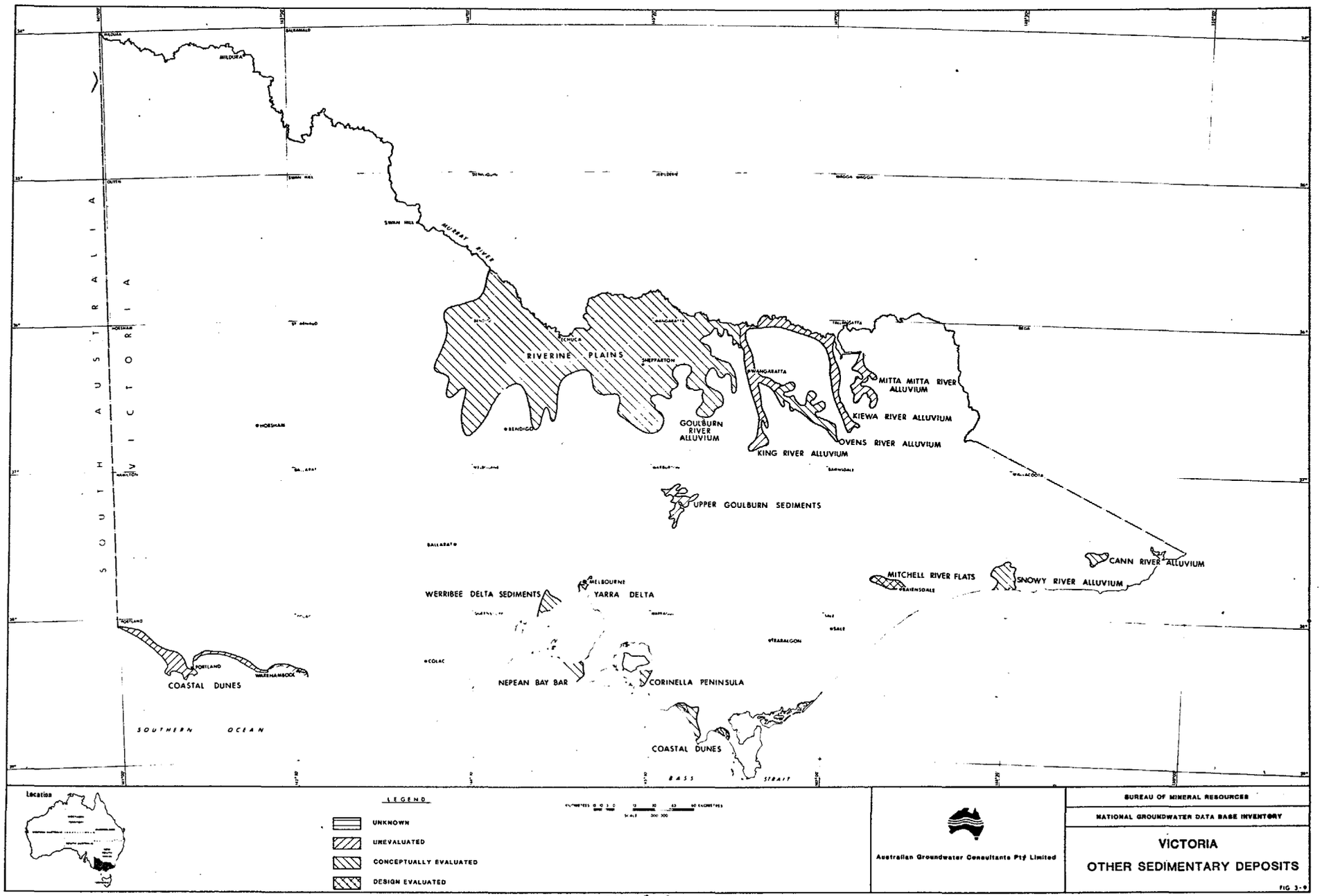

SOUTH AUSTRALIA
VICTORIA
MILDURA
SWAN HILL
MURRAY RIVER
RIVERINE PLAINS
TCHUCA
SHEPPARTON
BENDIGO
HORSHAM
GOULBURN RIVER ALLUVIUM
KING RIVER ALLUVIUM
OVENS RIVER ALLUVIUM
KIEWA RIVER ALLUVIUM
MITTA MITTA RIVER ALLUVIUM
UPPER GOULBURN SEDIMENTS
BALLARAT
MELBOURNE
WERRIBEE DELTA SEDIMENTS
YARRA DELTA
MITCHELL RIVER FLATS
SNOWY RIVER ALLUVIUM
CANN RIVER ALLUVIUM
PORTLAND
COLAC
SALE
TRARALGON
COASTAL DUNES
NEPEAN BAY BAR
CORINELLA PENINSULA
COASTAL DUNES
SOUTHERN OCEAN
BASS STRAIT
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
VICTORIA
OTHER SEDIMENTARY DEPOSITS
FIG 3-9

FIG. 3_9

Other Sedimentary Deposits

The deposits of Victoria include alluvial valley fill and coastal sediments. Areas in the Riverine Plains of Northern Victoria include Mitta Mitta, Kiewa, King, Ovens, Goulburn, Campaspe, Loddon, Avoca and Wimmera Rivers, as well as the Murray River.

The significant aquifers are presented on Figure 3-9 and mostly they have a data base which permits them to be considered conceptually evaluated.

The areas shown as design evaluated relate to specific evaluation projects such as the Shepparton Irrigation regional water table control program and the Mitchell River Flat recharge project.

The coastal aquifers systems are used intensively around Warnambool and Port Fairy in Western Victoria and are marked as unevaluated only where their utilisation is low. Some areas however could be considered to be design evaluated although this would require data compilation and analysis although this is not considered warranted.

3.3.4 Queensland

3.3.4.1 Classification Categories

Fractured Rocks

The fractured rock regions in Queensland are shown in Figure 3-10. They include rocks within the Cloncurry and Georgetown Massifs and the remainder which forms part of the Tasman Geosyncline. Several volcanic areas also occur within the State.

The fractured rock areas are mostly unknown to unevaluated owing to their poor potential for large scale usage. Data in these areas are generally scattered and it is normally difficult to extrapolate from one area to the next on site-specific groundwater conditions. Groundwater conditions at shallow depth are usually controlled by the local catchment areas and therefore assessment of potential usually requires a study of the local conditions. However sufficient data are available in most areas to produce hydrogeological data sheets or hydrogeological maps. To the west a BMR/Queensland Department of Mines study (Randal 1978) has yielded part of the Cloncurry massif (Mt. Isa Block) as conceptually known. This study also included areas in the sedimentary basins to the south and west.

Future developments in the fractured rock area are restricted to mining or township water supplies and would therefore be greatly assisted by information maps showing existing records or additional information collected and interpreted by way of bore census. For most areas, only 1:250,000 data maps could be produced rather than detailed hydrogeological maps.

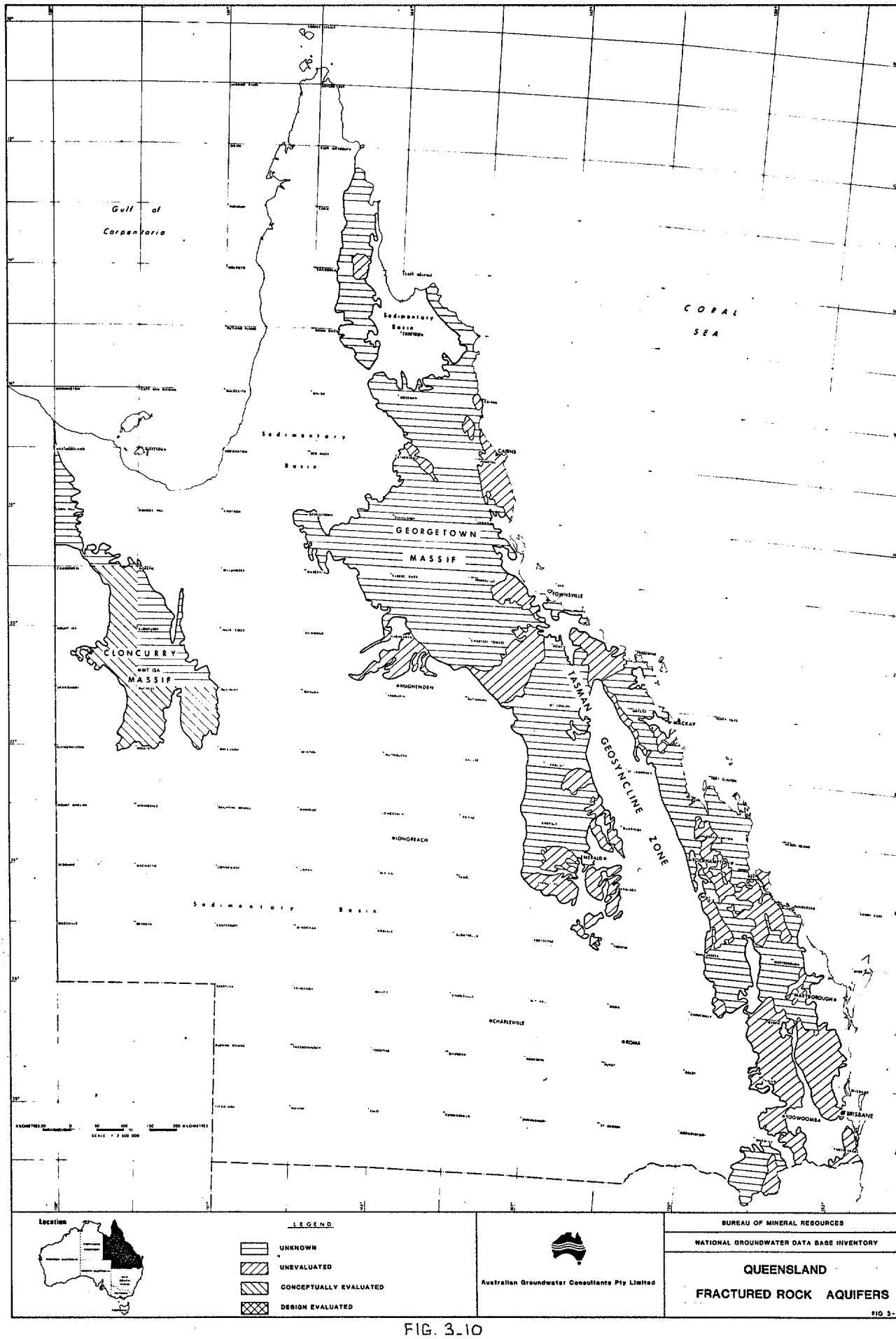

Gulf of Carpentaria
CORAL SEA
Sedimentary Basin
Sedimentary Basin
Sedimentary Basin
CAIRNS
GEORGETOWN MASSIF
TOWNSVILLE
CLONCURRY MASSIF
MT ISA
HUGHENDEN
TASMAN GEOSYNCLINE ZONE
MACKAY
LONGREACH
INSELDO
ROCKHAMPTON
MARYBOROUGH
CHARLEVILLE
ROMA
TOOWOOMBA
BRISBANE
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1:2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
BUREAU OF MINERAL RESOURCES
NATIONAL GROUNDWATER DATA BASE INVENTORY
QUEENSLAND
FRACTURED ROCK AQUIFERS
FIG 3-10

FIG. 3_10

Large Sedimentary Basins

There are numerous sedimentary basins in Queensland (Figure 3-11). The main basin is the hydrological Great Artesian Basin which can be divided into several geological provinces or entities. These include the Eromanga Basin and Surat Basin to the south, and south-east and the Carpentaria Basin to the north. The main concentration of bore data in Queensland occurs in the central part of the Basin, around Charleville and south of this region extending into New South Wales. The second area but with less density occurs between Hughenden and Longreach and west to the Cloncurry Massif. In the Carpentaria Basin and in the southwest of the GAB the bore density is low.

The Geological Survey of Queensland has collated data on the GAB east and south of the Cloncurry Massif area using 1:250,000 sheets in the areas shown as field work completed on Figure 3-10. Most of these data have not been interpreted. A large number of water samples were collected but they have not been fully assessed.

Field work has also been carried out within the GAB area from Charleville to the NSW border. Data on 5726 bores have been collated and entered on disc at the SGCC. About 2700 water samples, and wire line logs for 561 water bores and 380 oil wells have also been interpreted. Water chemistry has been evaluated for the south eastern Eromanga Basin (fifteen 1:250,000 sheet areas). Future work is to involve preparation of a report on the south eastern Eromanga Basin (50 to 60 percent complete at 1985).

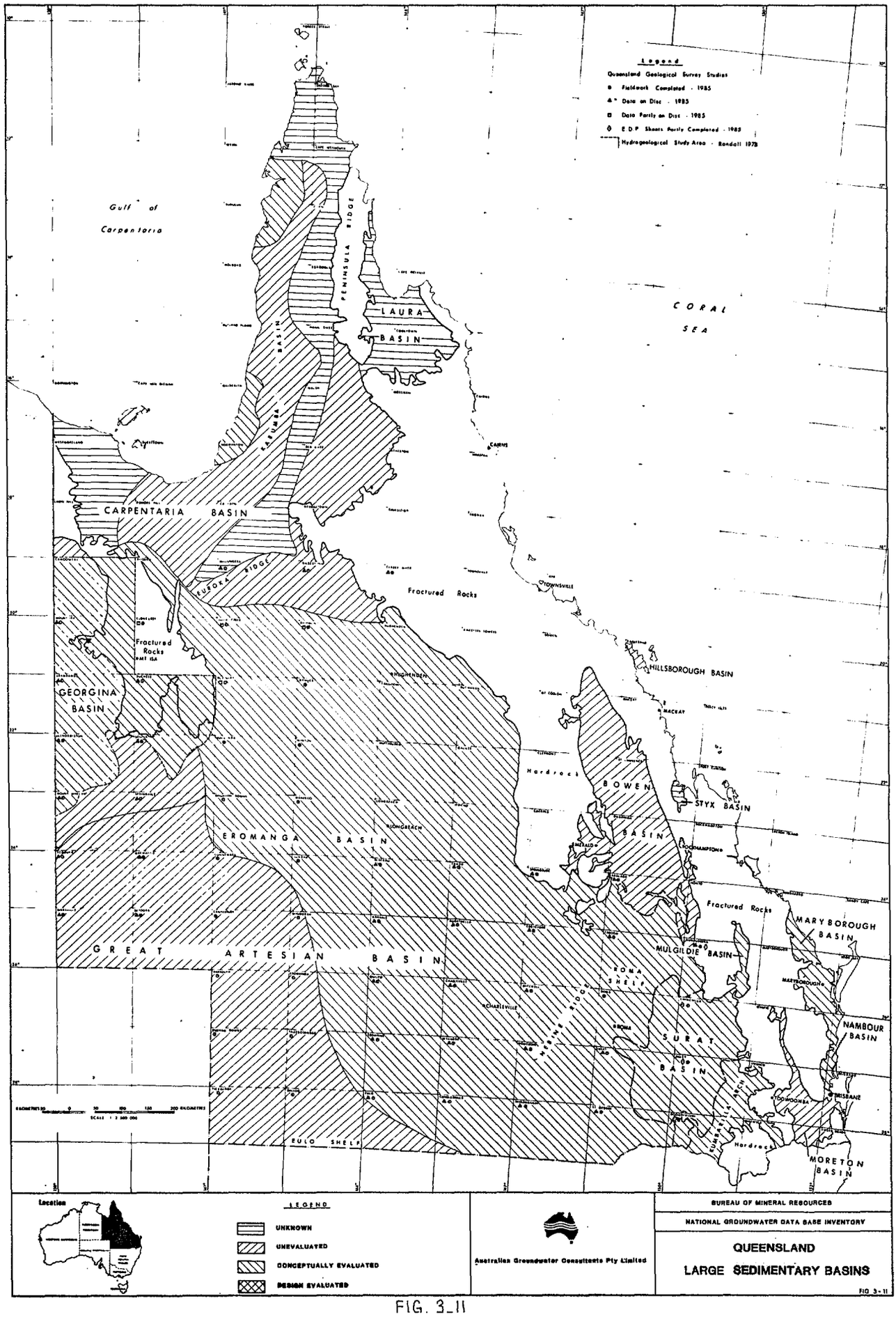
EDP sheets are to be completed for Roma, Goondiwindi, Dalby, Chinchilla and Mundubbera sheets including evaluation of groundwater chemistry. Also proposed is a report on the Surat Basin portion of the Basin.

Work has been carried out in the southwest corner of the Basin (Cooper Creek and North Broken Hill 1:1,000,000 hydrogeological sheets). Field work has been completed and EDP sheets and data files created for the respective 1:250,000 sheets shown in Figure 3-2. The data include 615 water samples and wire line logs for 19 water bores and 15 oil wells. All data are to be evaluated and a report prepared. No general interpretative work has been done however.

The study undertaken by the BMR on the GAB (Habermehl 1980) concentrated mainly on the central and southern parts of the basin south of the Euroka Ridge.

Whilst the GAB as an entity could be classed as conceptually known (a model study of the regional hydrodynamics has been carried out) it is evident that at a larger scale the areas to the southeast in Queensland are unevaluated because of the paucity of bore data and/or because the data have not been fully assessed and interpreted.

In the Gulf region the GAB is largely unknown to unevaluated because of a paucity of data. Areas marked as conceptually evaluated occur in the Normanton and Galbraith quarter million sheets and further north in the Weipa and Aurukun sheets.


Legend
Queensland Geological Survey Studies
Fieldwork Completed - 1985
Data on Disc - 1985
Data Partly on Disc - 1985
E.D.P. Sheets Partly Completed - 1985
Hydrogeological Study Area - Randall 1978
Gulf of Carpentaria
CORAL SEA
PENINSULA RIDGE
LAURA BASIN
CARPENTARIA BASIN
EUSOKA RIDGE
Fractured Rocks
Fractured Rocks
GEORGINA BASIN
HILLSBOROUGH BASIN
Hardrock
BOWEN BASIN
STYX BASIN
EROMANGA BASIN
Fractured Rocks
MARYBOROUGH BASIN
GREAT ARTESIAN BASIN
MULGILDIE BASIN
ROMA SHELF
SURAT BASIN
NAMBOUR BASIN
EULO SHELF
Hardrock
MORETON BASIN
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
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NATIONAL GROUNDWATER DATA BASE INVENTORY
QUEENSLAND
LARGE SEDIMENTARY BASINS
FIG 3-11

FIG. 3_11

Drilling in these regions has resulted in a general understanding of the groundwater flow systems at the scale shown.

