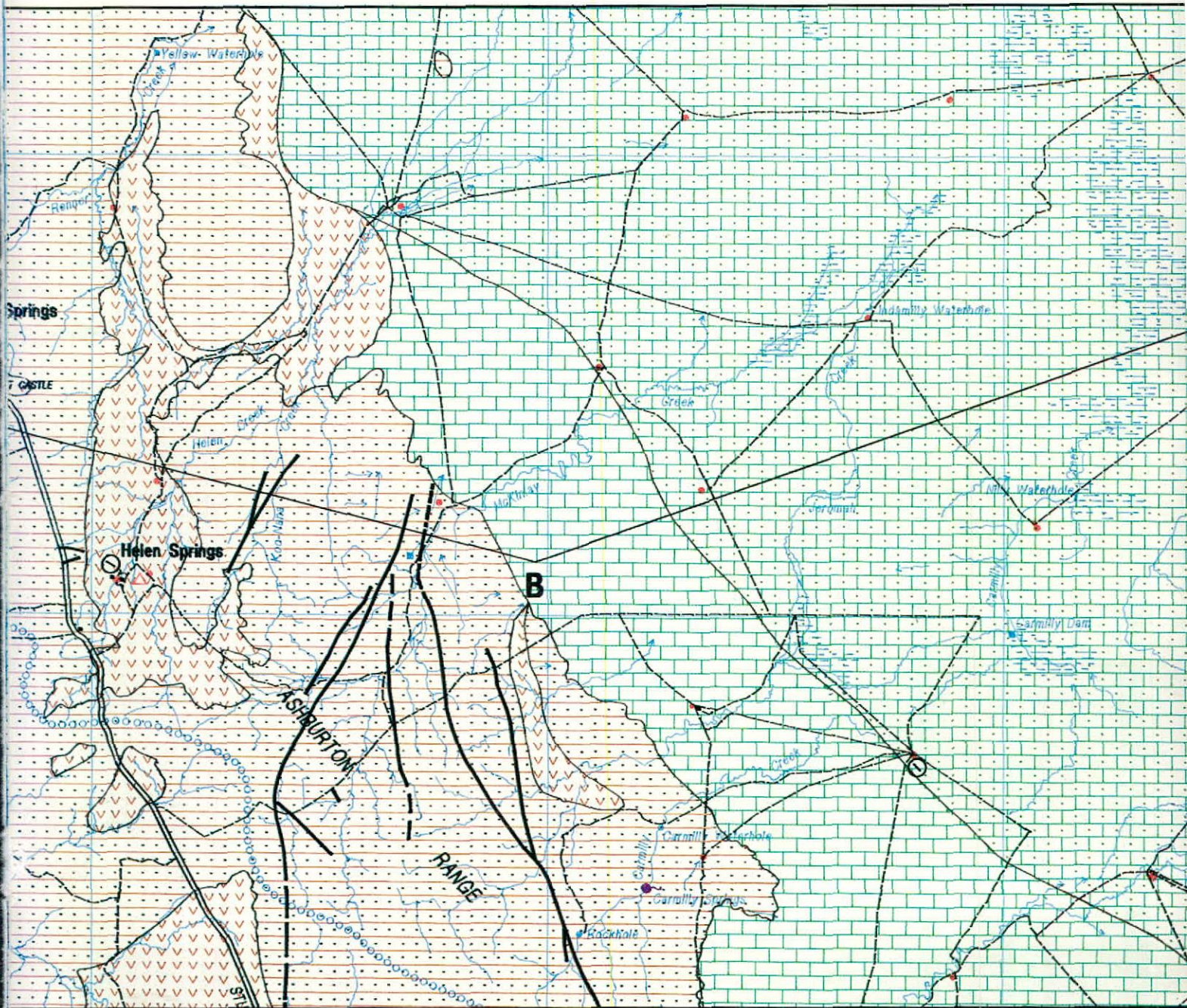


Hydrogeological Map Helen Springs Explanatory
Notes - 1:250,000 Scale Map

HYDROGEOLOGICAL MAP HELEN SPRINGS

Explanatory Notes
1:250 000 Scale Map



POWER
— AND —
WATER
AUTHORITY



Front Cover:

Extract from the 1:250 000
Helen Springs Hydrogeological Map

Back Cover:

Extract from MSS (Multispectral Scanner)
Scene ID: 5022000362
Date: 07.10.1984
Scale: 1:250 000
Bands: Multispectral Linear Array Bands 4 5 7

Personal Copy

Northern Territory of Australia
POWER AND WATER AUTHORITY

M. N. Verma.

M. N. VERMA

Hydrogeology of HELEN SPRINGS

Explanatory Notes for 1:250 000 Scale Map

M N Verma
P B Jolly

1:250 000 SHEET INDEX

NEWCASTLE WATERS SE 53-5	BEETALOO SE 53-6	WALLHALLOW SE 53-7
SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10	BRUNETTE DOWNS SE 53-11
GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14	ALROY SE 53-15