The other large sedimentary basins include the Georgina Basin and the basins of eastern Queensland. The southeastern portion of the Georgina Basin, which extends into the Northern Territory, has been studied extensively and is reported on in a comprehensive report prepared by Randal (1978) (Figure 3-11). Most of this area has therefore been assessed as conceptually known.

The large basins of eastern Queensland include, commencing in the northern part of the State, the Laura, Hillsborough, Styx, Bowen, Maryborough and Mulgildie and Moreton Basins (see Figure 3-11).

Very little is known about the Laura Basin owing to the paucity of data hence it has been designated as unknown in Figure 3-11. The basin is thought however to have groundwater potential and would be worth investigating further. Similarly the Styx Basin has been designated as unknown.

Data exist in the Bowen basin but are largely unevaluated. The Geological Survey of Queensland have undertaken a bore census over the region but the data have not been evaluated or interpreted. These data could be collated into information sheets.

The Maryborough Basin has been designated as conceptually evaluated as sufficient data exist for an understanding of the regional groundwater system.

Scattered data are available in the Moreton Basin, and have not been evaluated.

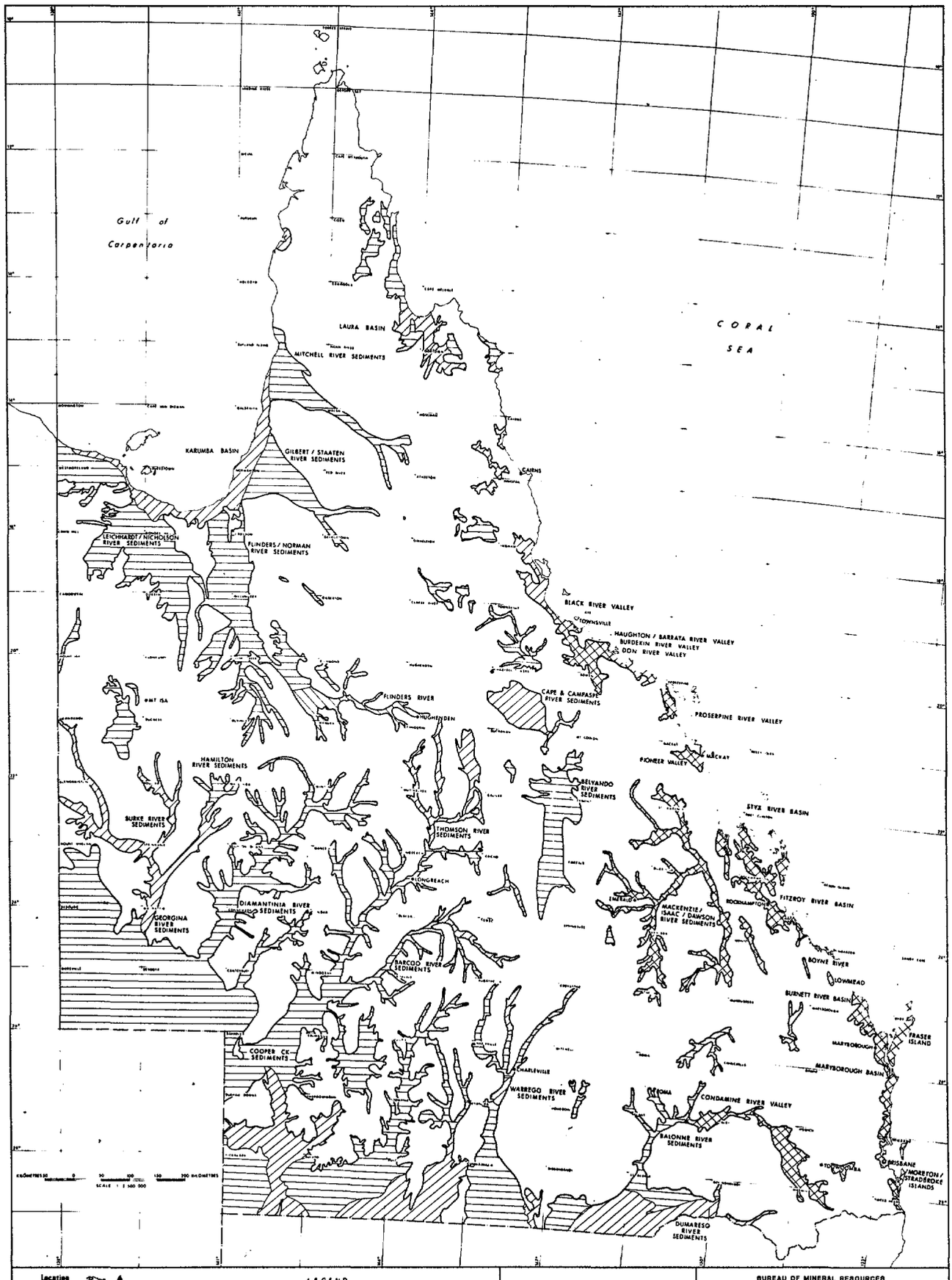
Other Sedimentary Deposits

The sediments occur commonly as unconsolidated to semi-consolidated Quaternary and Tertiary fluvial, deltaic and aeolian deposits. Along the coast these deposits have been extensively developed but inland, particularly where they occur above the Great Artesian Basin they remain undeveloped and hydrogeological conditions are largely unknown.

The coastal and island sandy sediments are generally well known and on a regional scale can be considered as design evaluated, although on a larger scale many areas would be classed as unevaluated.

The coastal valleys comprise numerous alluvial infill valley systems, often over deeper Tertiary basins, which include:

- Black and Alice
- Haughton
- Burdekin
- Lower Don
- Proserpine
- Pioneer
- Fitzroy


Gulf of Carpentaria
CORAL SEA
LAURA BASIN
MITCHELL RIVER SEDIMENTS
KARUMBA BASIN
GILBERT / STAATEN RIVER SEDIMENTS
CAIRNS
LEICHHARDT / NICHOLSON RIVER SEDIMENTS
FLINDERS / NORMAN RIVER SEDIMENTS
BLACK RIVER VALLEY
TOWNSVILLE
HAUGHTON / BARRATA RIVER VALLEY
BURDEKIN RIVER VALLEY
DON RIVER VALLEY
CAPE & CAMPASPE RIVER SEDIMENTS
FLINDERS RIVER
HUGHENDEN
MT ISA
PROSERPINE RIVER VALLEY
MACKAY
PIONEER VALLEY
HAMILTON RIVER SEDIMENTS
BELYANDO RIVER SEDIMENTS
STYX RIVER BASIN
BURKE RIVER SEDIMENTS
THOMSON RIVER SEDIMENTS
LONGREACH
EMERALD
MACKENZIE / ISAAC / DAWSON RIVER SEDIMENTS
ROCKHAMPTON
FITZROY RIVER BASIN
DIAMANTINA RIVER SEDIMENTS
GEORGINA RIVER SEDIMENTS
BARCOO RIVER SEDIMENTS
BOYNE RIVER
GLADSTONE
BURNETT RIVER BASIN
FRASER ISLAND
MARYBOROUGH
MARYBOROUGH BASIN
COOPER CK SEDIMENTS
CHARLEVILLE
WARREGO RIVER SEDIMENTS
TOOWOOMBA
CONDAMINE RIVER VALLEY
BALONNE RIVER SEDIMENTS
BRISBANE
MORETON / STRADBROKE ISLANDS
DUMARESQ RIVER SEDIMENTS
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1 : 2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
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NATIONAL GROUNDWATER DATA BASE INVENTORY
QUEENSLAND
OTHER SEDIMENTARY DEPOSITS
FIG. 3-12

FIG. 3_12

- Boyne
- Burnett
- Brisbane

Most of these valleys have been extensively investigated in their upper levels by the QWRC for water supplies and can be considered to be design evaluated. North of Townsville there may be significant basins not yet fully evaluated.

Very few data are available on the inland drainage systems, particularly those overlying the Great Artesian Basin. As the GAB has traditionally provided groundwater supplies, little attention has been given to the surficial aquifers. Nevertheless these deposits are likely to contain isolated aquifers of low to medium salinity although a large section of these deposits would yield high to very high salinity groundwater. Most of them have been classed as unknown. Some data are available but unevaluated in the Hamilton, Burke and Georgina River sediments. Unevaluated areas also occur south of Charleville in the Warrego, Upper reaches of the Thomson, Barcoo, Dumaresq river sediments.

Upstream areas of the Flinders River have been investigated and the area has been conceptually evaluated. Detailed investigations have been carried out in the Condamine and it is therefore shown as design evaluated status. Perhaps some of the Border Rivers area should also be of this status.

Very little is known about the Tertiary aquifers in the State, in particular the Belyando and Campaspe Rivers Area. The Tertiary aquifer system of the Black River near Townsville, at one time thought to contain limited groundwater, boasts a well field which has for 13 years delivered an average supply of 16 ML/day for a processing plant. Wellfields are being developed in the Campaspe River area for mining projects.

Recent investigations carried out by the Queensland Geological Survey has indicated localised good quality groundwater from Tertiary sediments in the Upper reaches of the Cooper Creek region.

The Proserpine Basin (Tertiary) has some groundwater data which have not been evaluated. Most of the data in this region are available from bores penetrating the overlying alluvial sediments along the Proserpine River Valley which has been extensively investigated by the Queensland Water Resources Commission.

There could be some value in upgrading the knowledge on some other inland drainage rivers particularly close to the Dividing Range where good quality might be expected. These areas frequently have deep Tertiary basins which are virtually unknown and could have minor irrigation potential (ie. Alpha-Belyando River Area, and the Campaspe basin west of Charters Towers). It is understood that the QWRC has carried out some drilling in these areas, and that results are poor; however further evaluation appears warranted. This may also apply to the Flinders & Cloncurry River Quaternary sediments.

The Karumba Basin (Tertiary) and river alluvium along the inland margins of the Gulf drainage basin could be of value for irrigation but these areas are generally unknown and further investigation would be required including drilling to upgrade knowledge and status.

3.3.5 Western Australia

3.3.5.1 Classification Categories

Fractured Rocks

The fractured rock areas occupy much of the settled (western) part of the State (Figure 3-13,3-15).

They include the major Archaean Yilgarn Block, and the smaller Archaean Pilbara Block near the northwest coast. Large Proterozoic sedimentary basins occupy the intervening area, including the Hamersley and Bangemall Basins. Finally, there are several fringing areas of Proterozoic metamorphic and igneous rocks. These areas constitute the extensive Western Australia Shield, which extends virtually from the south to the north coast, and which is overlain by only thin surficial sediments and scattered minor basin areas.

The other major fractured rock area comprises the Kimberley Block in the extreme northeast of the state, the Musgrave Block to the south, and areas in between generally along the border with the Northern Territory.

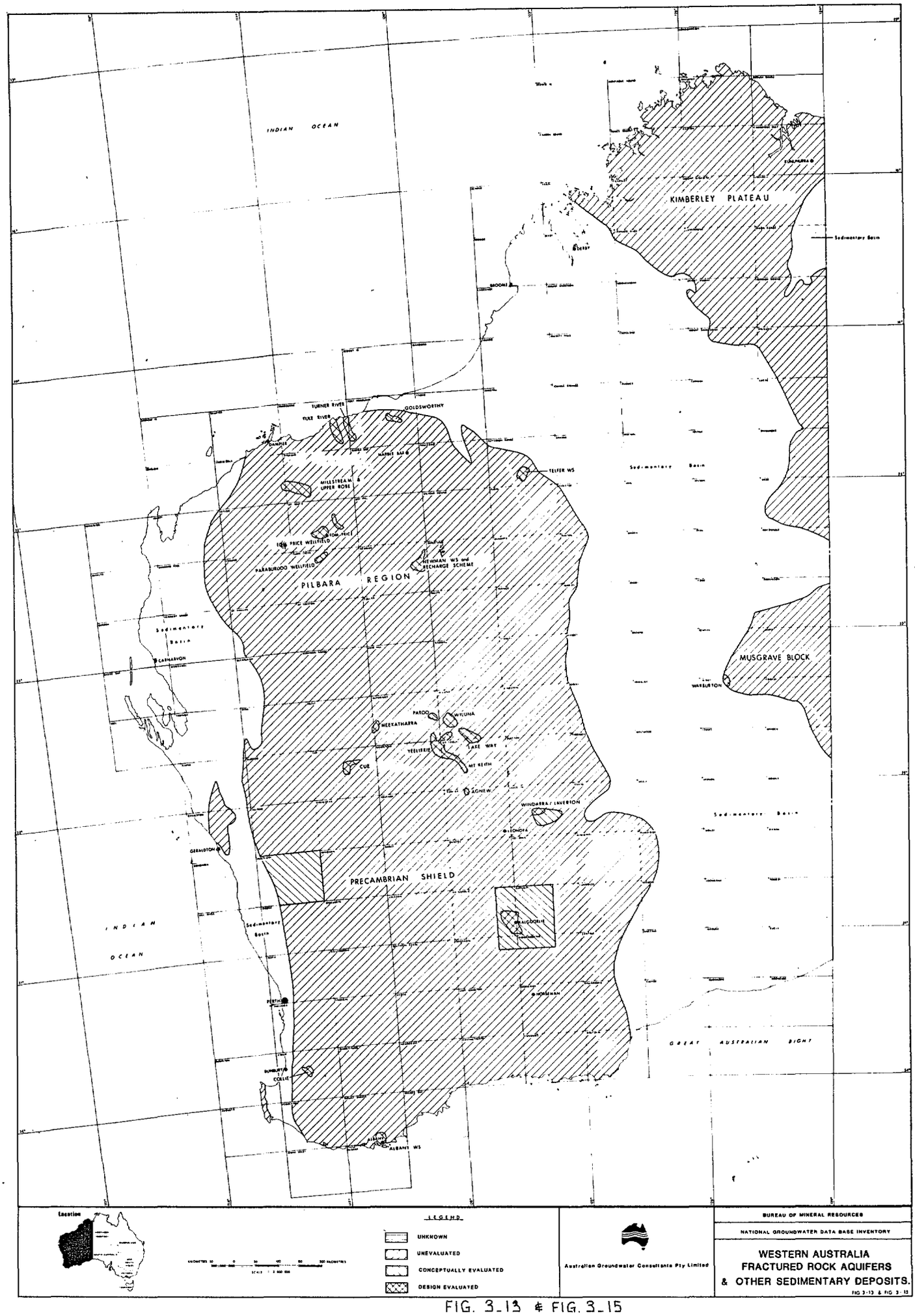
The fractured rock areas of the state are of great importance to both the state and national economies, since they contain much of the mineral wealth of the nation, including large deposits of iron ore, and major occurrences of gold, nickel, uranium and other minerals.

The fractured rock areas can be broadly subdivided into the following regions.

- Yilgarn region
- Pilbara - Hamersley - Bangemall region
- Kimberley - Musgrave region

The Yilgarn region is generally characterised by moderate to low yields, and much of the southern part of this region is dominated by high to very high salinities. However, there are localised areas where large yields occur, and the region supports many important mine water supply developments. Water quality improves in the northern part of the region and many town and mine water supplies of acceptable quality have been developed. Most of the groundwater potential exists in the superficial sediments and the upper weathered and fractured zone of the Archean basement rocks.

The Hamersley Basin, and parts of the Kimberley Block are characterised by higher groundwater yields and better quality, due to the higher rainfall and more extensive development of fractured systems and solution channel permeability, in favoured rock types. Once again, the surficial sediments possess major



Location

KILOMETRES 50 0 50 100 150 200 KILOMETRES

SCALE 1 : 5 000 000

LEGEND

- UNKNOWN
- UNEVALUATED
- CONCEPTUALLY EVALUATED
- DESIGN EVALUATED

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WESTERN AUSTRALIA FRACTURED ROCK AQUIFERS & OTHER SEDIMENTARY DEPOSITS.

FIG 3-13 & FIG 3-15

FIG. 3_13 & FIG. 3_15

groundwater potential, often in association with the fractured rock aquifers.

The Pilbara Block, in spite of a high rainfall, has inferior fractured rock aquifer potential, due primarily to the nature of the rock types. Likewise, parts of the Kimberley Block and the Bangemall Basin are characterised by low groundwater yields.

Little is known about the Musgrave Block and the other inland fractured rock areas, but limited investigation have shown that the surficial sediments may contain useful aquifers as may the basement rocks where favourable rock types occur.

Assessment of available groundwater data indicates that the majority of fractured rock areas are unevaluated. However, there are considerable data in existence which have not been compiled and collated.

It should be noted that in many of the design evaluated areas within the fractured rock regions, shown on Figures 3-13,3-15, groundwater is often extracted from aquifer systems which embrace both the surficial sediments, including channel infill deposits, and the underlying weathered and fractured mantle of the basement rocks. Generally, the two components of the aquifer system are complementary, and cannot be distinguished hydrologically.