Report 50/1992

Darwin, July 1992

CONTENTS	i
SUMMARY	1
1. INTRODUCTION	1
2. GEOGRAPHIC SETTING	1
2.1 Climate	
2.2 Physiography	
2.3 Land Use	
2.4 Surface Water Hydrology	
3. GEOLOGY	5
3.1 Stratigraphy and Structure	
4. HYDROGEOLOGY	7
4.1 Carbonate Rock Aquifers	
4.1.1 Georgina Basin	
- Gum Ridge Formation	
- Anthony Lagoon Beds	
4.1.2 Wiso Basin	
- Montejinni Limestone	
4.2 Volcanic Rock Aquifers	
- Helen Springs Volcanics	
4.3 Fractured Rock Aquifers	
- Tennant Creek Block	
- Tomkinson Creek Beds	
5. GROUNDWATER QUALITY	11
5.1 Georgina Basin	
- Gum Ridge Formation	
- Anthony Lagoon Beds	
5.2 Wiso Basin	
- Montejinni Limestone	
5.3 Volcanic Rock Aquifers	
- Helen Springs Volcanics	
5.4 Fractured Rock Aquifers	
- Tennant Creek Block	
- Tomkinson Creek Beds	
6. PROSPECTIVE AREAS FOR HORTICULTURE	16
6.1 Sustainable Yield of Each Prospective Horticultural Area	
7. SUMMARY OF GROUNDWATER RESOURCES	18
8. USE AND APPLICATION OF THE MAP	18
9. REFERENCES	19
10. ACKNOWLEDGEMENTS	20

APPENDICES	
APPENDIX A	21
MAP PREPARATION METHOD	
- Collation of Data	
- Data Processing	
- Remote Sensing - Landsat MSS Images	
- Application of GIS	
APPENDIX B	23
BORE DATA BASE	
Description	
Access	
LIST OF FIGURES	
1 Location of Helen Springs 1:250 000 Map	2
2 Physiographic Units of the Map Area	4
3 Geological Cross-Sections of Lines 1, 2, 3 and 4	8
4 Water Levels of Bores 5338 and 5427 and Rainfall Data for Barrow Creek and Tennant Creek	10
5 Durov Diagram	13
6 TDS, SO ₄ and Fluoride Contours for Georgina Basin	14
7 SAR and HCO ₃ /Cl Contours for Georgina Basin	14
8 Deuterium-Oxygen ¹⁸ Graph for Georgina Basin	15
9 Potential Areas for Horticultural Development	15
LIST OF TABLES	
1 Mean Monthly and Annual Rainfall at Various Stations	3
2 Stratigraphy of the Helen Springs Region	6
3 Bore Statistics	9
4 A Comparison of Water Quality	12
5 Water Analysis Results of Tritium, Deuterium and Oxygen ¹⁸ .	12

SUMMARY

In 1989, the Power and Water Authority (PAWA) commissioned a study to investigate the potential of groundwater resources in the Tennant Creek region. The requirement as specified by the Department of Primary Industries, in line with government policy, was to identify areas where groundwater of a suitable quality and quantity existed to meet the demands of potential horticultural developments. Four of the six areas identified in that study lie within the Helen Springs 1:250 000 map sheet area. This commentary and accompanying 1:250 000 hydrogeological map are intended to provide more detailed knowledge on these four areas, in addition to a broad understanding of the groundwater resources of the region covered by the Helen Springs Map Sheet.

This map has been compiled on an Intergraph Geographic Information (GIS) System. The map has been prepared to Australian Water Resources Council Guidelines, with minor modification to suit the GIS system, and therefore conforms to the colour scheme and principles of the UNESCO International Legend for hydrogeological maps. The project included the compilation and production of the map and a data base containing information on 218 bores.

1. INTRODUCTION

The 1:250 000 scale Helen Springs hydrogeological map sheet area is bounded by latitudes 18° 00'S and 19° 00'S, longitudes 133° 30'E and 135° 00'E and covers an area of about 18,000 sq km. The Stuart Highway is the main bitumen thoroughfare traversing north-south through the middle of this area and access to various cattle stations is usually by well-graded gravel roads. The map and explanatory notes provide an assessment of the hydrogeology and groundwater resource potential of this area. The area includes all or part of nine cattle stations - Anthony Lagoon, Banka Banka, Brunchilly, Eva Downs, Helen Springs, Muckaty, Newcastle Waters, Powell Creek and Rockhampton Downs. The map area extends from the Georgina Basin on the east to the Wiso Basin on the west, separated by the Tennant Creek Block (Figure 1).

2. GEOGRAPHIC SETTING

2.1 Climate

The area lies in the semi-arid climatic region with temperatures ranging from 10° to 25°C between May and August to 20° to 42°C from September to April. Most of the rain falls during the monsoonal period between December and May. The average annual rainfall of 446mm has been calculated from the data available. Rainfall data for the Helen Springs map sheet is available from 1873. Rainfall stations at Banka Banka (B'anka), Brunchilly (B'chly), Eva Downs (EvaDn), Helen Springs (H'Sp) and Muckaty (Muc'ty) are still open. Powell Creek (PowlCk) and Renner Springs have closed. A summary of rainfall records for the study area is provided in Table 1. Renner Springs Station data is not included due to inconsistent recordings.

Average monthly and annual evaporation have been selected from the nearest station located at Tennant Creek for the period from 1973 to 1980. This data is considered to be representative of the sheet area. Average monthly evaporation rates for January, April, July and October are 335, 324, 228 and 384mm respectively, with average annual evaporation of 3778mm (Bureau of Meteorology 1988).

2.2 Physiography

The Helen Springs sheet area is a part of Hays' (1967) Main Plateau of the northern part of the Northern Territory, which comprises the Barkly Tableland (Dunn et al, 1968) in the east, and the Wiso Tableland (Hossfeld, 1954) in the west, separated by the Ashburton and Whittington Ranges. Three physiographic units have been differentiated on the basis of topography and superficial deposits and are shown on Figure 2.

a) The Ashburton and Whittington Ranges form the highest country with peak elevation of about 405m AHD decreasing in height towards the north. These ranges are composed mainly of resistant silica cemented sandstone of the folded Pre-Cambrian Tomkinson Beds which form strike ridges and plateau. The highest plateaux appear to be remnants of a former more extensive plain, the Ashburton Surface of Hays (1967). Less

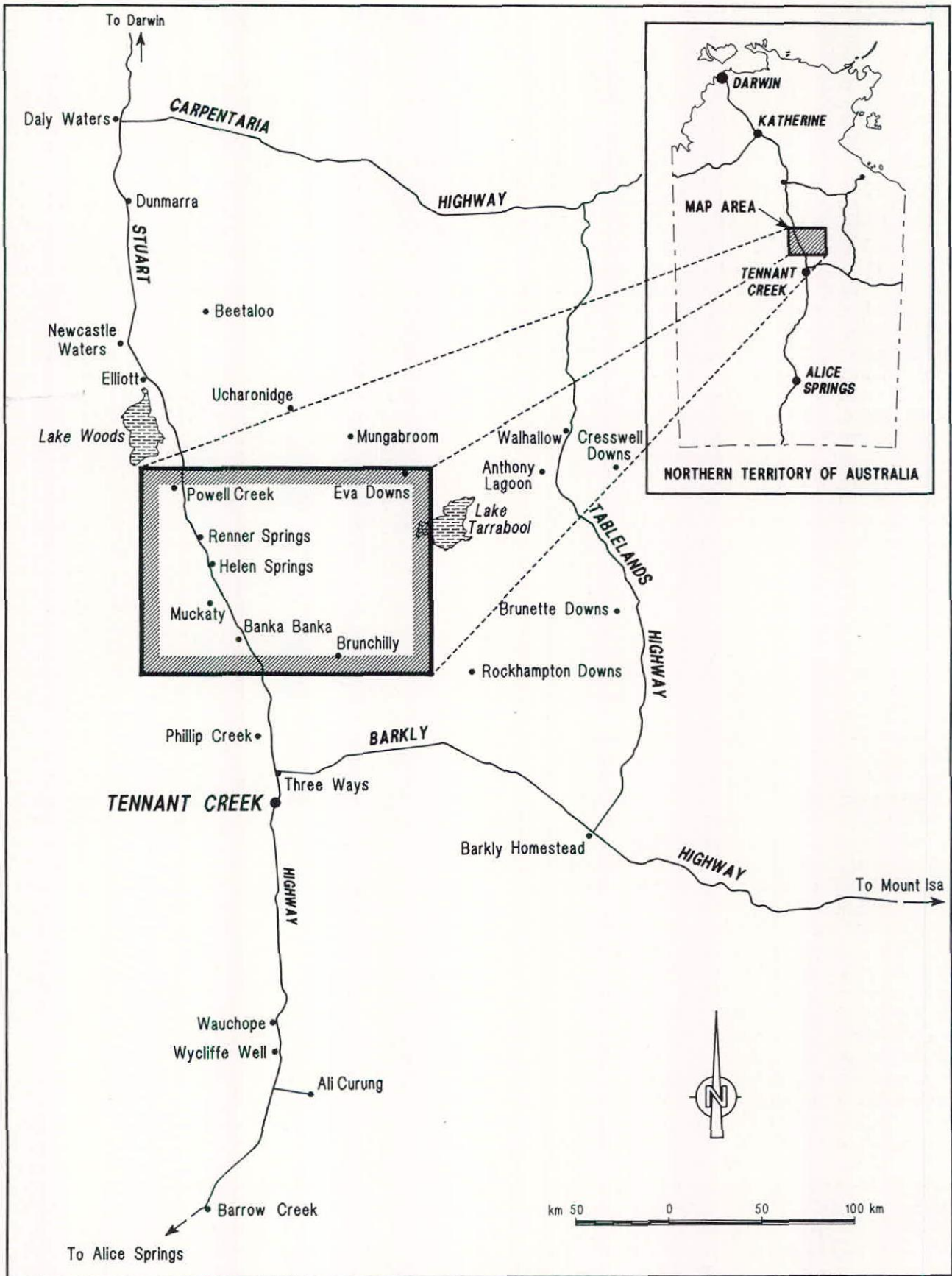


Figure 1: LOCATION OF HELEN SPRINGS 1:250000 MAP

TABLE 1 MEAN MONTHLY AND ANNUAL RAINFALL AT VARIOUS STATIONS

Month	B'Banka	B'Chly	H'Sp	PowlCk	EvaDn	Muc'ty	Average
Jan	101.4	88.3	115.3	109.9	147.4	108.8	111.8
Feb	125.5	103.3	115.6	125.4	115.5	106.0	115.2
March	79.3	75.0	67.4	76.5	54.4	55.9	68.2
Apr	15.4	15.9	12.3	16.5	29.7	11.8	16.9
May	16.7	15.9	13.0	7.9	6.5	13.0	12.1
June	5.1	6.1	3.5	5.2	2.7	5.1	4.6
July	4.8	8.9	3.6	6.0	0.0	2.6	4.3
Aug	2.3	1.9	2.4	2.8	2.9	2.0	2.4
Sept	8.5	9.7	7.6	6.0	13.1	7.1	8.7
Oct	22.1	19.7	19.6	16.0	27.0	18.5	20.5
Nov	19.5	38.4	26.0	33.6	29.0	20.9	27.9