Large Sedimentary Basins

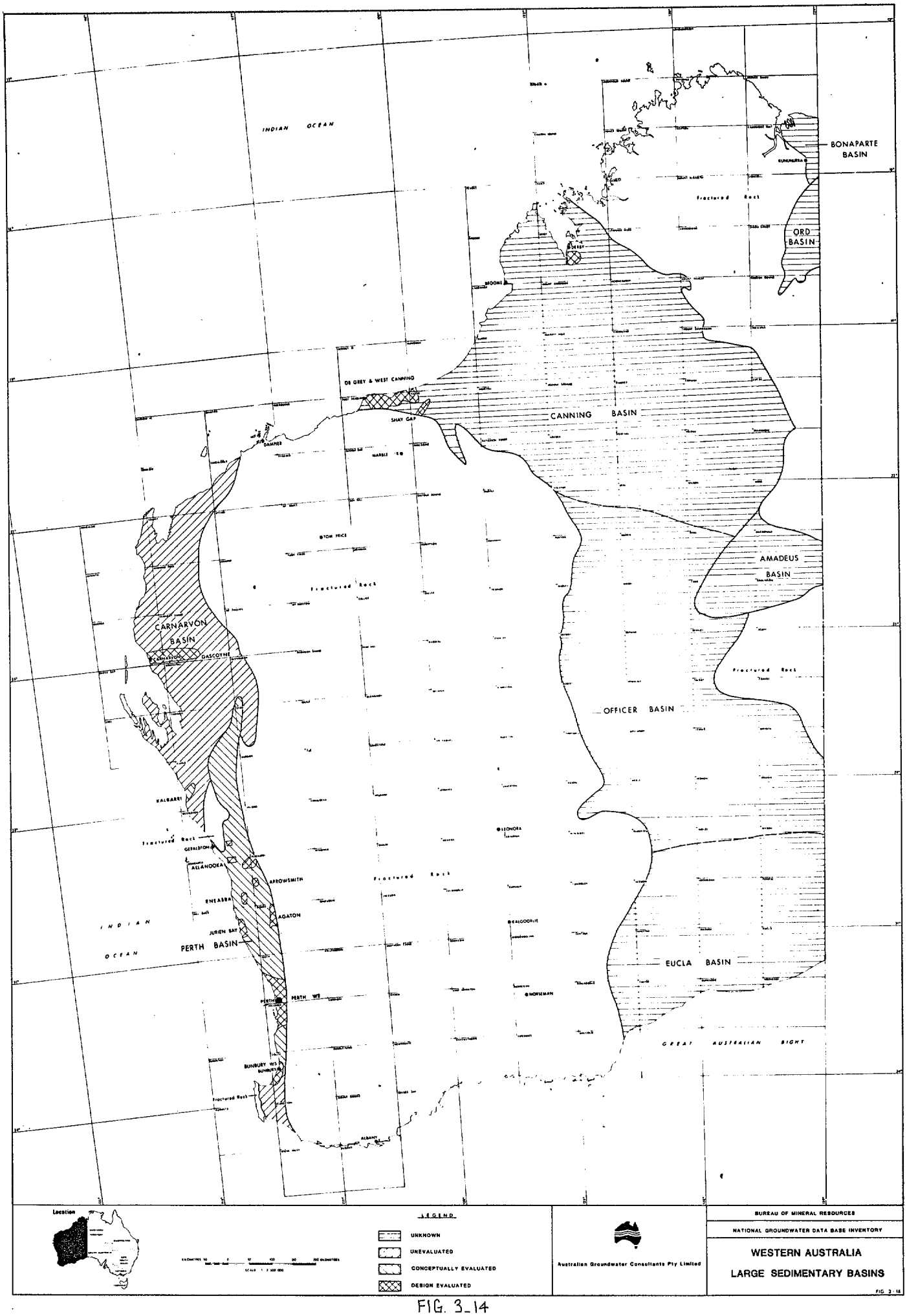
The non-fractured rock areas of the State include two major regions occupied by Phanerozoic sedimentary basins. The western basin region, lying west of the Precambrian Shield, comprises the Perth and Carnarvon Basins, and extends from south to north along the west coast. The eastern basin region lies east of the Shield, between the Shield and the Kimberley - Musgrave region, and comprises the Canning Basin in the north, the Officer Basin in the centre and Eucla Basin in the south.

Apart from parts of the central and southern Perth Basin, it can be generally stated that the sedimentary basins of Western Australia are largely unknown to unevaluated. A number of small design evaluated areas can be identified, and are denoted on Figure 3-14. These are generally the source areas for town and mining project water supplies.

Canning Basin

The Canning Basin is contained entirely within the State, and contains a sequence of Phanerozoic sediments more than 10,000 m thick. Practically nothing is known of the groundwater conditions in the sequence, except in a few localities near the basin margins, however the Basin is believed to contain vast reserves of groundwater, some of which should be of good quality. The basin is also overlain by extensive surficial deposits, which possibly possess good groundwater, although it may be predominantly saline.

Most of the Canning Basin is classified as unknown.


INDIAN OCEAN
BONAPARTE BASIN
ORD BASIN
Fractured Rock
DE GREY & WEST CANNING
SHAY GAP
CANNING BASIN
AMADEUS BASIN
CARNARVON BASIN
GASCOYNE
OFFICER BASIN
KALBARRI
GERALDTON
ALLANOOKA
ARROWSMITH
ENEABBA
AGATON
JURIEN BAY
PERTH BASIN
PERTH
BUNBURY
ALBANY
LEONORA
KALGOORLIE
NORSEMAN
EUCLA BASIN
GREAT AUSTRALIAN BIGHT
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
Australian Groundwater Consultants Pty Limited
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NATIONAL GROUNDWATER DATA BASE INVENTORY
WESTERN AUSTRALIA
LARGE SEDIMENTARY BASINS
FIG 3-14

FIG. 3_14

Officer Basin

This basin occupies a large area within the State, and extends eastwards into South Australia. It contains around 1000 m of Phanerozoic sediments.

Hydrogeologically, it is not regarded as important, since the limited information available suggests that in general groundwater is deep, yields are low, and quality is poor. Some lower salinity water has been obtained locally. Certain structural features indicate possible good potential in specific areas.

Information exists for some areas which needs to be evaluated. The basin is best classified as unknown.

Eucla Basin

This basin also extends into South Australia. Sediments extend to depths of 750 m or more in the onshore areas.

Aquifers contain mainly saline water, although localised brackish water supplies are developed. This basin is classified as unevaluated.

Perth Basin

The Perth Basin occurs along the southern half of the west coast, and contains up to 10,000 m of sediments. It is conceptually known, with several design evaluated areas.

Carnarvon Basin

The Carnarvon Basin lies along the west coast, to the north of the Perth Basin, and contains Phanerozoic sediments up to 10,000 m thick. The basin is characterised by variable hydrogeological conditions. In general, the density of available data and the amount of interpretative work which has been carried out is such that the Basin as a whole is classed as unevaluated, except for minor local design evaluated areas.

Other Sedimentary Deposits

These deposits cover a large area of the State as alluvium, colluvium, chemical sediments (calcrete, goethite, silcrete) and aeolianite. They are developed as surficial deposits over the fractured rock areas and the sedimentary basins. Important deposits occur as valley-fill sediments in an extensive Tertiary paleodrainage system developed on the Shield and Basin sediments, particularly in inland areas. They are not shown in detail on the plans except where they are design evaluated.

Groundwater in the surficial deposits probably represents the largest unevaluated groundwater source in Western Australia. They are an important source of groundwater for the mining industry.

Calcrete and other chemical sediments are extensively developed

in alluviated drainages in the central part of the State, and these deposits can yield large quantities of groundwater. Paleochannel deposits are also well developed over the fractured rock areas and sedimentary basins, also with the capability of supporting large yields. Many areas with potential have been unexplored, particularly in the Canning and Officer Basins. Recent satellite imagery studies have revealed that these deposits are extensive, and could contain important groundwater resources.

Detailed hydrogeological assessment of the surficial deposits will be important in determining the groundwater resources of the north-eastern part of the State, in particular in the Canning Basin.

In places the surficial deposits and shallow sedimentary deposits can be difficult to differentiate from the underlying fractured rocks and basin sediments. Although in general the surficial deposits can be classed as unevaluated there is no doubt however that their potential is vast. Whilst it has been common practice in the past to label these areas as having poor potential because of salinity, many of these highly saline aquifers are being used extensively in the mining industry.

In addition to the surficial deposits, there are recognised smaller basins located within the fractured rock regions which contain important groundwater resources. These include the Collie Basin and Bremer Basin near the south of the State, which although small in area, are nevertheless major souraces of groundwater supply for municipalities, industry and mining. Localised design evaluated areas are shown on Figures 3-13,3-15.

3.3.6 Northern Territory

3.3.6.1 Classification Categories

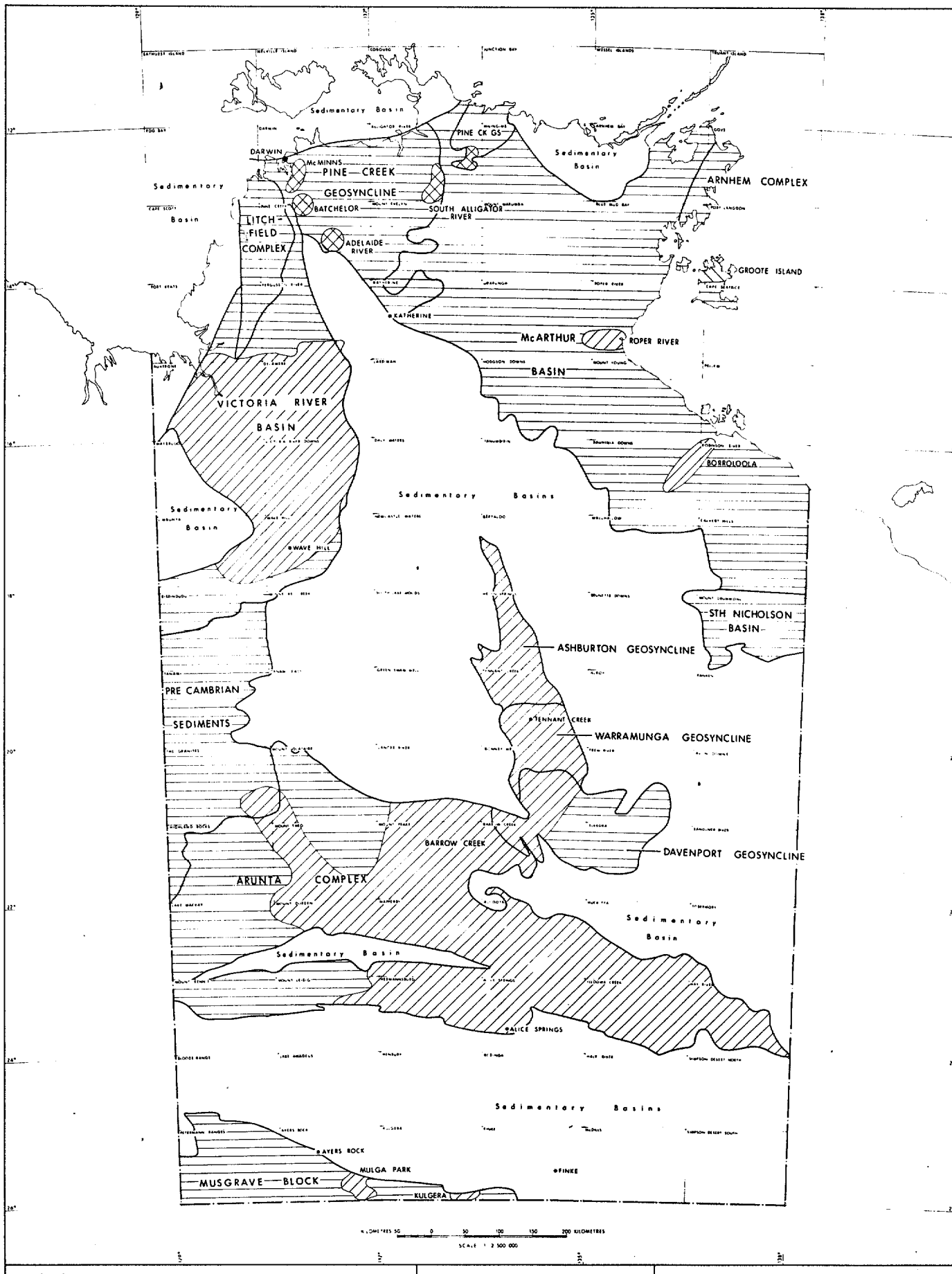
Fractured Rocks

The fractured rock regions of the Northern Territory are shown on Figure 3-16.

The classification includes the traditional basement complexes of Archaean and Early Proterozoic rocks comprising: Musgrave Block, Arunta Complex, Tennant Creek Complex (Ashburton, Warramunga, Davenport Geosynclines), Pine Creek Geosyncline, Litchfield Complex and the Arnhem Complex.

In addition, the Late Proterozoic basin sediments are included as fractured rocks since the water occurrence here is mostly associated with structural fractures with no basin-type hydrodynamic continuity. These areas comprise the Victoria River Basin, McArthur Basin, and South Nicholson Basin.

Throughout the Northern Territory the fractured rock areas provide useful small supplies of water for stock and domestic use. Future development in the southern part of the Territory would be restricted to these small supplies due to lack of sufficient and regular rainfall to recharge local storages. In



Location

LEGEND

- UNKNOWN
- UNEVALUATED
- CONCEPTUALLY EVALUATED
- DESIGN EVALUATED

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NATIONAL GROUNDWATER DATA BASE INVENTORY

NORTHERN TERRITORY

FRACTURED ROCK AQUIFERS

FIG 3-16

FIG. 3_16

the high rainfall areas in the north, potential exists for large scale development for townships and mining projects as has taken place for the Darwin and Jabiru water supplies (cavernous dolomite) and for mining at Nabarlek, Koongara, Pine Creek, Adelaide River and Jabiluka.

Apart from the specific wellfield areas of high yield development the groundwater data are sparse relative to the scale of fractured rock areas. For the Central Australia area the BMR has published bore census data maps (1:250,000 scale). This work could be extended to cover the whole of the Territory to provide guidance for mining and property development schemes.

A regional study of the hydrogeology and distribution of cavernous dolomite aquifers in the Pine Creek Geosyncline from Darwin to Jabiru could show useful quantities of water for irrigation purposes around the margin of the coastal plain.

Large Sedimentary Basins

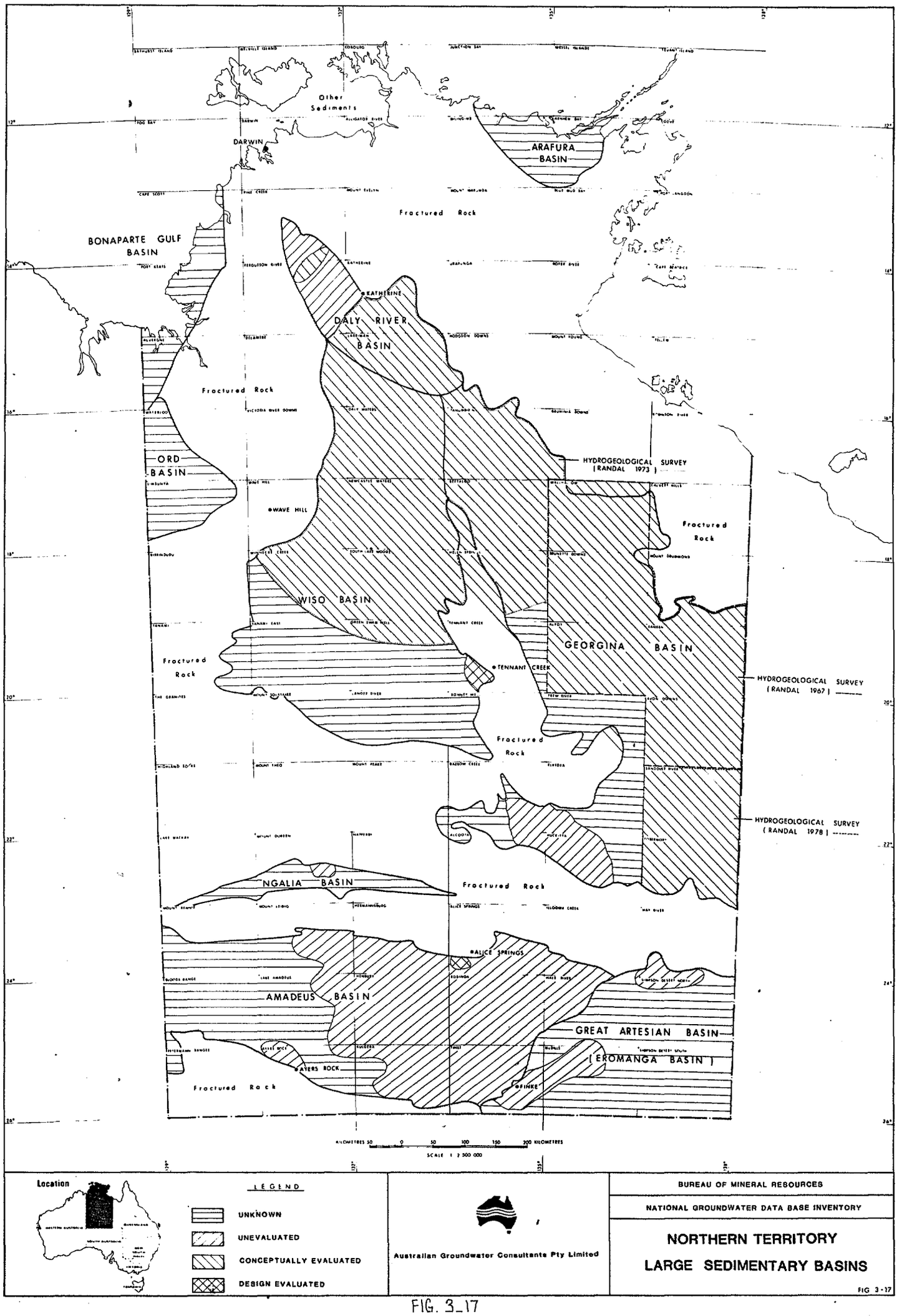
The basins in this category are shown on Figure 3-17. Groundwater use is generally restricted to pastoral and homestead support and large areas are undeveloped owing to remoteness and the desert environment. Unknown areas include much of the Wiso and Ngalia Basins, the western half of the Amadeus Basin, the Ord-Bonaparte Gulf Basin, Arafura Basin, and much of the Great Artesian Basin.

An even but sparse spread of stock watering bores over the remaining areas provides data to demonstrate the continuity of hydrogeological systems throughout the basins.