Dec	43.7	53.1	55.6	67.9	50.1	51.4	53.6
Annual	444.3	437.0	441.8	473.7	478.3	40.31	446.2

All measurements in mm; Source : Bureau of Meteorology

resistant intervals in the Tomkinson Creek Beds eroded preferentially to form valleys which were partially infilled with Cambrian volcanic and sedimentary rocks and Lower Cretaceous sediments. Seasonal streams draining the ranges terminate in floodouts in the sand plains bordering the ranges.

b) Sand Plains, with a superficial cover of red sand supporting spinifex and low trees and shrubs, form an important physiographic unit. The sand plain to the west of the Ashburton and Whittington Ranges is the eastern extremity of a large semi-desert, Sand Plains also occur between the ranges and on the grassy downs to the east, on a surface sloping gently away from the ranges. The boundary between the downs country and the sand plains is clearly visible on Landsat MSS images (Bands 4,5 and 7). Sand is largely colluvial, but reworked in part by streams and wind. Longitudinal dunes trending east north-east, now fixed by vegetation, occur in the southwest corner of the sheet area.

c) The Downs Country is lower than the adjacent areas of sand plains and ranges. It is covered by heavy grey pedocalcic soils (black soils) supporting Mitchell and Flinders grass. The country has low relief and contains parts of two closed depressions, which extend into adjoining Sheet areas.

The widely-spaced seasonal water courses drain into ephemeral lakes, most of which occur within these closed depressions. Most of this Downs country is underlain by Cambrian (mostly Anthony Lagoon Beds) and younger sediments. On the higher

ground there are low rises with rubble of Cambrian and Mesozoic rocks. Some of these rises have a capping of laterite and may represent outliers of a more extensive laterite tableland on the Beetaloo sheet to the north (Brown and Randal, 1969).

2.3 Land Use

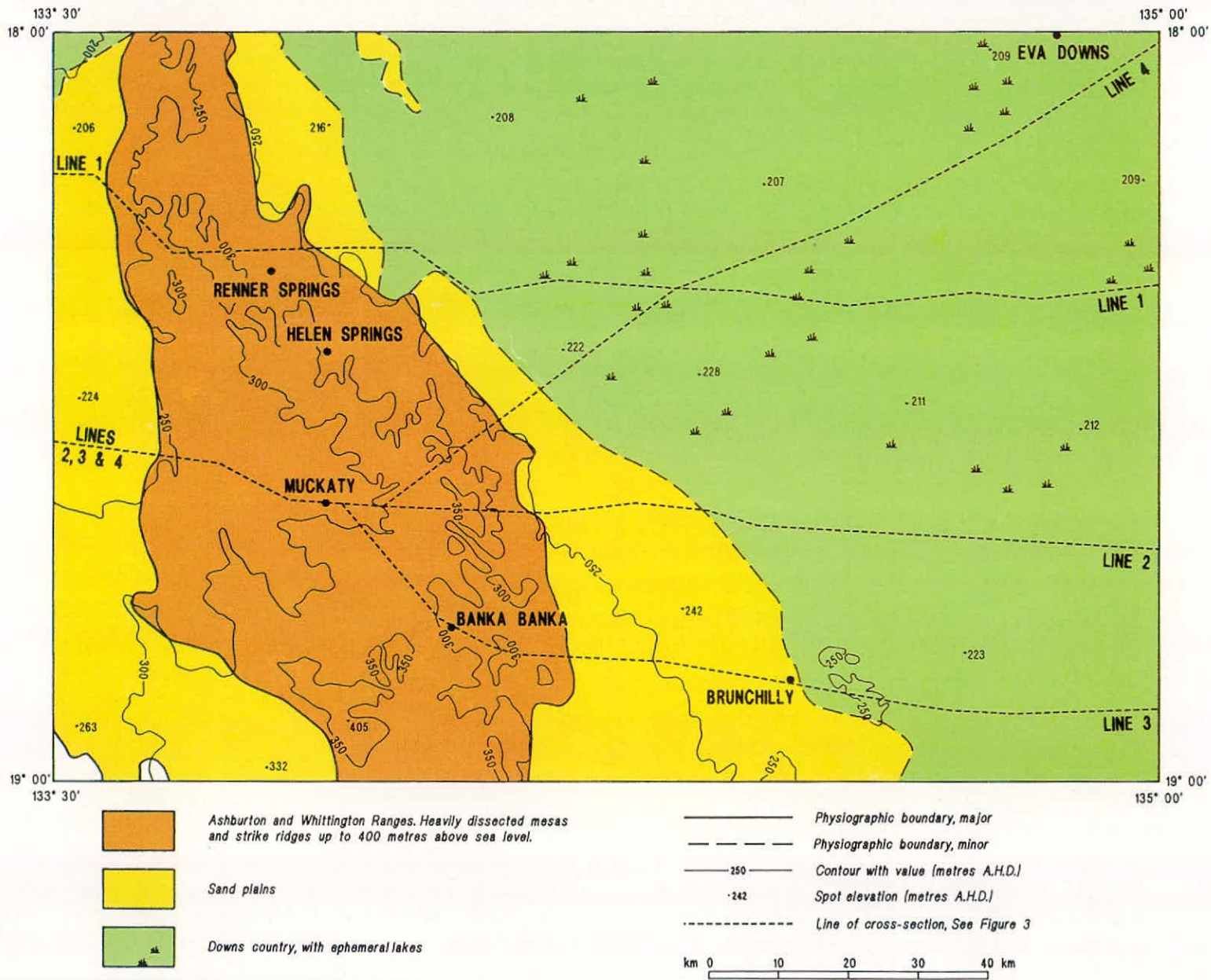
The major user of land in this area is the pastoral industry. There are nine cattle stations located in the map sheet area, these being Anthony Lagoon, Banka Banka, Brunchilly, Eva Downs, Helen Springs, Muckaty, Newcastle Waters, Powell Creek and Rockhampton Downs. A minor land user in this area is the mining industry. Previously, manganese has been mined around Bootu Creek and Muckaty Station. Exploration drilling for oil, coal and gemstones has also been carried out in the past and reports are available from the NT Department of Mines and Energy.

2.4 Surface Water Hydrology

There are numerous seasonal creeks along the flanks of the Ashburton and Whittington Ranges and they feed ephemeral waterholes both within the Tennant Creek Block and sandy plains. Both Creswell and Puzzle Creeks, which originate in the northeast of the Barkly Tableland, drain into Lake Tarrabool. A small part of Lake Tarrabool lies on the eastern edge of the Helen Springs map sheet. In the northwest corner of the Helen Springs map sheet is a small portion of Lake Woods into which Newcastle and Bucket Creeks drain from the north. Both these lakes are subject to periodical filling from monsoonal rainfall. However, for long periods they are dry.

Figure 2 : PHYSIOGRAPHIC UNITS OF THE MAP AREA

4



The drainage pattern within the Tennant Creek Block is mainly 'dendritic', while on either side of the Tennant Creek Block the pattern is 'linear' down the slope and disappearing into the sand plains creating floodouts which are clearly visible on the Landsat images. Due to seasonal low rainfall and high evaporation, surface water is inadequate for full pastoral development in this region. Droughts occur often due to below average rains. Randal (1973) summarised droughts of different periods from 1900 up to 1968, of which the major ones were: 5 years between 1907 and 1920; 6 years between 1925 and 1938; from 1946 to 1949 and in 1951 and 1952.

3. GEOLOGY

About two-thirds of the Helen Springs map area lies along the western boundary of the Georgina Basin and a small area (on the western side) lies along the eastern margin of the Wiso Basin. The Tennant Creek Block of Lower Proterozoic age separates these two basins. For hydrogeological mapping, a number of simplifications have been made to the stratigraphy within the Tomkinson Creek Beds, due to their similar hydrogeological characteristics. Six units of the Tomkinson Creek beds are combined into one unit (refer Table 2).

3.1 Stratigraphy and Structure

The Tomkinson Creek Beds were deposited in a shallow sea on extensive tidal flats on a subsiding floor during the Lower Proterozoic. Some folding and erosion of early sediments preceded a later phase sedimentation which included Carpentarian sediments. A dolerite sill was intruded in the northwest. Subsequent folding and faulting of the Tomkinson Creek Beds followed by erosion of folded and faulted sedimentary rocks produced a topography with strike ridges and valleys which is known as the Tennant Creek Block. Carpentarian sediments of the Tomkinson Creek Beds have been correlated as equivalent to the Tawallah, McArthur, Nathan and Roper Groups of the McArthur Basin (Ward, 1982).