Limited drilling investigations have have been carried out to assess irrigation potential in the Daly River Basin (Dept. of Transport & Works, 1984). On a basin scale the hydrogeology is considered as unevaluated due to the lack of widespread drilling data. Regional hydrogeological surveys conducted by Randal (1967, 1973 and 1978) allow most of the Georgina Basin to be classified as conceptually evaluated to depths of about 200 metres. Beyond this depth the groundwater system is unknown. Although designated as conceptually known the hydrodynamics of the Georgina Basin have not been assessed. Randal (1973) also collated data on the northern Wiso Basin. The Tennant Creek water supply is obtained mostly from sandstones west of Kelly Well in the Wiso Basin.

Concentrated development from the Mereenie Sandstone of the Amadeus Basin south of Alice Springs for township supply, industry and irrigation allows this area to be designated as design evaluated. Due to increasing demand for water resources in this area there is a need to extend by investigation the areas of design evaluation. Bore census maps for the eastern part of the Amadeus Basin have been published by BMR.

In other sedimentary basin areas the future water usage will probably remain as stock and domestic, with local concentrated development for township expansion.


Other Sediments
DARWIN
ARAFURA BASIN
Fractured Rock
BONAPARTE GULF BASIN
KATHERINE
DALY RIVER BASIN
Fractured Rock
ORD BASIN
HYDROGEOLOGICAL SURVEY (RANDAL 1973)
WAVE HILL
Fractured Rock
WISO BASIN
GEORGINA BASIN
Fractured Rock
TENNANT CREEK
HYDROGEOLOGICAL SURVEY (RANDAL 1967)
Fractured Rock
HYDROGEOLOGICAL SURVEY (RANDAL 1978)
NGALIA BASIN
Fractured Rock
ALICE SPRINGS
AMADEUS BASIN
GREAT ARTESIAN BASIN
(EROMANGA BASIN)
AYERS ROCK
Fractured Rock
OODNADATTA
KILOMETRES 50 0 50 100 150 200 KILOMETRES
SCALE 1 : 2 500 000
Location
LEGEND
UNKNOWN
UNEVALUATED
CONCEPTUALLY EVALUATED
DESIGN EVALUATED
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NATIONAL GROUNDWATER DATA BASE INVENTORY
NORTHERN TERRITORY
LARGE SEDIMENTARY BASINS
FIG 3-17

FIG. 3_17

On a National scale, present evaluation studies on the Great Artesian Basin are carried on with little reference to input from the Northern Territory areas. The margins of the GAB in the Territory provide useful quantities of good quality stock water. Intense storm rainfall on an infrequent annual basis provides rapid runoff and infiltration to these areas. Similarly, underflow in the Georgina Basin is southeast towards the GAB in Queensland. A basin analysis of the hydrodynamics of these two areas could provide a better understanding of the total GAB system.

Other Sedimentary Deposits

The distribution of this category is shown on Figure 3-18. In the southern half of the Territory these sediments consists of Tertiary and Quaternary fluvial basins and paleochannels, often with a calcrete or ferricrete capping overlying sands and clays. Where Recent river alluvium overlies the older sediments it becomes an integral part of the total reservoir. These areas have received some degree of drilling investigation because of their importance as relatively large reservoirs of good quality water in the arid zone for townships, irrigation, and mining support.

The Alice Springs town and farm areas of the Todd River were for many years the only source of domestic water and are considered as design evaluated. The Yulara township wellfield at Ayers Rock is at design evaluation level but the overall Tertiary sub-basin is marked as conceptually evaluated. A similar approach is taken for the Tertiary basins at Tea-Tree, Stirling and Willowra where design evaluation is limited to around small wellfields. The Tertiary palaeochannels in the Granites area are being investigated for a mine development water scheme. The Tennant Creek water source is partly from a Tertiary/Quaternary basin at Kelly Well, as is the Warrego Mine source.

Other Tertiary palaeochannels may exist around the margins of the Wiso Basin but have not yet been discovered.

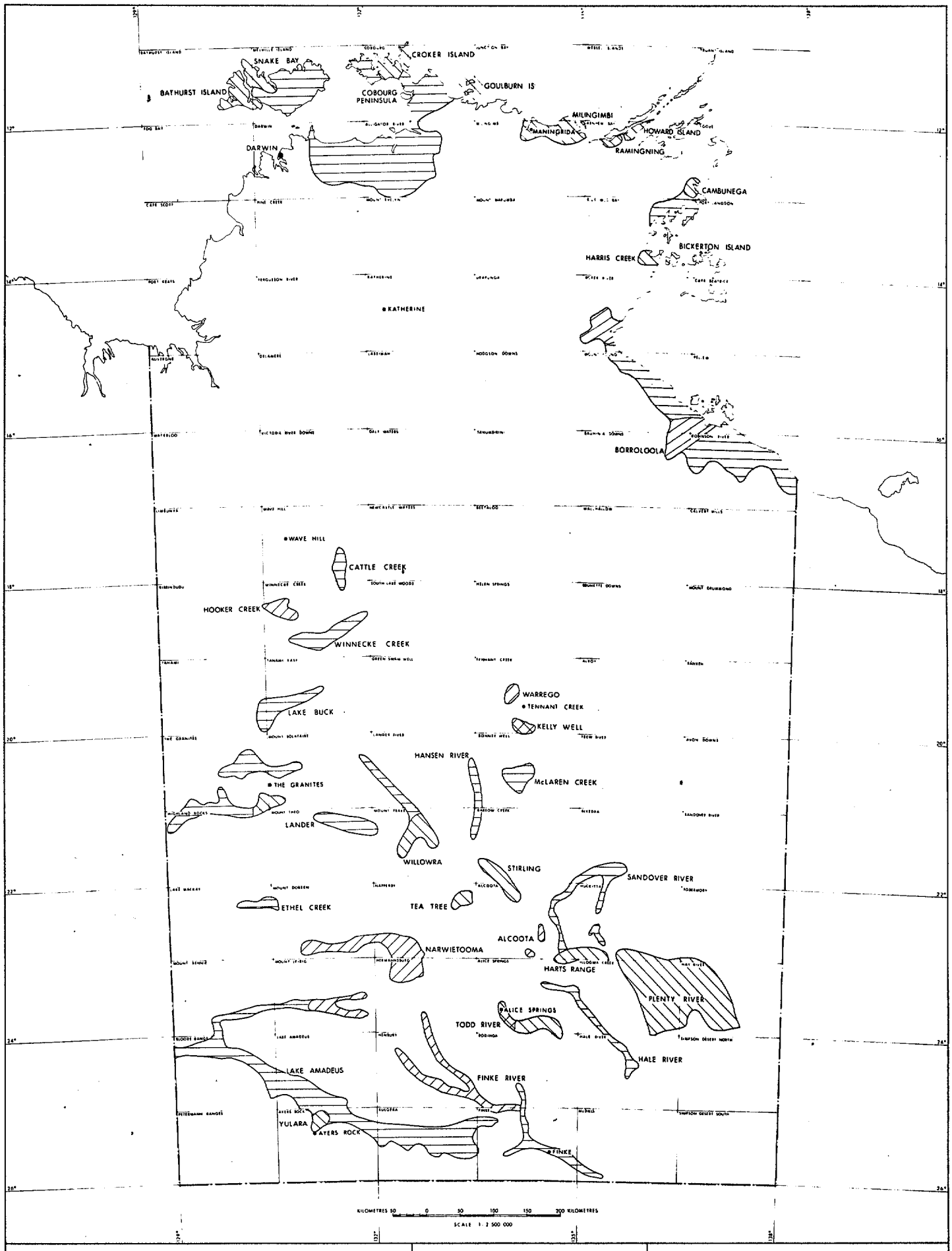
In the northern part of the Territory are included the Cretaceous coastal and island deposits which are gradational upwards into Tertiary and Quaternary sands. These provide water for the Gove bauxite mine, and townships sources for Bathurst Island, Croker & Goulburn Islands, Cobourg Peninsula, Maningrida, Milingimbi, Snake Bay and Elcho Island. Where developed these deposits are design evaluated. Elsewhere they are unknown.

3.3.7 Tasmania

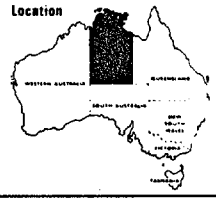
3.3.7.1 Classification Catagories

Fractured Rock Aquifers and Sedimentary Deposits

Fractured rock aquifer areas predominate in Tasmania, with sedimentary deposits occupying a smaller area. For this reason both are shown on Figure 3-19. The fractured rock areas in the western half of the State consist of predominantly Lower Proterozoic metamorphic and igneous rocks. Terrain is



Location



LEGEND

- UNKNOWN
- UNEVALUATED
- CONCEPTUALLY EVALUATED
- DESIGN EVALUATED

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NORTHERN TERRITORY
OTHER SEDIMENTARY DEPOSITS

FIG 3-18

FIG. 3_18

mountainous and well-watered and consequently there has been no groundwater development in this region. Hence the area is largely unknown.

Groundwater development occurs predominantly in the northern and eastern part of the State. Much of this area is underlain by Volcanic (Tertiary basalt) and intrusive rocks including also Permian and Triassic sediments.

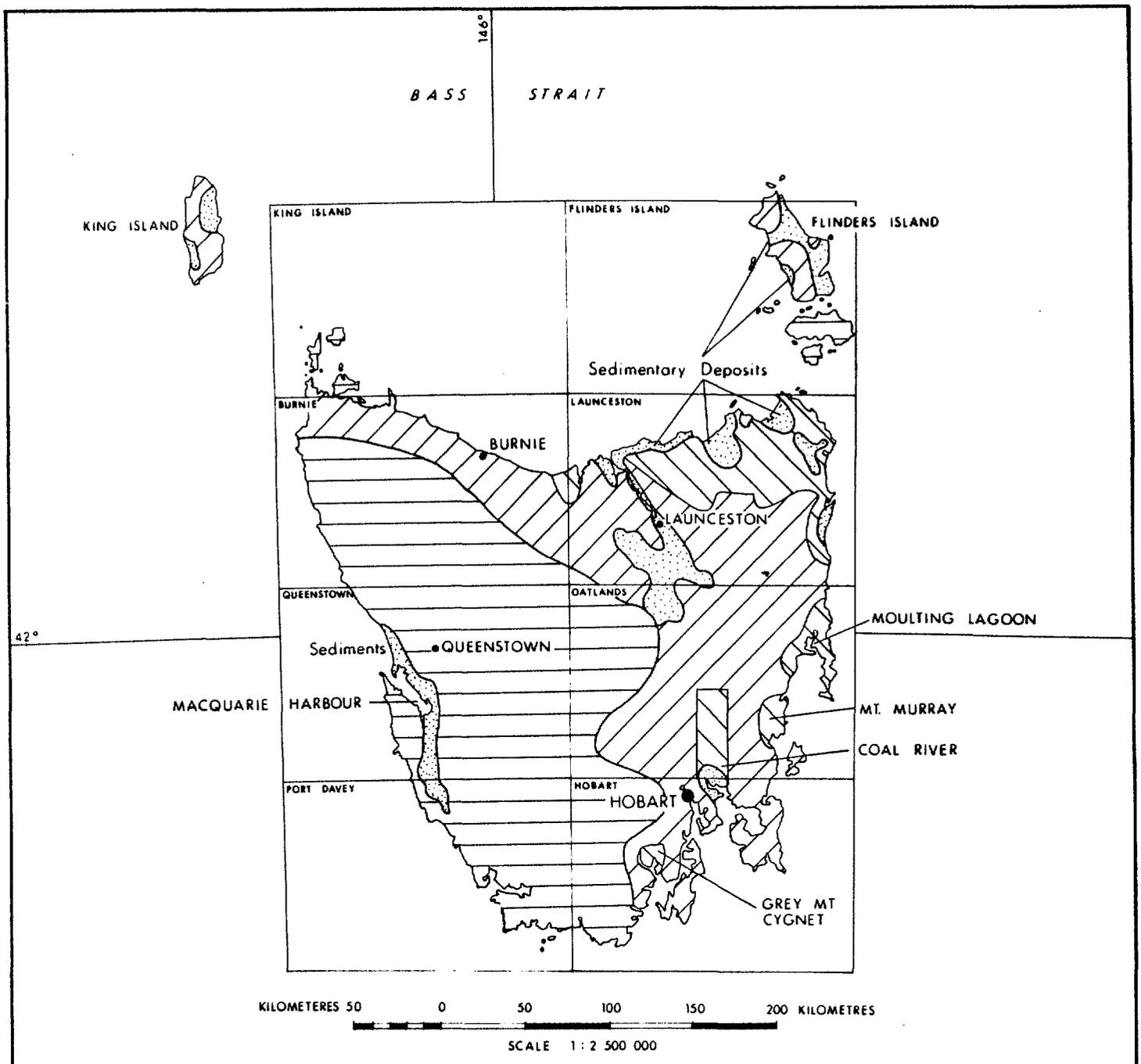
Major groundwater development has been from Tertiary basalt, Triassic and Permian sediments, and to a lesser extent from Cambrian rocks. The data from these regions have been unevaluated although statistical data on successful and unsuccessful bores have been produced by the Mines Department. Some 3000 bores have been sunk in the State including about 150 on King and Flinders Island although data on these are sketchy.

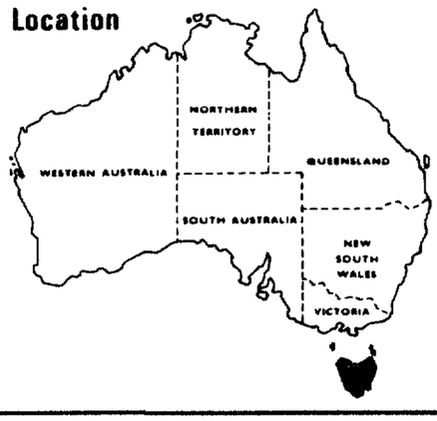
Groundwater can also be obtained from Tertiary sediments along Macquarie Harbour located on the west coast but the area is unevaluated.

Data in the northeast corner of the State are presently being compiled and this area has therefore been designated as conceptually evaluated. The conceptually evaluated area also includes the sedimentary deposits shown in Figure 3-19.

Immediately north of Hobart along the Coal River the area has been marked as conceptually evaluated and covers an area where intensive groundwater investigations have been completed and reports are being prepared.

It also includes an area surrounding and including Cygnet southwest of Hobart.





LEGEND

- UNKNOWN
- UNEVALUATED
- CONCEPTUALLY EVALUATED
- DESIGN EVALUATED

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Bureau of Mineral Resources

National Groundwater Data Base Inventory

TASMANIA

FRACTURED ROCK AQUIFERS & SEDIMENTARY DEPOSITS

FIG 3-19

4.0 RECONNAISSANCE AND EXPLORATION PROGRAM

Bore census, collection and collation of data on to 1:250,000 sheets and interpretation has been determined as the basic activity to fulfil the objectives of the forward program. The format of the end result map will depend on the amount of data available and its distribution to fairly represent the hydrogeology of a region. Accordingly we have assumed a number of mapping standards varying from a simple data information sheet into a detailed hydrogeological map. Detailed costs to produce these maps are given below. In summary, the mapping standards and costs are as follows:

- Full colour map plus field work	$63,000
- Full colour map with no field work	$45,000
- Black/White Map with Field Work	$42,000
- Black/White Map with no Field Work	$25,000
- Printing cost per map	$28,000

1. Full Colour Map plus Field Work

	COST
Supervising Hydrogeologist	7,800
Hydrogeologist	20,480
Sub-Professional	2,500
Field Expenses	4,000
Sub-Total (say)	$35,000

Probable range $30,000 to $40,000.

Printing Costs (Based on data supplied by BMR see below)

	28,000
TOTAL	$63,000

2. Full Colour Map with no Field Work

	COST
Supervising Hydrogeologist	6,240
Hydrogeologist	7,680
Sub-Professional	2,500
Sub-Total (say)	$17,000
Printing Costs	28,000
TOTAL	$45,000

3. Black/White map with field work. Cost similar

to full colour less colour printing process.

	say	$42,000

4. Black/White Map without field work

	say	$25,000

5. Printing Costs (Data from BMR)

Redrafting 2 to 3 weeks (Class 3-4)		2,500
Preparation/Costs Edit Layout Design 100 man days		12,000
		$14,500
Printing ($1000 per colour)		
	say	$13,000
	TOTAL SAY	$28,000

It is recognised that financial constraints on Commonwealth funding may require program recommended for the five year investigation to be curtailed. For this reason each State program recommended herein includes a priority ordering based in part on the program justification criteria set out in Section 3.1 of the report. The priorities have been determined by the consultants and have not been discussed with the State authorities.

4.1 SOUTH AUSTRALIA

Within South Australia there are two hydrogeological units which currently have unknown status. These are the South Australian portion of the Officer Basin, in the west of the State, and shallow palaeochannel aquifers which occur around the margins of the Great Artesian Basin in the central-north and northeast of the State and around the margin of the Officer Basin.

Neither area is completely covered by reliable bore census data, although some parts of the Great Artesian Basin have been surveyed in recent years.

4.1.1 Proposed Program (Figure 4-1)

4.1.1.1 Bore Census/Hydrogeological Data Sheets of the Officer Basin

By carrying out a bore census in the nine 1:250,000 sheet areas followed by interpretative analysis it may be possible to improve the level of knowledge from unknown to conceptually known at least on a local to semi-regional scale. Much of the area is inaccessible desert with internal drainage to shallow palaeochannel basins. These systems could be mapped from airphotos and satellite imagery and may be further investigated by ground survey around the basin margins where good quality water may exist. A large part of the area is owned by local aborigines and there is a need to improve the knowledge of the groundwater resource to provide the data necessary for selection of specific areas which could be developed. An allowance has been made for some shallow drilling in the area.

4.1.1.2 Hydrogeological Mapping of the Fluviatile System

The far northern region of South Australia is an area where groundwater information about shallow aquifers is regionally and often locally unknown.