In the Lower Cambrian, deposition of fluviatile sandy gravels and dune sands in valleys was followed by a period of rapid polar motion and a phase of

tectonic instability. During this period terrestrial basalts erupted intermittently over parts of the hinterland (area behind the coast). Extrusion of these basalts (Helen Springs Volcanics) occurred during the period from Lower Cambrian to Ordian (early Middle Cambrian), in places forming small domes. It is believed that this tectonic instability was caused by north-south plate movements which resulted in mainly vertical displacements. Helen Springs Volcanics have been correlated to the Antrim Plateau Volcanics and also to the Peaker Piker Volcanics. The source of these three volcanics is considered the same (Bultitude, 1972).

In both the Georgina and Wiso Basins, sediments were deposited when the epicontinental sea transgressed from both the north and south during the Middle Cambrian (550-450Ma). At this time Northern Australia was in the Northern Hemisphere (Shergold and Druve, 1980). As a result of faulting associated with these plate movements, subsidence of the hinterland occurred during late Ordian and an epicontinental sea migrated from the north and south. A sequence of silt-shale-chert and calcareous materials were deposited - Gum Ridge Formation - which rest unconformably on the Helen Springs Volcanics. They occur mainly along margins of the Tennant Creek Block - along the Ashburton and Whittington Ranges and in the southeastern corner of the sheet area. Vegetation is usually thicker over these sediments than over other formations. The Gum Ridge Formation consists of siliceous siltstone, chert, silicified limestone, sandstone and leached calcareous sandstone and it interfingers with the Anthony Lagoon Beds in the Georgina Basin (refer Figure 3).

At the close of the Ordian, in the Georgina Basin, a gentle orogenic pulse led to the emergence of the carbonate banks and a karstic topography was developed on which evaporites, halite, anhydrite and gypsum formed. This was followed by a rapid subsidence and deposition of carbonate sediments in a warm shallow sea (Anthony Lagoon Beds). This formation consists of a red bed sequence, composed of dolomite, red and purple shale and gypsiferous rocks.

TABLE 2 STRATIGRAPHY OF THE HELEN SPRINGS REGION

CAINOZOIC:

- Cza - Alluvium, some black soil
- Czb - Black and grey clayey soils, some sand and gravel
- Czs - Sand, sandy soils, some lateritic material

Tertiary

- Miocene Brunette Limestone (Tb) - 5m thick
White chalcedonic limestone with chert nodules, chalcedony, some sandstone
- Tertiary Laterite (Tl) - 6m thick
Laterite, ferruginous rubble, some soil cover

~~~~~ U N C O N F O R M I T Y ~~~~~

MESOZOIC:

Lower Cretaceous

- Mullaman Beds (K) - 43m thick  
Sandstone, pebbly sandstone, quartz sandstone, siltstone, siliceous claystone, siltstone with radiolaria, some cobbles and pebbles

~~~~~ U N C O N F O R M I T Y ~~~~~

PALAEOZOIC:

Middle Cambrian (Georgina Basin)

- Anthony Lagoon Beds (Cmy) - 55 to 350m thick
Sandstone and dolomitic siltstone, dolomite, dolomitic limestone with chert nodules
- Gum Ridge Formation (Cmg) - 3 to 150m thick
Fossiliferous siltstone and chert; silicified limestone; some sandstone and leached calcareous sandstone; silicified limestone

Middle Cambrian (Wiso Basin)

- Montejinni Limestone (Cmm) - 110m thick
Limestone, dolomite, siltstone

~~~~~ U N C O N F O R M I T Y ~~~~~

Lower Cambrian

- Helen Springs Volcanics (Clh) - 37m thick  
Basalt, basal sandstone and breccia

~~~~~ A N G U L A R U N C O N F O R M I T Y ~~~~~

PRE-CAMBRIAN: LOWER PROTEROZOIC

Tennant Creek Block

- Tomkinson Creek beds (Plt)
- Plt1 - Dolerite sill
- Plt2 - Medium to very fine grained quartz sandstone with mud clasts
- Plt3 - Medium to very coarse grained sandstone, minor conglomerate, dolomite breccia
- Plt4 - Siltstone, some thin interbeds of fine grained sandstone
- Plt5 - Calcareous siltstone, limestone, dolomite, some leached carbonate rocks
- Plt6 - Chert, siliceous siltstone (largely surface alteration of underlying carbonate-bearing rocks).

Source 1:250 000 Geological Map, BMR (1969)

Note: Stratigraphy and lithology of each bore is available in a tabulated form as a supplement to this commentary.

Usually these sediments are overlain by black soils and Tertiary laterites/limestones.

There is no record of any sedimentation in the sheet area between the Middle Cambrian and the Cretaceous. During this period the Ashburton-Whittington Ranges were uplifted, forming a broad arch. Erosional planation removed most of the Cambrian rocks from the uplifted area and formed the Ashburton Surface of Hays (Hays, 1967). A later cycle of erosion, probably preceded by warping and uplifting, produced a differentially eroded surface before deposition of Lower Cretaceous sediments occurred. Lower Cretaceous sedimentation began with deposition of fresh water sediments, probably both fluvial and lacustrine. A later widespread Albian marine transgression left behind fine-grained sediments. Further uplift and warping was followed by erosion of areas of less resistant rocks to a surface of low relief, the Tennant Creek Surface of Hays (1967). Favourable rock types of this surface were laterised in a warm humid climate in the Lower Tertiary and produced Tertiary Laterites. Some erosion of the Tertiary Laterites was followed by deposition of the Miocene Brunette Limestone in freshwater to brackish lakes. Laterisation on rises may have continued during deposition of the Limestone in depressions.