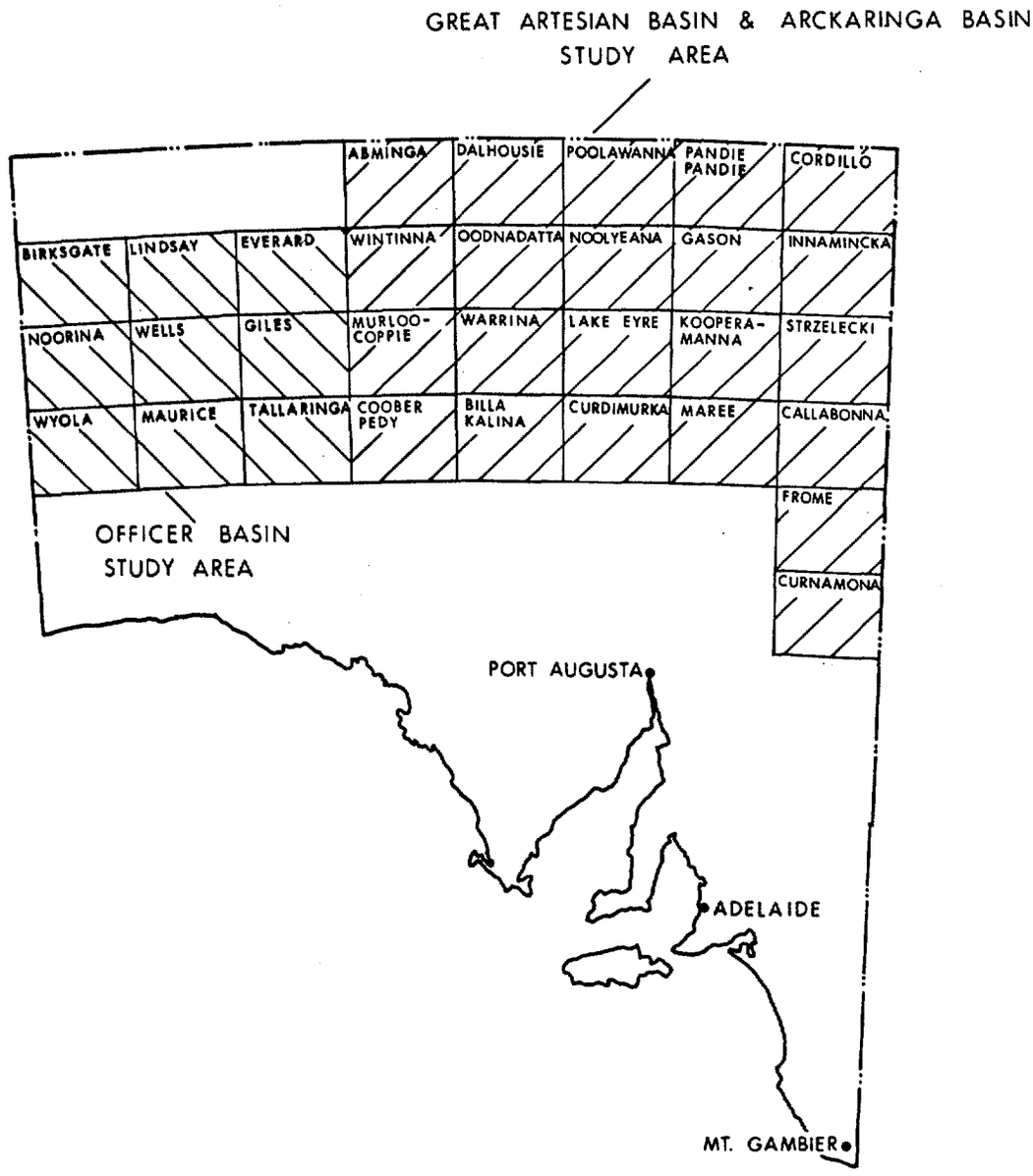
In a similar way to the proposed work in the Officer Basin this program involves bore census work around the margins of the GAB in areas in the central northern, the northeastern and eastern border areas of the State at 1:250,000 scale. About 22 sheets are included in this area of which 14 have been surveyed for bore data and for which data reports are available. The remaining 8 require surveys to be carried out. One sheet, Poolowanna could possibly be omitted since it lies within the Simpson Desert; the adjacent east and west sheets have already been surveyed and could be included.

4.1.1.3 Shallow Drilling Program

This work should follow the hydrogeological mapping and is intended to check interpretations of that program.

4.1.2 Objectives

To carry out bore surveys and then collate all data to produce hydrogeological maps or data sheets of the Officer Basin and



1 : 250 000 MAP SHEET AREAS FOR PROPOSED INVESTIGATION

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SOUTH AUSTRALIA
PROPOSED STUDY AREAS

FIG 4-1

Great Artesian and Arckaringa Basin regions so as to upgrade the status of the shallow aquifers from unknown to conceptually known. Also to prepare maps or data sheets for the main aquifers of the Great Artesian Basin.

4.1.3 Criteria Assessment

Both the Officer, Great Artesian and Archaringa Basins areas have State importance and extend sufficiently far across State borders to have National importance as well.

It should be possible to upgrade the status of shallow aquifers from unknown to conceptually known, or at worst to unevaluated if sufficient data are available at the conclusion of field work. It is not expected that the status of the main Great Artesian Basin aquifers will change as a result of this work, but the compilation of data and map production will in itself be beneficial in making data for assessment work more readily available.

The immediate benefits will be in making assessments of groundwater potential in two large areas of the State in which shallow groundwater conditions are unknown. There may be subsequent benefits for pastoral and aboriginal water users in the short to medium term, following collation and publication of the data.

4.1.4 Methodology

1. Carry out bore census work in map areas not covered, select possible drilling sites, and carry out limited exploration drilling.
2. Assess existing reports and other data and collate into 1:250,000 hydrogeological maps or data sheets, with explanatory notes.

4.1.5 Staffing

Some 31 1:250,000 sheets have been identified for the program, of which 17 require a field survey. It is unlikely that more than 8 would become final full colour maps, these being in areas where the hydrogeology of the main Great Artesian Basin system is well known. The majority would probably be produced as black and white data sheets.

One contract hydrogeologist would be required (approximately 3 man years) plus two sub-professional staff. There are several sub-professional field staff in the South Australian Department of Mines & Energy with ample competence to carry out the field work, and their familiarity with working in remote parts of the State is such that it would be beneficial to use them for that purpose. Hydrogeological input to the field work could be restricted to familiarisation visits.

4.1.6 Costs

Mapping

Assuming that 8 full colour hydrogeological maps produced (of which 6 have bore census data available) and the remaining 23 appear as black and white data sheets (of which 8 have bore census data available) the total cost would be as follows:

8 colour maps (1:250,000)	
2 @$63,000 each, 6 at $42,000 each	$378,000
23 black & white sheets (1:250,000)	
15 @$45,000 each, 8 at $25,000 each	$875,000
	$1,253,000

Drilling

	$
Supervising Hydrogeologist	15,000
Contract Hydrogeologist	20,000
Drilling 15 bores x 50 m	75,000
Testing, etc.	30,000
Upgrade Maps	6,000
Mobilisation	20,000
TOTAL	166,000

4.1.7 Expected Results

Once the work is completed explanatory notes for maps or data sheets should be available for the South Australian sections of the Great Artesian Basin and the Officer Basin. It is likely that data for the shallow groundwater in all of the basins studied will be scant, but even that should be a major improvement on the current situation.

The marginal areas of the Great Artesian Basin should be collated to the coloured hydrogeological map stage which will be a vast improvement on the current data accessibility.

4.1.8 Priorities

In the event that funding is constrained, then priority should be given to the Great Artesian and Archaringa Basin study areas since the resources in these areas are more likely to be placed under development stress than the Officer Basin. In addition the GAB studies will coordinate with the NSW and Queensland studies.

4.2 NEW SOUTH WALES

Within New South Wales there are areas of unevaluated fractured rock and riverine drainage system aquifers extending across 13 1:250,000 sheets in the centre of the State within which abundant bore census information is available. There is also an area of 13 1:250,000 sheets in the northwest of the State for which the aquifers, within both fractured rocks and riverine drainage

systems, are unknown or unevaluated, and for which bore census data need to be obtained. Some of these sheets also contain the major inland drainage systems which have been previously funded under the Federal/State program.

4.2.1 Proposed Program (Figure 4-2)

Hydrogeological Mapping of the Central Fractured Rock Province and Riverine Drainage Systems including the Murray Basin

1. Areas where bore data are available.
   It is proposed to evaluate the data available in those 13 1:250,000 sheet areas which extend north from the Victorian border in the centre of NSW.
2. Areas where bore data need to be collected.
   It is proposed to carry out a bore census within the 1:250,000 sheets in the northwest of the State, followed by evaluation of the data.
3. Drilling in the Murray Basin to evaluate the deeper sedimentary sequences.

It is envisaged that the work will be carried out over a period of five years commencing with the more remote areas in the northwestern corner of the State.

4.2.2 Objectives

To collate all data whether currently available or collected by bore census in order to produce (1) hydrogeological maps in the riverine plains and fractured rock areas of central NSW and (2) hydrogeological data sheets in similar areas in the northwest of the State. The latter sheets will include the aquifers of the Great Artesian Basin, in accord with similar proposed programs in adjacent areas of Queensland and South Australia. All would be accompanied by explanatory notes. The drilling program will supplement the work presently being carried out by the BMR on the Murray Basin.

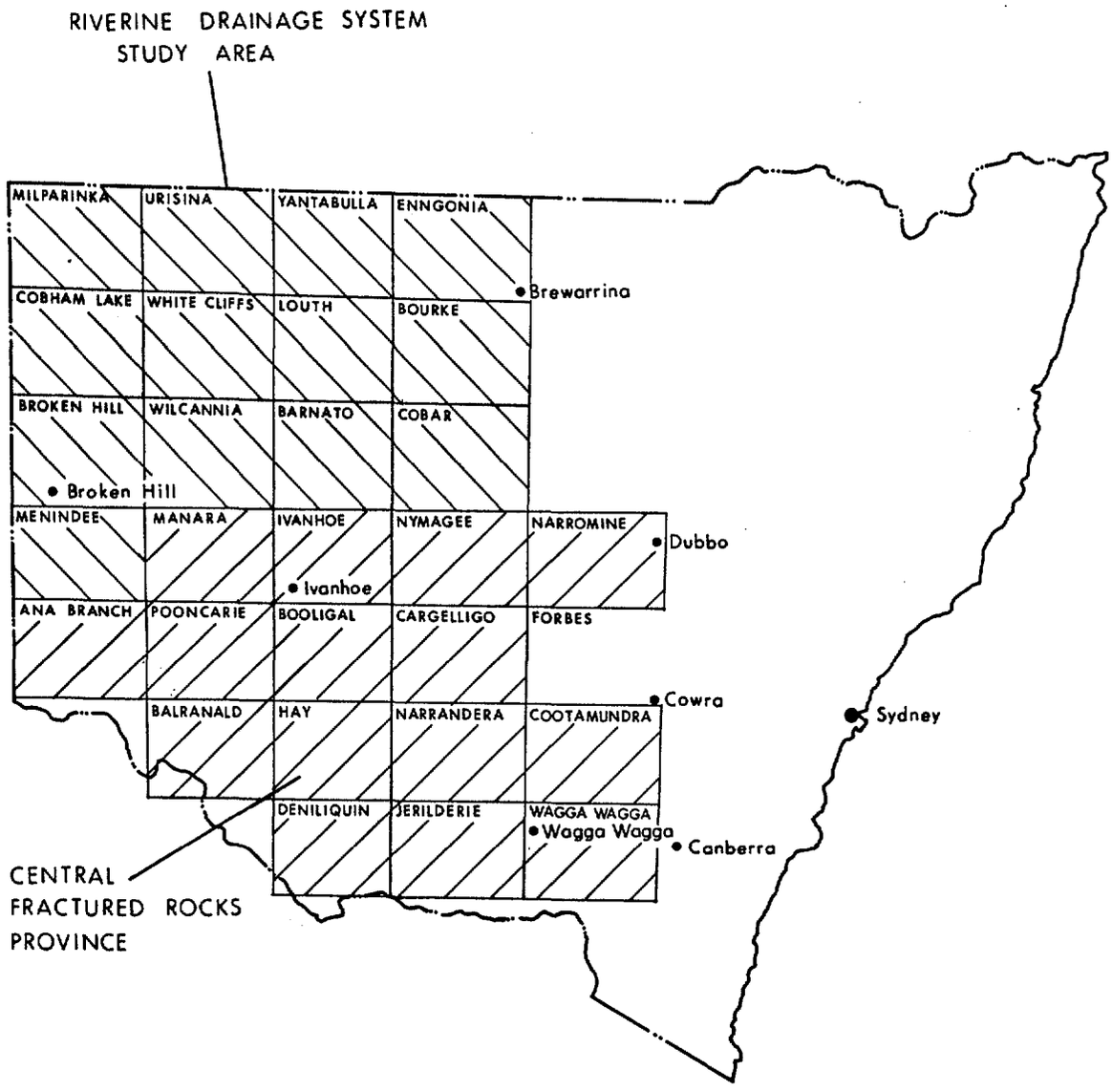
4.2.3 Criteria Assessment

Both inland and fractured rock areas of central NSW and the north west areas have State importance, and the northwestern areas is of National importance when considered in conjunction with adjacent interstate areas.

The central area warrants evaluation in order to make available the large amounts of uncollated, unevaluated information which has been collected over the years.

In addition, data from the Murray Basin should be collected. This task is presently being undertaken by the BMR Hydrogeology Group. The 1:250,000 maps covering the basin are being used as the base map for compilation of information.

Although this study has started the maps have been included for completeness. It may be necessary to adjust the final cost to allow for the bore census and interpretation work completed once the present program commences.



1 : 250 000 MAP SHEET AREAS FOR PROPOSED INVESTIGATION

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NEW SOUTH WALES

PROPOSED STUDY AREAS

FIG 4-2

It should be possible to upgrade the central area from unevaluated to conceptually known, and the riverine aquifers from unknown to unevaluated or conceptually known. The drilling program in the Murray Basin will upgrade the deeper sediments of the basin from unknown to conceptually known.

4.2.4 Methodology

1. Carry out bore census work in the map areas not covered.
2. Assess existing reports and other data and collate into 1:250,000 hydrogeological maps and data sheets, with explanatory notes.
3. Carry out deep drilling program in the Murray Basin.

4.2.5 Staffing

1. Central area
   On contract hydrogeologist, part-time supervisor and sub-professional assistance would be required.
2. North-west area
   Two contract hydrogeologists, part-time supervisor and sub-professional assistance would be required.
3. Drilling
   One contract hydrogeologist plus sub-professional. Staff would be available from the BMR to carry out this work.

4.2.6 Costs

Mapping

13 hydrogeological maps (1:250,000) @$42,000 each	$ 546,000
13 hydrogeological data sheets 1:250,000) @$45,000 each	$ 585,000
	$1,131,000

Drilling (Murray Basin)

Supervising Hydrogeologist	15,000
Contract Hydrogeologist	20,000
Drilling 8 Bores x 300 m	240,000
Testing	20,000
Mobilisation	20,000
	$315,000

4.2.7 Expected Results

In the central area the work will result in proper evaluation and publication in hydrogeological map form of a large amount of data which is currently held as individual bore records.

In the north-west the riverine drainage system aquifers, some fractured rock aquifers and main Great Artesian Basin aquifers will be surveyed and the results presented in the form of hydrogeological data sheets. This will integrate with similar

sheets being prepared in adjacent areas of South Australia and Queensland to provide coverage over much of the southwestern part of the Great Artesian Basin, much of the overall area being in the Lake Eyre drainage basin.

The drilling in the Murray should allow a better assessment of the deeper aquifers of the Murray. The hydrodynamics and hydrogeochemistry of these systems are presently unknown.

4.2.8 Priorities

If funding is limited it is recommended that the program of evaluation and bore census around the margins of the Murray and GAB should be carried out and the drilling in the Murray Basin be held over or undertaken within other project budgets. This ordering of priorities will contribute a better understanding of the two basins which are of major national importance as well as presenting opportunities for arid zone recharge studies to those basins. If the costs need to be further reduced then the bore census and data collations should be concentrated along the South Australian and Queensland Borders so long as the central fractured rock belt in the west of the State is covered.

4.3 VICTORIA

4.3.1 Proposed Program

AGC suggest that three 1:250,000 sheets in Victoria be compiled as hydrogeological maps. These include the following (see also Figure 4-3).

Priority No. 1	St. Arnaud
Priority No. 2	Ballarat
Priority No. 3	Hamilton

The three sheets are adjoining and straddle the western end of the Great Dividing Range in Victoria.