Since Miocene time, erosion of the higher country and deposition of alluvial fans and lake deposits have proceeded. Pedocalcic soils have developed in the lower areas and sandy colluvial deposits have been partly reworked by streams and wind action. Warping to form the internal drainage basins could have been initiated before deposition of the Miocene Limestone and has possibly continued to the present day.

4. HYDROGEOLOGY

Three distinct hydrogeological environments exist in the Helen Springs Region, of which two are sedimentary basins (Georgina and Wiso) separated by the Tennant Creek Block. Carbonate rocks in all these three environments have good groundwater potential.

Aquifers have been classified according to their potential with consideration

of their lithological, stratigraphical and/or structural characteristics. At 1:250 000 scale, aquifer units have been represented according to stratigraphic Formation or Group and categorised according to the groundwater resources potential that is typical for the unit without further subdivision. A summary of bore statistics is contained in Table 3.

4.1 Carbonate Rock Aquifers

4.1.1 Georgina Basin

In the Georgina Basin, the major aquifers have been developed in carbonate rocks of the Gum Ridge Formation and the Anthony Lagoon Beds of Middle Cambrian age. Regional groundwater flow direction is to the north-west, as indicated on the Hydrogeological Map.

Gum Ridge Formation (Cmg)

The Gum Ridge Formation overlies the Helen Springs Volcanics which rest with unconformity on the Tennant Creek Block. In the Georgina Basin it either underlies or interfingers with the Anthony Lagoon Beds. The Gum Ridge Formation covers about 15% of the Helen Springs map sheet area with a total of 36 bores in this Formation. This represents about 17% of the total number of bores. The Formation consists of fossiliferous siltstone and chert, silicified limestone, some sandstone and leached calcareous sandstone and silicified limestone. The depth to water intersections varies from 15 to 168 (90 to 160m AHD) in the Georgina Basin, while within inliers in the Tennant Creek Block water intersections may occur as high as 288m AHD. The surface expression of this formation is represented by the physiographic Sand Plains in the Georgina Basin with relatively dense vegetation. Groundwater recharge in the Gum Ridge Formation is primarily by infiltration of water from seasonal creeks. Regional groundwater flow direction in the Gum Ridge Formation is to the east north-east. Most of the discharge from the Gum Ridge Formation is by throughflow into the Anthony Lagoon Beds. Average standing water level in this unit ranges from 15m (175m AHD) in the west to 90m (170m AHD) in the east near the contact with the Anthony Lagoon Beds. Aquifer yields range from 0.5 to 5.0 L/s with possibility of higher yields (25 L/s) if cavities are present in the limestone.