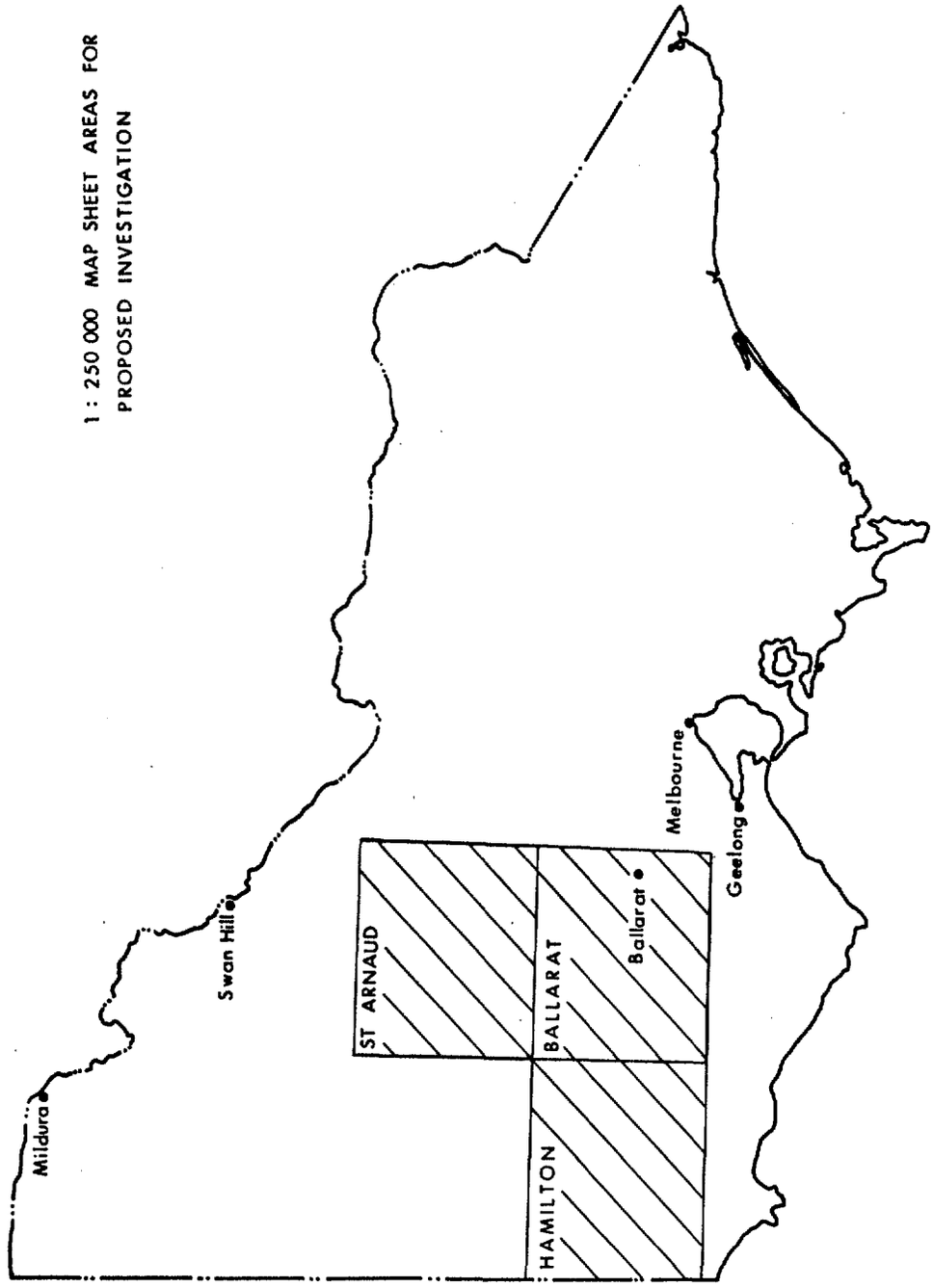
These three 1:250,000 sheets have a data base which is in part held within the DME (now DITR) bore records and early mining report (Goldfields) files and which exists in the field in stock and domestic water supply bores drilled prior to the proclamation of the Groundwater Act in 1969. In addition drilling of 3 deep bores in the Murray Basin is recommended. This work will complement that proposed in NSW and provide information on the deeper aquifers in the basin which are presently unknown.

4.3.2 Objectives

The aim of the program is to upgrade the resource classifications from unknown or unevaluated to conceptually known. This will then be equivalent to the status of adjacent areas to the north, west and south.

4.3.3 Criteria Assessment

The three sheets are seen as being justified on a national basis because the hydrological and hydrogeological processes operating



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VICTORIA

PROPOSED STUDY AREAS

FIG 4 - 3

are either unknown or unevaluated and yet they affect the water resources available in two interstate basins and thereby the water resources of three States namely-

NSW - Southwest
VIC - Northwest and southwest
SA - Southeast

Whilst larger areas of the State are less well known, this area because of its position relative to rural population, intensive agriculture and industrial centres (e.g. Ballarat, Stawell and Maryborough) is placing demands and stresses on water resources which affect much larger adjacent areas, e.g. salinity in the Murray Basin and Otway Basin, water demands for Geelong and the Murray irrigation area.

There are known to be many bores in the area that are not in the files though the files are substantial and valuable. The cost is reasonable against the result.

The area has existing problems with being drought prone. Urban and rural water supplies need to be improved and groundwater irrigation will be practiced if suitable water resources can be proven in association with suitable soils.

With an established population and reasonable soil resources the results of the survey can be expected to be employed quickly and potentially with long term benefits to the communities and downstream land holders (e.g. water table problem alleviation).

It is concluded these three 1:250,000 map sheets and the programs meet the requirements of the federal project in every aspect as well as serving the community needs.

The drilling proposed in the Murray Basin will enable some section of the deeper aquifer to be upgraded from unknown to conceptually known.

4.3.4 Methodology

The work program involves initially a data search and collation exercise within the DME and RWC files and a culling to obtain only reliable full information for plotting of groundwater occurrence, quality, use and dynamics (flow rates, recharge, discharge etc.). Stream flow records would be evaluated as to baseflow and salinity.

Thereafter a field data collection program would be undertaken to get adequate data in the areas of need, including well yield, water level, water quality and dynamics.

4.3.5 Staffing

One contract hydrogeologist, part-time supervisor and sub-professional assistance would be required.

4.3.6 Costs

Mapping

3 colour hydrogeological maps (1:250,000) @$63,000 each	TOTAL $189,000

Drilling (Murray Basin)

Supervising Hydrogeologist	5,000
Contract Hydrogeologist	18,000
Drilling 3 bores x 500 m	150,000
Testing	8,000
Mobilisation	4,000
	185,000
	$374,000

4.3.7 Priorities

The Victorian program is quite small by comparison with the needs of other States but if it were necessary to reduce the program back it should be the drilling which is deleted since it is likely that this will be covered by other programs. This will as in NSW entail a loss of data on the hydrodynamics and salt mass transport evaluation of the basins and should if possible be carried out at a later date.

The collection and collation of data from the Ballarat and St. Arnaud 1:250,000 sheets will however markedly improve the understanding of recharge to the Murray and Otway Basins as well as assist in defining the resources in an area which may be developed in the near future for its gold and other minerals.

4.4 QUEENSLAND

4.4.1 Proposed Program (Figure 4-4)

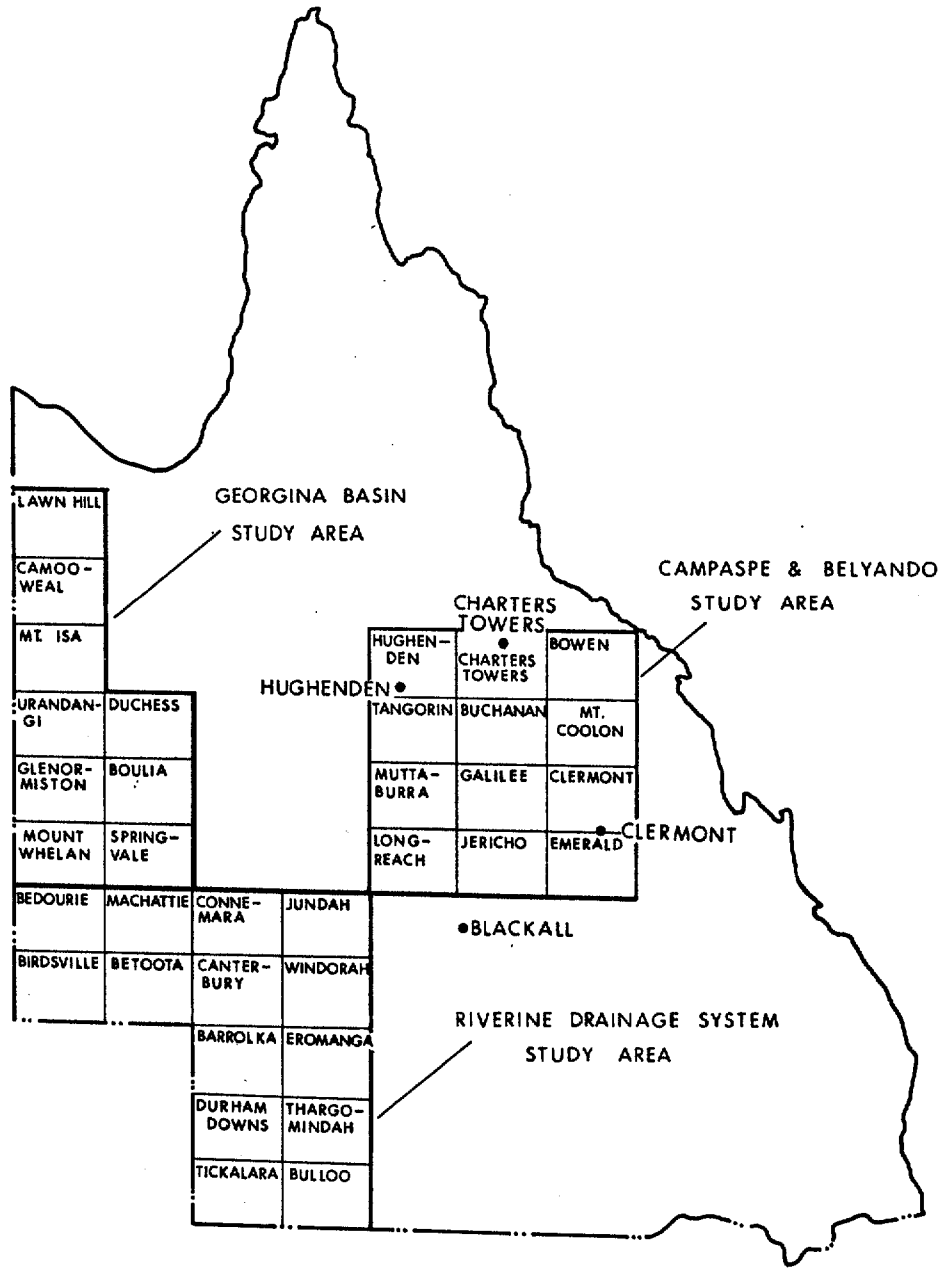
4.4.1.1 Hydrogeological Mapping of Central-Eastern Section of Queensland

This area is important for mining and may have irrigation potential from the Campaspe and Belyando shallow sedimentary aquifer systems, which are largely unknown to unevaluated. There is a need to collate existing data for presentation, and to upgrade the data with a new bore census.

The area contains 12 1:250,000 sheets and is bounded approximately in the north by Charters Towers, in the south by Blackall, to the west by Longreach and by Clermont to the east (see Figure 4-4).

4.4.1.2 Objectives

To carry out bore surveys and limited investigative drilling in order to upgrade knowledge of the sedimentary aquifer systems from unknown to conceptually known.



1 : 250 000 MAP SHEET AREAS FOR PROPOSED INVESTIGATION

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QUEENSLAND
PROPOSED STUDY AREAS

FIG 4-4

4.4.1.3 Criteria Assessment

In view of existing and potential developments in the area this work has both State and National importance. A relatively modest input should demonstrate whether the groundwater potential of these aquifer systems is significant. Subsequent benefits for farmers or major devlopment projects should follow collation and publication of the data.

4.4.1.4 Methodology

1. Carry out bore census work in the 12 1:250,000 map sheets.
2. Drill up to 15 shallow test bores within the Tertiary basin deposits to test for yield and water quality.
3. Assess existing reports and other data and collate into 1:250,000 hydrogeological maps or data sheets together with explanatory notes.

This program would serve to identify the groundwater potential which could be followed up by a more detailed drilling program in a Federal/State co-operative program.

4.4.1.5 Staffing

One contract hydrogeologist would be required for about 2 years to carry out the work plus sub-professional and supervising hydrogeologists to assist in collection, collation and interpretation of the data.

Twelve 1:250,000 sheets have been identified for the program, all of which require a field survey.

4.4.1.6 Costs

Mapping

Assuming that all 12 sheets would be published as black and white data sheets the cost would be:

12 black and white sheets (1:250,000) @$45,000 each	$540,000

Drilling

Supervising Hydrogeologist	15,000
Contract Hydrogeologist	20,000
Drilling 15 bores x 50 m	75,000
Testing, etc.	30,000
Upgrade Maps	6,000
Mobilisation	20,000
	$166,000
	706,000

4.4.1.7 Expected Results

Once the work is completed explanatory notes for maps or data sheets should be available for the entire area of shallow sedimentary aquifers in the Campaspe and Belyando drainage systems. It is possible that data for the shallow groundwater in some of the area studied will be scant, but given the drilling program there will be a major improvement on the current situation.

4.4.2.1 Georgina Basin Study

The data need to be integrated within work already done in Queensland and Northern Territory. The area has potential for stock, industry and mining.

4.4.2.2 Objectives

To carry out bore surveys in areas not previously covered and to integrate information collected in previous studies of the region together with data in the Northern Territory.

4.4.2.3 Criteria Assessment

A considerable amount of data already exists for most of this basin, however it needs to be integrated. Once this is done the hydrodynamics of the basin can be studied in more detail. The Basin is considered to be of National importance.

4.4.2.4 Methodology

1. Carry out bore census work in map areas not yet covered.
2. Assess existing reports and other data and collate into 1:250,000 hydrogeological maps or data sheets, with explanatory notes.

4.4.2.5 Staffing

One contract hydrogeologist would be required for about 18 months to carry out the work plus supervising hydrogeologist and sub-professional.

4.4.2.6 Costs

Assuming that 9 1:250,000 sheets would be produced, 3 of them as colour hydrogeological maps and 6 as black and white data sheets, and that the 3 maps would be produced from areas already covered by bore census work, the cost would be:

3 colour maps (1:250,000) @$42,000 each	$126,000
6 black and white sheets (1:250,000) 2 @$45,000 each, 4@$25,000	$190,000
	$316,000

4.4.2.7 Expected Results

The study will provide a clear indication of the state of knowledge about the Queensland portion of the Georgina Basin, as an extension of the work being undertaken in the Northern Territory, and should upgrade the status from unknown to unevaluated, with respect to both shallow and deep aquifers.

4.4.3.1 Hydrogeological Mapping of the Riverine Drainage Systems

The southwest region of Queensland is an area where groundwater information about shallow aquifers associated with ancestral river systems is regionally and often locally unknown.

In a similar way to the proposed work in South Australia this program involves data interpretation in areas in the southwest border area of the State at 1:250,000 scale. Fourteen sheets are included in this area all of which have been surveyed for bore data.

4.4.3.2 Objectives

To collate all data to produce hydrogeological maps or data sheets of the Great Artesian Basin in the study area so as to upgrade the status of the shallow aquifers from unknown to conceptually known whilst also preparing maps or data sheets for the main aquifers of the Great Artesian Basin.

4.4.3.3 Criteria Assessment

The area has State importance and extends sufficiently far across State borders to have national importance as well.

It should be possible to upgrade the status of shallow aquifers from unknown to conceptually known, or at worst to unevaluated if insufficient data are available at the conclusion of field work. It is not expected that the status of the main Great Artesian Basin aquifers will change as a result of this work, but the compilation of data and map production will in itself be beneficial.

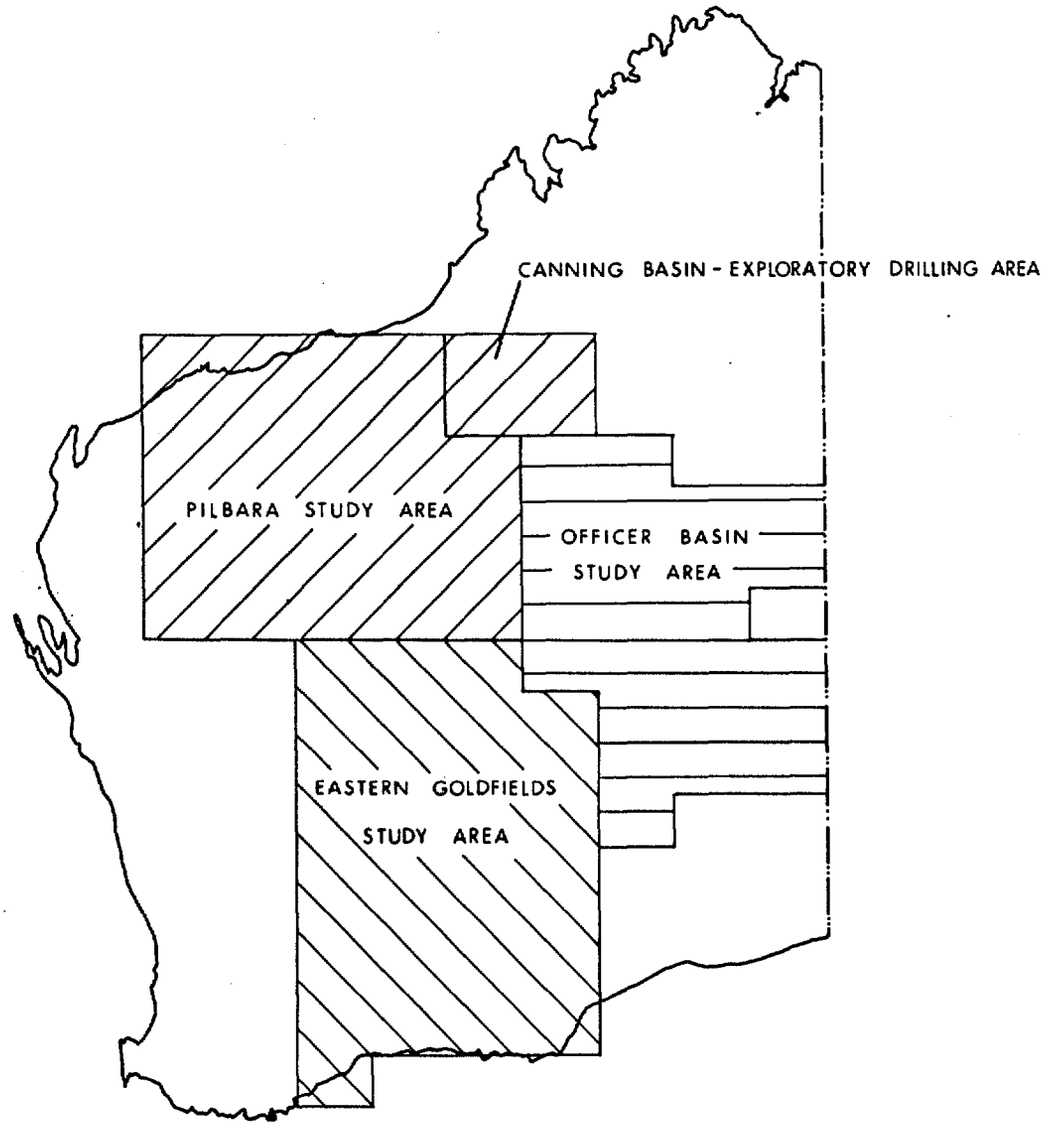
The immediate benefit will be making an assessment of groundwater potential in an area of the State in which shallow groundwater conditions are unknown. There may be subsequent benefits for pastoral and other water users in the short to medium term, following collation and publication of the data.

4.4.3.4 Methodology

Assess existing reports and other data and collate into 1:250,000 hydrogeological maps or data sheets, with explanatory notes.

4.4.3.5 Staffing

One contract hydrogeologist could carry out the work in about 1.5 years, with some sub-professional assistance in collating and compiling the data.



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WESTERN AUSTRALIA

PROPOSED STUDY AREAS

FIG 4-5

4.4.3.6 Costs

Mapping

Assuming that twelve of the fourteen 1:250,000 sheet areas (all but Bedourie and Machattie) will have sparse data from which only hydrogeological data sheets will be prepared, the costs would be:

2 colour (1:250,000) @$45,000 each	$90,000
12 black & white sheets (1:250,000) @$25,000 each	$300,000
	$390,000

4.4.3.7 Expected Results

Once the work is completed explanatory notes for maps or data sheets should be available for the Queensland section of the Great Artesian Basin adjacent to the South Australian study area. It is likely that data for the shallow groundwater in part of the area studied will be scant, but even that will be a major improvement on the current situation.

Two 1:250,000 sheets of the Great Artesian Basin should be collated to the coloured hydrogeological map stage and 12 sheets should reach the hydrogeological data sheet stage, which will be a vast improvement on the current data accessibility.

4.4.4 Priorities

The threefold program recommended for Queensland covers three distinctly different environments of which AGC believe the priorities should be directed toward the hydrogeological mapping of Central-Eastern Campaspe and Belyando area and the Georgina Basin study area. This priority is applied on the grounds of need and national significance. The Campaspe Belyando areas lie in a region where competition for water resources is developing between industry and agriculture, and the Georgina Basin is a large interstate basin having significance to the water resources of Queensland, NT and SA. By comparison the status of the shallow aquifers over the GAB sediments is less immediately important.

4.5 WESTERN AUSTRALIA

4.5.1 Proposed Projects

In Western Australia there is a need to collate existing groundwater data from fractured rock provinces and present these data in comprehensive hydrogeological maps accompanied by supplementary explanatory notes.

The priority areas include two regions which are of national significance and where much of the data has been unevaluated. These two areas include (Figure 4-5):

. The Eastern Goldfields
. The Pilbara Region

The projects should be carried out consecutively and ultimately provide complete coverage of fractured rock provinces in Western Australia.

4.5.1.1 Eastern Goldfields Project

Currently available groundwater data in this region are fragmented and dispersed and need to be consolidated to improve the knowledge of the occurrence of groundwater resources and to allow for its development. Saline and hypersaline groundwaters are of value to the mining industry in this region and need to be considered together with better quality waters.

4.5.1.2 Objectives

To collate bore census data from about 10,000 bores and wells; data in numerous consultants reports, and historic data. From this information, produce hydrogeological maps generalising the hydrogeological data, produce accompanying explanatory notes with descriptions and assessments of the groundwater resources.

The area is subject to a level of development of national significance. The map and publication would therefore be of immediate benefit to the mining industry and to pastoralists, and other interested groups or individuals.

4.5.1.3 Methodology

1. Prepare base hydrogeological maps utilising existing bore data and geological mapping, to delineate the aquifer systems, water table, salinity and yield data; using where possible 1:250,000 scale maps as a working base.
2. Carry out further bore census work if required.
3. Prepare larger scale maps using 1:250,000 maps or data sheets as the basic building blocks.

4.5.1.4 Costs

About 32 1:250,000 sheets would need to be utilised. Assuming say 10 require no bore census the costs would be as follows:

10 Black & White Maps (no bore census) @$ 25,000 each	$250,000
22 Black/White Hydrogeological Maps & Data Sheets @$42,000 each	$924,000
	$1,174,000

If these maps are combined into say 5 1:500,000 sheets and allowing $20,000 for full colour production an additional $100,000 should be added to the above.

4.5.1.5 Staffing

It is proposed that up to 4 contract hydrogeologists be employed to undertake the project.

Two sub-professional staff would be required for routine plotting and possibly additional bore census work.

The work would be under the supervision of a senior hydrogeologist of the Geological Survey or alternative who would be responsible for map presentation scheduling, and ensuring the work is completed on time.

4.5.2.1 Pilbara Region Project

The objectives, methodology, staffing work program and costs would be similar to the Eastern Goldfields Project.

4.5.3.1 Canning and Officer Basins

Additional areas for investigation in order of priority include the Canning Basin, and surficial deposits of the Officer Basin.

Virtually no useful groundwater data are available in the central regions of the Canning Basin, although it is known that it is potentially a vast groundwater resource.

The cost of comprehensive deep drilling program within the Basin is beyond the scope of the Inventory program. However, some preliminary bores could allow significant evaluation of this region if selected properly.

An extended program of investigation is proposed in Section 5.0 of this report.

Surficial aquifers which include possible palaeochannel fluviatile systems within the Officer basin are important. Mapping, and some shallow drilling is suggested here to improve the knowledge of these areas. The status of knowledge of shallow groundwater in this basin could be upgraded from the unknown to the locally evaluated stage by undertaking this work.

4.5.3.2 Proposed Program

1. It is recommended that 2 deep bores and 5 shallow holes be sunk in the Canning Basin at suitable selected sites to test for both yield and water quality. The drilling could be carried out within the area delineated within part of the basin shown in Figure 4-5 for the Canning Basin. The drilling program should follow on from the hydrogeological mapping to be undertaken in the Pilbara Project.

2. Two deep bores be sunk in the Officer Basin at suitable selected sites.

4.5.3.3 Methodology

1. On the basis of the Pilbara hydrogeological mapping extended

into the Canning Basin select two specific bore sites. Select a further five bore sites to test shallower groundwater systems on the margin of the basin.

2. Select two bore sites in the Officer Basin to test yield and salinity variation in the deeper aquifer systems.
3. Drill all bores and carry out pumping tests of short duration and determine water quality variations.

4.5.3.4 Staffing

It is proposed that a hydrogeologist and one sub-professional be available to carry out the work plus a supervising hydrogeologist.

It is expected that the work would be completed within a period of 6 months from the date of commencement.

Costing	$
Supervisor	5,000
Contract hydrogeologist	15,000
Technical assistant	10,000
Field expenses	6,000
Drilling 4 bores x 300 metres	240,000
10 bores x 50 metres	100,000
Pump testing, etc.	20,000
TOTAL	396,000

4.5.4 Priorities

The priorities for investigation programs in W.A. are clearly in the order

Eastern Goldfields
Pilbara Region
Canning Basin
Officer Basin.

Three programs for the Canning and Officer Basins are set out separately (Section 5) and are considered to be very important nationally. These are not however seen as being as critical or immediate as those surrounding the Eastern Goldfields and Pilbara Region.

4.6 NORTHERN TERRITORY

4.6.1 Proposed Program

In the Northern Territory as in other States there is a need to collate hydrogeological data into map form. Figures 3-16 to 3-18 show the status of available knowledge and indicate the regions where attention should be focused. The areas marked as unevaluated are the most likely for the production of meaningful hydrogeological data sheets or hydrogeological maps. In areas marked as unknown the data are either scarce or do not exist and it would be pointless in attempting to map these regions since it would not be possible to upgrade from unknown to conceptually known status without extensive drilling.

Assessment indicates the following areas (see Figure 4-6) where compilation and collation of existing information should be attempted.

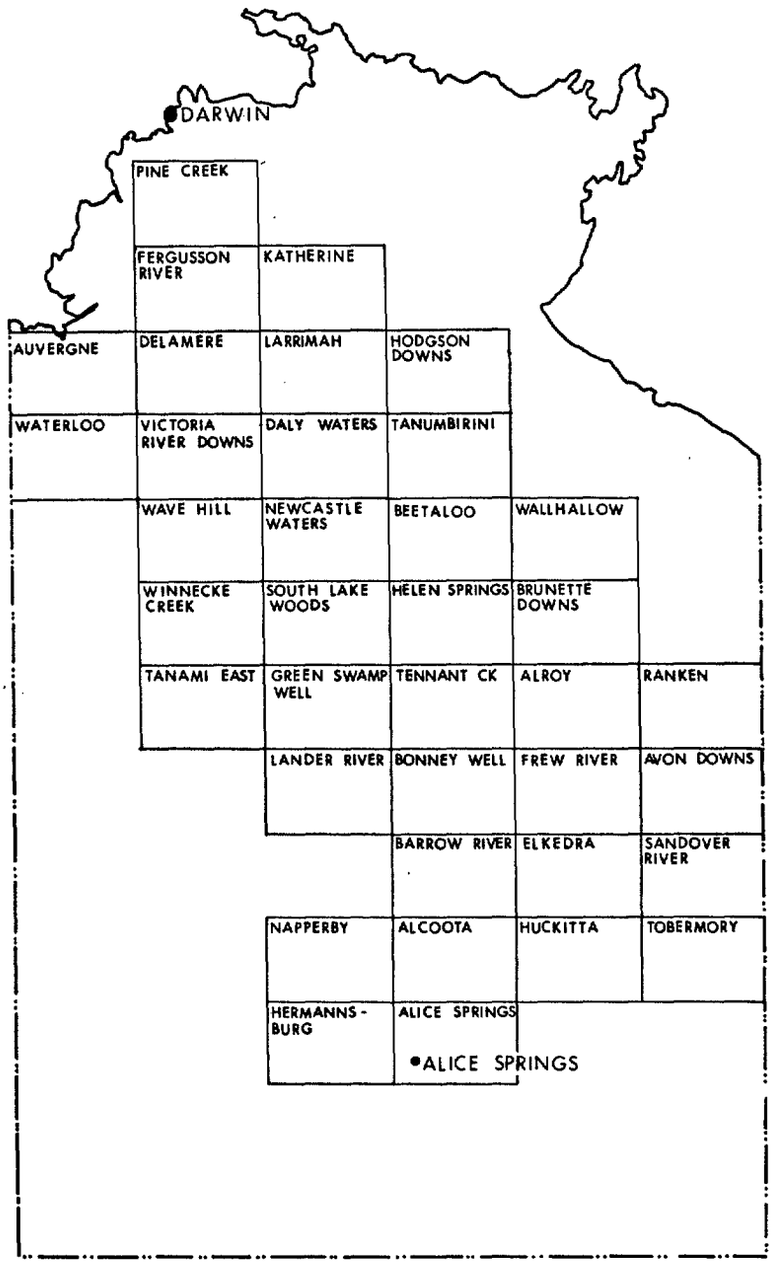
1. The Ord/Victoria River Basin.
2. Pine Creek Geosyncline.
3. The Tennant Creek Geosyncline Belt.
4. The central and eastern Arunta Block.
5. Central and eastern Amadeus Basin and margins of GAB.
6. Sandover River area of Georgina Basin.

The Pine Creek Geosyncline is marked as unknown but where specific areas of investigation have taken place there are important groundwater sources developed to a design evaluated stage. Because of its closeness to Darwin, to new mining development, and to the agricultural potential of the coastal plain, it warrants further investigation. Data from the design evaluated areas could be collated with stock and domestic bore data to produce data maps and a preliminary hydrogeological evaluation. The high yields from the cavernous dolomites around the edge of the coastal plains could be a valuable irrigation source.

The Daly River Basin is marked as unevaluated but all existing data have already been collated plus a traverse line of drillholes installed across the Basin. On a basin scale the evaluation completed is adequate for the data available. The area has importance for irrigation development but will require extensive drilling to upgrade to conceptually evaluated status.

Mapping and hydrogeological analysis of the intake areas of the GAB, particularly along the Plenty, Hay, Illogwa, Hale, and Finke Rivers would provide significant input to a better understanding of the GAB on a National scale.

Sufficient data are available in most areas of the Georgina Basin to consider it as a complete hydrogeological unit. This basin is known to contain deeper aquifers which are as yet untapped. Very little is known about these aquifers. To investigate the deeper aquifers will require a suitable drilling program which extends beyond the suggested budgets of the program. However, we believe at least one deep test bore should be drilled in the basin at a suitable site to demonstrate the aquifer potential. Although



1 : 250 000 MAP SHEET AREAS FOR PROPOSED INVESTIGATION

Australian Groundwater Consultants Pty Limited.

Bureau of Mineral Resources

National Groundwater Data Base Inventory

NORTHERN TERRITORY

PROPOSED STUDY AREAS

FIG 4-6

little use is made of the deeper aquifers, the potential is such that the basin could by analogy be considered as a smaller unexplored version of the Great Artesian Basin.

Much of the data on the Georgina Basin have been published; however we believe that all data should be transferred to the Intergraph system (including the Queensland portion) so that a complete hydrogeological map of the basin could be produced using 1:250,000 hydrogeological maps as the basic unit of data collation.

Colour map production at 1:250,000 scale using the final hydrogeological legend may also be warranted.

The completion of mapping of this basin together with that proposed in Queensland, will enable a more complete evaluation to be made. Further study could then be continued by the BMR Hydrogeology Group of the hydrodynamics of the system.

4.6.2 Objectives

To map areas of the Territory using where possible 1:250,000 scale maps by collecting/collating existing data in specific identified areas. To interpret these data where possible, and produce either hydrogeological data sheets or hydrogeological maps with explanatory notes. The aim will be to focus on areas of unevaluated data, and where possible to include complete hydrogeological units such as the Georgina Basin.

4.6.2.1 Criteria Assessment

All of the areas outlined above include areas of both State and national importance. Of the above areas the Amadeus Basin, the Daly River Basin, the GAB and the Georgina Basin (including the Queensland part of the basin) represent complete hydrogeological units. There is a need to present the collected data in some summarized form for more precise regional groundwater resources assessment at a State or national level.

It will be possible to upgrade many areas from unevaluated status to conceptually evaluated status by suitable collation of existing information without the need for a comprehensive drilling program.

Considerable benefits will be derived from the proposed collation and presentation. Much of the data is presently held in manuscript form. Collating data either into hydrogeological data sheets or hydrogeological maps will greatly enhance the availability of the information to the public as well as providing a sound basis for future groundwater resource assessment work.

The preparation of maps will provide immediate benefits in terms of groundwater resource assessment, and more importantly a better understanding of the hydrodynamics of the groundwater systems which will be ultimately required for proper management of the resource.

4.6.3 Methodology

Data should be assembled for the 1:250,000 sheets in the respective areas shown (Figure 4-6).

4.6.4 Staffing

Up to two contract hydrogeologists would be required plus sub-professional staff. As discussed previously much of the work would involve collating existing data into map form. Some of field work would be required to obtain further data, or to clarify information. Final draft maps would be in the form of hydrogeological data sheets or hydrogeological maps which could then be produced either as full colour maps by the Bureau of Mineral Resources or used as basic units on the Intergraph system to smaller scale maps as required.

About 37 1:250,000 sheets have been identified for the program. It seems unlikely that more than 10 to 15 would become final full colour hydrogeological maps. The remainder, could be completed as black and white maps and be used in compiling smaller scale maps say at 1:50,000 or 1:1,000,000 for the major hydrogeological units.

4.6.5 Costs

4.6.5.1 Mapping

Assuming 15 full colour hydrogeological maps are produced and the remaining 22 as black and white/data sheets, the total cost would be as follows:

15 colour maps (1:250,000) @$63,000 each	$945,000
22 Black & White Hydrogeological Maps and Data Sheets @$42,000 each	924,000
	$1,869,000

4.6.5.2 Drilling

Drill deep hole into Georgina Basin, aquifer testing 600 metres	144,000
TOTAL	$1,953,000

The maps have been costed as if all require a new bore census to take account of the remoteness of many of the areas.

4.6.6 Expected Results

Once the work is completed, map and explanatory notes should be available for the major part of the hydrogeological units in the Northern Territory. Data now only available in manuscript form will be collated and available to the public.

The maps produced should be invaluable for assessing general site specific potential as well as improving the groundwater data base and its accessibility for practicable application.

It would also enable specific drilling programs to be planned more effectively and to optimize funding. The work is important nationally in providing preliminary assessment of an understanding of the hydrodynamics of specific hydrogeological units.

4.6.7 Priorities

The density of data in the NT makes the status of knowledge classifications tenuous at best. If priorities must be given to allow program reduction it has to be on a base of national interest and the immediacy of benefits which may flow from resource evaluation upgrading. To this extent the Ord and Victoria River Basins are already being cleared for intensive tropical agriculture and along with the Pine Creek Geosyncline should be given a high priority.

Again coverage of the rivers which recharge the GAB and the Georgina Basins is important in relation to these national assets, with work in the Georgina Basin.

The remaining areas of the Arunta Complex and the Tennant Creek area of the Warramunga and Davenport Geosynclines seem less important for the present program.

4.7 TASMANIA

4.7.1 General

As outlined in Section 3.0 data in Tasmania is unevaluated to conceptually evaluated. Whilst not considered to be relevant to the present study, the State should be encouraged to produce 1:250,000 hydrogeological maps in the northern and eastern part of the State. The maps should include Burnie, Launceston, Flinders Island, Oatlands and Hobart.

The work program could be undertaken as part of the State/Commonwealth co-operative program.

5.0 EXTENDED INVESTIGATION PROGRAM

5.1 GENERAL

AGC recommend that National reconnaissance program should be extended beyond 5 years to include additional 1:250,000 mapping areas. These areas should be selected based on the criteria outlined in this report. Ultimately it is envisaged that the entire continent should be covered similar to the existing coverage of geological 1:250,000 scale maps. These will include areas covered through Federal/State Co-operative funding and additional reconnaissance programs.

Commonwealth funding could be extended to cover all future 1:250,000 collation, leaving the States to produce larger scale maps of more developed regions where considerable Commonwealth/State funds have already been expended. Whilst coverage of the continent will admittedly take many years to complete we strongly urge that this be a final objective. Obviously intermediate objectives for the coverage could be set for shorter terms of say 5 years by continuing the program in selected areas. The costs for such a program over additional 5 year periods are likely to be similar to that proposed in this report. However in the first 5 years, a major proportion of the continent will have been covered.

Also, updated information would need to be added to existing mapped areas say every 5 to 10 years and a decision made to publish these updates.

2/ 5.~~1~~ INVESTIGATION DRILLING PROGRAMS

In addition to the above work the inventory has highlighted certain areas which will require much more intensive investigation than would be possible during the 5 year program outlined in this report or the extended program discussed above. These areas are discussed in more detail below.

2/ 5.~~1~~.1 Canning Basin

Of all the large sedimentary basins in Australia excluding perhaps the Great Artesian Basin, it is evident that this Basin has probably the greatest groundwater potential and should be investigated more fully on a regional basis.

Since the status of the area is unknown the program would depend primarily on drilling for assessing the groundwater system. A nominal 25 bores drilled up to 300 metres deep across the Basin would allow the basin to be upgraded from unknown to conceptually known. The drilling should be spread uniformly over the entire basin and should not be concentrated in one partaicular zone. Drilling would be accompanied by suitable geophysical logging and hydraulic testing and preliminary model studies to assess the regional hydrodynamics of the Basin. Total estimated cost for such an investigation is likely to be in the vicinity of $1.5 m. The maximum possible use should be made of data available from petroleum exploration in planning this work and evaluating aquifers.

2/ 5.1.2 Other Basins and Deposits

The importance of Tertiary aquifer systems in Queensland has been outlined in this report. Further drilling should be undertaken in more detail to delineate these aquifers systems particularly in Queensland.

In addition some of the other large sedimentary basins should be investigated by suitable drilling programs. These include the Karumba, Styx, Laura Basins in Queensland and the Officer and Eucla in Western Australia in particular. Some further exploratory work may also be required in the Murray Basin to complement the model studies presently being carried out. An element of research which should not be overlooked in all the studies is the possibility of selected areas being used as containment sites for hazardous waters for which no other safe storage locations exist at present.

No accurate costs can be given at this stage but an estimated $3 m would cover investigation in these areas.

2/ 5.1.3 Additional Exploratory Drilling

Additional exploratory drilling will obviously be required in mapping areas proposed in this report in all States. The exact extent of this drilling will become clearer once the hydrogeological maps and data sheets are prepared. Recommendations on drilling should be made by contract staff during the mapping compilation described in this report. An approximate estimate of $3m should be allocated for this exploratory testing drilling and supervision and reporting to supplement the hydrogeological mapping.

2/ 5.1.4 Research Aspects

While both the five year and extended programs recommended here will upgrade the status of knowledge of our National groundwater resources, many systems will require further research.

The detailed definitions of this research in particular areas will become clearer as the five year program proceeds, although many of the reseach aspects will need to be addressed during the five year program.

The BMR groundwater research group has both the expertise and the basin wide experience to carry through these research aspects in co-operation with the States.

It is expected that the present team of four research professionals would be required plus 2 to 3 additional professional and other support staff as required. Costs are expected to amount to about $2.0m for the 5 year program only.

Some of the areas of research which will need to be addressed during the five year program and beyond include:

- Hydrodynamics and hydrochemistry of large sedimentary basins and other areas to be mapped and development of conceptual models of these systems.
- Relationship of groundwater flow between the Georgina, Amadeus and Great Artesian Basin.
- Regional simulation of mass transport in the Murray Basin using three dimensional analysis.
- Review of hydrogeological conditions within Australia suitable for either hazardous and/or radioactive waste disposal and determination of long term effects.
- National review of availability of groundwater resources with respect to known and potential mineral resources.
- Mechanisms of salinisation of major aquifers related to paleoclimates and osmotic effects in deeper aquifers.
- Study and review of deeper hydrogeological and possible paleoflow systems.
- Quantitative evaluation of recharge of aquifers in Australia in arid regions and evapotranspiration losses of major tree species in these areas.

6.0 MAP PRODUCTION

6.1 LOGISTICS

Figure 6-1 illustrates the flow chart for the proposed production of the hydrogeological maps or data sheets. It is proposed that the States undertake the necessary bore census collection and collation of existing and new data using their own contract staff. Where necessary, additional field bore census and/or field checking of the information should be carried out. The data should then be compiled into 1:250,000 mapping sheets and the data interpreted. If sufficient data are available, the map can be completed as a hydrogeological map. Legends used should be those finally recommended by the hydrogeological mapping sub-committee of the AWRC groundwater committee. The maps should be completed in draft form. In addition, hydrogeological explanatory notes should be completed for each map and data sheet. The format and style of these explanatory notes should be the same for each map developed in each respective State. An example of suggested headings is given in Appendix I. It is recommended that, should the program proceed, that the AWRC groundwater committee through the hydrogeological mapping sub-committee review this format thoroughly before making a firm recommendation. Pilot studies recommended in this report would assist in this task.

The explanatory notes and maps when finally prepared should then be edited for consistency from State to State.

Following this phase the maps could then be digitized to a computer graphics system. Once on this system, a decision could then be made to print individual 1:250,000 sheets in preliminary and then as required in a final form.

Two options exist for the map production phase illustrated in Figure 6-1 for steps 3 to 7.

Firstly the BMR through use of inhouse graphics terminal(s) and printing facilities could undertake this work. This would require that staffing be increased and facilities of map production be improved and extended.

Additional computer terminals would also be required to service the digitization phase of map production.

The sheer volume of maps/data sheets to be generated as well as other reasons may make this path impracticable and undesirable. Alternatively, the States could undertake to carry out steps 2-5, leaving the BMR to produce selected smaller scale maps as required using the 1:250,000 scale data stored on the graphics system as the basic building blocks. These could for example be maps of hydrogeological units of National importance. The scale of these maps will however be critical in assessing their usefulness (see Section 3.0).

If the States are to undertake this role, and a consistent output is to be assured, graphics terminals will need to be provided to each State organisation for their use. Estimated cost would be

in the region of $1M plus contract staff to operate the system, edit and check the data base.

In the production of the hydrogeological maps it will be important to standardise the hydrogeological legends. At present two formats have been proposed which have in this report been designated as the IAH and the Australian legend (see Appendix J for detailed discussion). AGC recommend that the Australian legend be used in preference to the IAH legend although AGC conclude that for small scale maps where geology cannot be presented the IAH legend would be suitable.

6.2 PILOT PROGRAM

In order to determine more precisely the costing of each step illustrated in Figure 6-1 a pilot program is recommended. This program should:

- Determine more precisely overall costing, staffing and logistic requirements for bore census, collection and collation of data.
- Determine computer graphic system and printing requirements and costs more precisely.
- Test the adequacy of hydrogeological legends proposed by the Hydrogeological Mapping Sub-committee.
- Highlight likely problems that could be encountered during collation, compilation, digitising and the final printing process.

The program we propose is to produce four 1:250,000 sheets as shown below with associated costs.

MAPS	BUDGET COSTS
Two full colour hydrogeological maps	126,000
Black and White hydrogeological map (preliminary)	45,000
Hydrogeological data sheet	25,000
	$196,000

The program could be undertaken during the 1985/86 financial year.

The two full colour maps should be selected in two different areas. One should preferably be in a sedimentary basin or sedimentary area. The other in a fractured rock enviroment. Both should be selected in high bore-density zones in order to allow sufficiently detailed interpretations to be presented on the map. The other two could be selected where the bore density is much lower, so as to illustrate the type of map that could be produced.

In addition to the above costs about $60,000 should be assigned for preparation of the hydrogeological menu for the computer graphics system. This cost would include experienced and sub-professional staff to prepare the menu. Guidelines for menu

preparation could be taken from Hydrogeological Mapping Sub-Committee recommendations.

6.3 FIVE YEAR PROGRAM CO-ORDINATION AND MANAGEMENT

The five year program is being funded by the Commonwealth with a view to national interest and priorities. It would be appropriate for the BMR as the Commonwealth expert body in geological and hydrogeological matters to direct and co-ordinate the program if the States are to carry out the work.

The BMR would play an important role particularly in ensuring the consistency of interpretations at State boundaries and for individual maps. A close liaison will be required between BMR staff and the State authorities. This liaison should be preferably on a face to face basis since this is likely to engender a better co-operative atmosphere than through other forms of communication. A travel budget of about $50,000 over 5 years for BMR staff is therefore suggested.

AGC also recommends that should a State not wish to participate in the program that the BMR be funded to undertake the work program for that State. This will likely necessitate an increase in staffing of the hydrogeological group or the use of contract staff to carry out the work.

7.0 CONCLUSIONS

1. An evaluation of the data bases in various State organisations has shown that there are many areas in each State where there are data available and sufficient to assess the groundwater system but where the data have not been evaluated and/or collated. Many areas, particularly in the central, western and northern parts of the continent have data insufficient to assess the groundwater flow systems.

2. The assessment has indicated that although some data are published, particularly on specific project areas, large parts of all the data bases exist as raw data stored on either EDP systems, in manuscript form or in files.

   Interpreted data are generally not released to the public or to other interested groups although there are exceptions.

3. Hydrogeological mapping is generally not carried out since it is seen as of generally low priority and often, suitable staff to undertake this task are not available. Most published data are in the form of small scale water-resource maps and explanatory notes outlining the broad-brush groundwater potential of the State or as groundwater investigation reports in specific regions. Some areas have been investigated in considerable detail but no reports are available or if available are not released for general distribution.

4. Most authorities interviewed are in general agreement with the concept of the National Reconnaissance program with certain reservations. These reservations are that the program should achieve more than the filling of "knowledge gaps" and that there should be a "need to know" test applied to the respective areas of investigation.

5. If the States take on the responsibility of the program then it is likely that contract staff or consultants will be required to carry out the work program. Should a State not wish to particuipate in the program then the BMR should be funded to carry out the work.

6. The project has indicated a need to provide some means of collating and presenting groundwater data at a larger scale. This report recommends preparation of hydrogeological maps or, where data are inadequate, data sheets for specific areas identified in each State. The areas have been selected based on a number of criteria.

   In addition a limited program of drilling has been recommended. This drilling program has been selected to yield significant information for the cost involved.

7. The five year program proposed should achieve the following:

   - Interpretation of a large section of existing data presently stored in raw form in respective data bases in each State and presentation of this information at a larger scale than has been attempted previously.

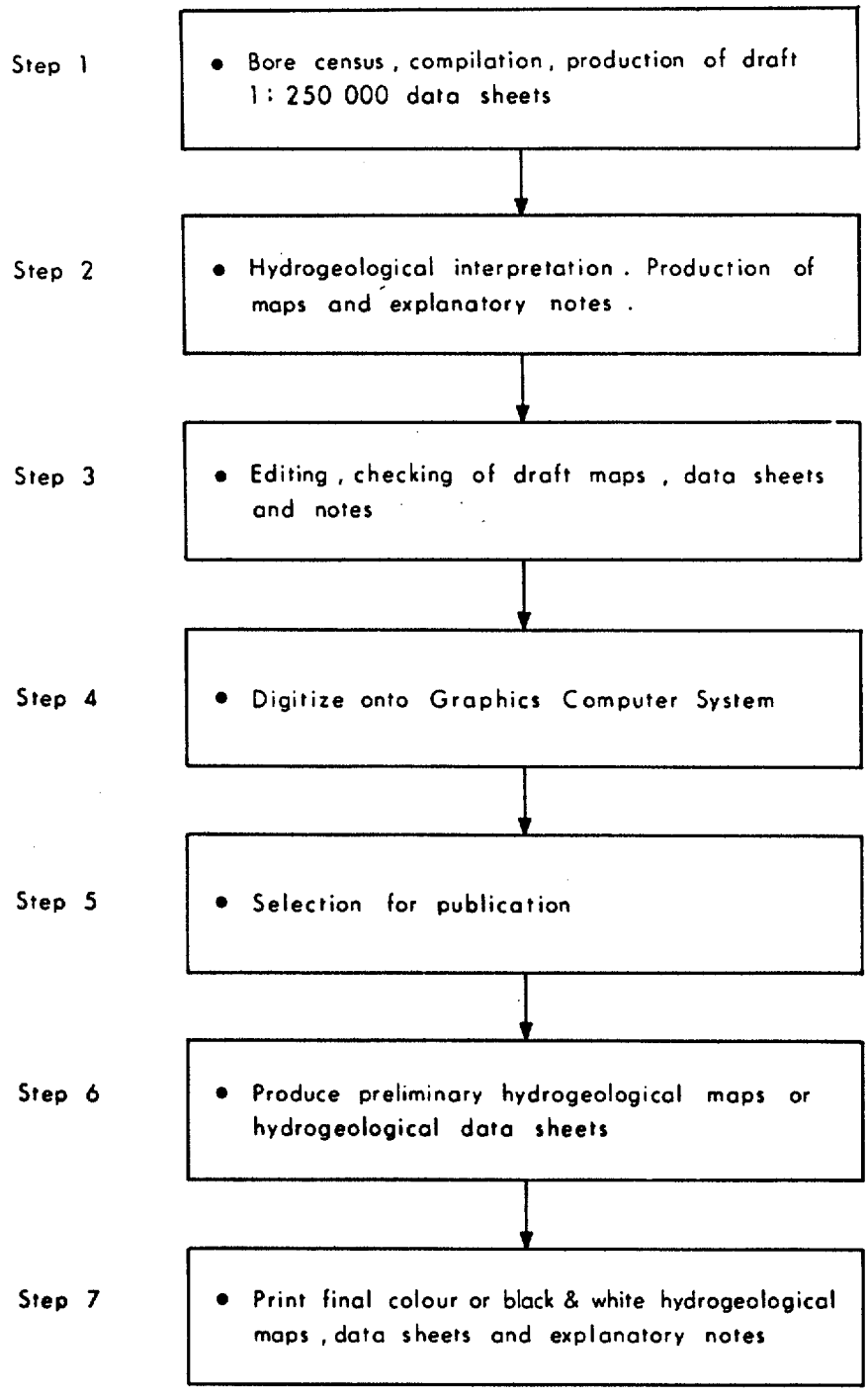
- Collate and present some of the data that have been obtained as part of the previous Commonwealth/State funding.
- Collate and present data in the more remote regions of Australia, where possible integrating this collation across State boundaries to cover large hydrogeological units.
- Publish the 1:250,000 hydrogeological maps or data sheets thereby making these interpreted data available to the public and other interested groups. Maps would be published in either colour or black and white with explanatory notes.

8. An expanded and future program should include an extension of the preparation of hydrogeological maps or data sheets. AGC consider that such mapping in conjunction with State/Commonwealth funded mapping ought to continue ultimately to cover the entire continent. The areas outlined in this report have been selected based on specific criteria for the shorter term study.

9. It is recognised that financial constraints on Commonwealth funding may require program recommended for the five year investigation to be curtailed. For this reason each State program recommended includes a priority ordering based in part on the program justification criteria set out in Section 3.1 of the report. The priorities have been determined by the consultants and have not been discussed with the State authorities.

10. In addition to mapping, research into various aspects of groundwater flow systems will be required.

    Many of these research aspects will become clearer once the five year program commences. Areas of research which should be addressed and which are likely to flow from the 5 year program are outlined in Section 5.1.4 of this report.



Australian Groundwater Consultants Pty Limited

Bureau of Mineral Resources

National Groundwater Data Base Inventory

MAP PREPARATION, DIGITIZING & PRINTING

FIG 6-1

8.0 RECOMMENDATIONS

- That the five year forward program be based on collection and collation of hydrogeological data in selected areas supplemented by some exploratory drilling.

- That the programs be undertaken by either the relevant State organisation staff or contract staff or consultants with results compiled either by the BMR or the States on a graphics computer system and to the final printing stage.

- That 1:250,000 sheets be used as the base for the program and that the legends used be those recommended by the AWRC Hydrogeological Mapping Sub-committee. Explanatory notes should also also be prepared with both the data sheets and the maps.

- That the Hydrogeological Mapping Sub-committee strongly consider the adoption of an Australian Legend (for large scale mapping) where colour, and colour tones be used to distinguish salinity and probable yields respectively in preference to the modified I.A.H. approach which uses aquifer type as a basic parameter.

- That an expanded program consider extending the production of hydrogeological data sheets or maps consistent with the general aim of the program. Of particular importance are the continued exploration in the Murray Basin and new exploration in the Canning Basin, studies of the large sedimentary basins, the smaller Tertiary Basins and palaeochannel systems aquifers. Many of these regional studies could be carried out by the BMR Hydrogeological Group.

- If the Bureau of Mineral Resources acts as a collating body to edit and supervise preparation of the hydrogeological data sheets or maps that its staffing and facilities be increased accordingly.

- That specific research aspects flowing from the 5 year program be addressed by the BMR hydrogeological group (see Section 5.4.1 of this report).

- If the States act as the collating agency that graphics computer system terminals be set up within the appropriate authority for use on the proposed program.

- If any State does not wish to participate in the 5 year forward program that the BMR be funded to carry out the program of work.

- That a pilot program be set up during 1985/86 to hydrogeologically map four selected areas. During this pilot program the collation, map production requirements and costs could be more closely assessed and adjustments made to the costing outlined in this proposal. In additions it will allow suitability of the proposed hydrogeological legends to be assessed more accurately.

- It is recommended that the States through the State/Commonwealth co-operative funding be encouraged to hydrogeologically map design evaluated or conceptually evaluated areas which would benefit from a larger scale presentation. Larger scales of 1:100,000, 1:50,000 or even 1:10,000 should be utilised where appropriate. This should ensure that groundwater data in the more intensive investigation areas are disseminated and available to the public in an interpreted form.

- That the BMR takes on the role of supervision and management of the proposed 5 year forward program and that close liaison be established between BMR staff and the relevant State authorities.

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