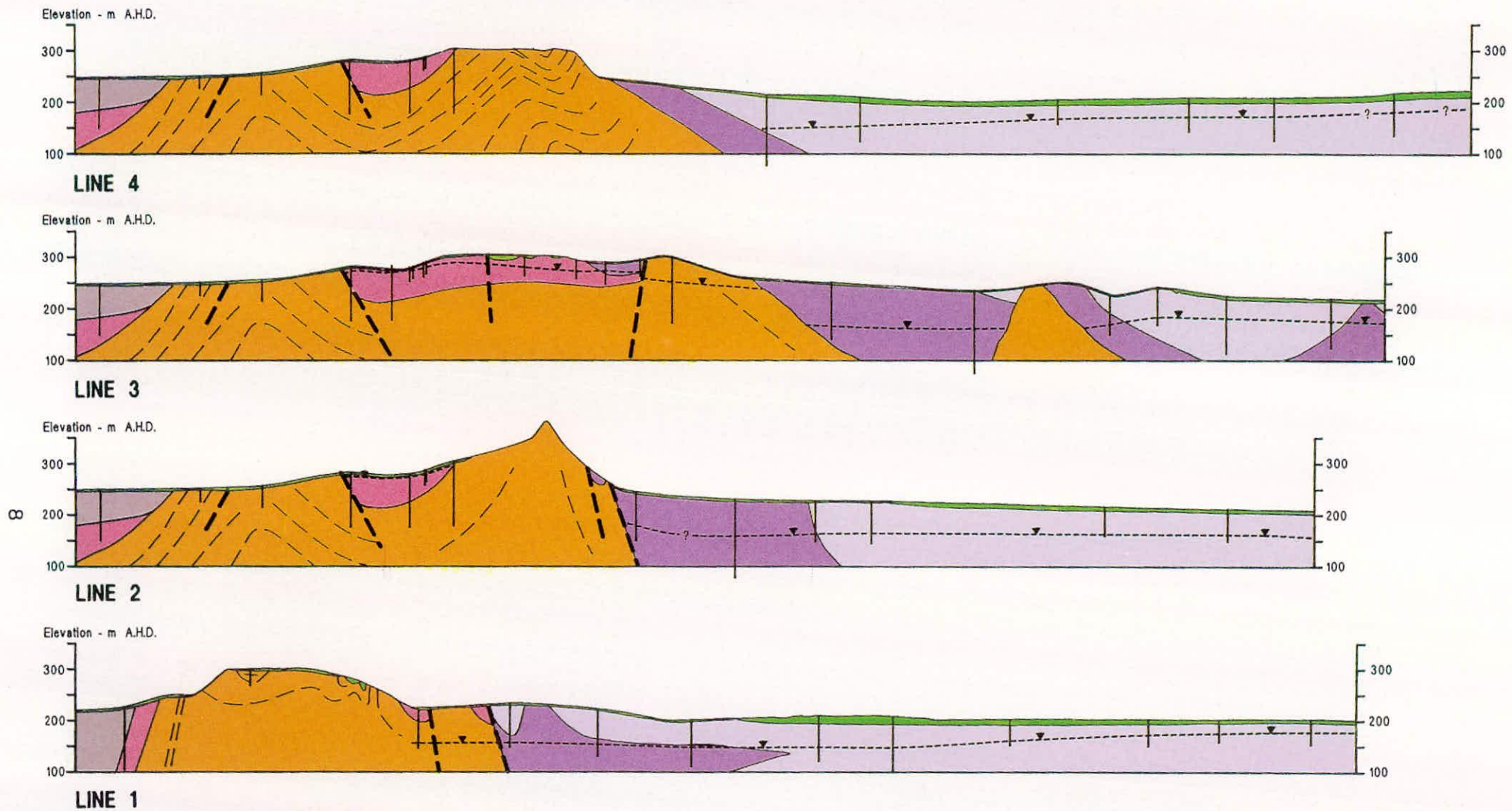


Figure 3 : **GEOLOGICAL CROSS-SECTIONS
OF LINES 1, 2, 3 & 4 (looking north)**

(See Figure 2 for locations of Cross-sections)

km 0 10 20 30

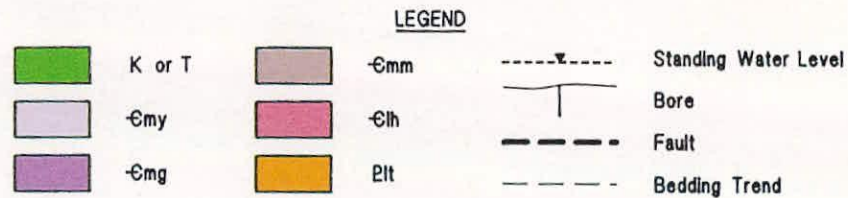


TABLE 3 BORE STATISTICS

| Aquifer | | Total Bores | | Areal Extent | SWL | Yield |
|----------------|---------------------|-------------|----|--------------|--------------------|-------------|
| Unit | Depth Range (m bgl) | No | % | % | m AHD (m bgl) | range (L/s) |
| Cmy | 35 - 144 | 110 | 52 | 52 | 160-180
(18-76) | 1.0-12.0 |
| Cmg | 15 - 168 | 36 | 17 | 15 | 170-177
(15-91) | 0.5- 5.0 |
| Cmm | 56 - 93 | 5 | 2 | 1 | 165-175
(24-49) | 0.5- 5.0 |
| Clh | 2 - 64 | 20 | 9 | 1 | 160-290
(1-67) | 0.5- 5.0 |
| Plt | 2- 140 | 47 | 22 | 33 | 194-280
(2-86) | 0.1- 5.0 |

bgl - below ground level

Anthony Lagoon Beds (~~Cmy~~)

Anthony Lagoon Beds cover about 50% of the Helen Springs map sheet area and a total of 110 bores have been drilled in this aquifer unit. This is over 50% of the total number of bores drilled in the Helen Springs map sheet area. This formation consists of dolomite, sandstone, dolomitic siltstone and dolomitic limestone with chert nodules. The depth to where water supplies are intersected varies from about 35 to 145m (100 to 150m AHD). Yields ranging from 0.5 to 25.0 L/s make these aquifers the most productive on this map sheet.

Recharge to the Anthony Lagoon Beds aquifers is by (a) direct infiltration of rainwater, (b) infiltration of water from the Tarrabool Lake and other small seasonal lakes and (c) groundwater throughflow from the Gum Ridge Formation from the west. Water level and water quality data indicate that (b) is the major source of recharge.

The amount of recharge can be gauged from a comparison with data reported for a similar study area within the Georgina Basin located approximately 200km to the south in the vicinity of Warrabri (Ali Curung). This area has a mean annual rainfall of 350mm, as compared to Helen Springs with 446mm, with similar seasonal and long-term distribution. Water levels from two bores in the Warrabri area (Figure 4) have been compared with rainfall from the nearest rainfall stations - Barrow Creek and Tennant Creek (Jolly, 1991). The data shows that there was a 8.6m rise in water levels during the mid 1970s due to very much above average rainfalls (ie >600mm). These declined

to their original levels in the late 1980s. The return period for an annual rainfall in excess of 600mm is 15 years in the Warrabri area.

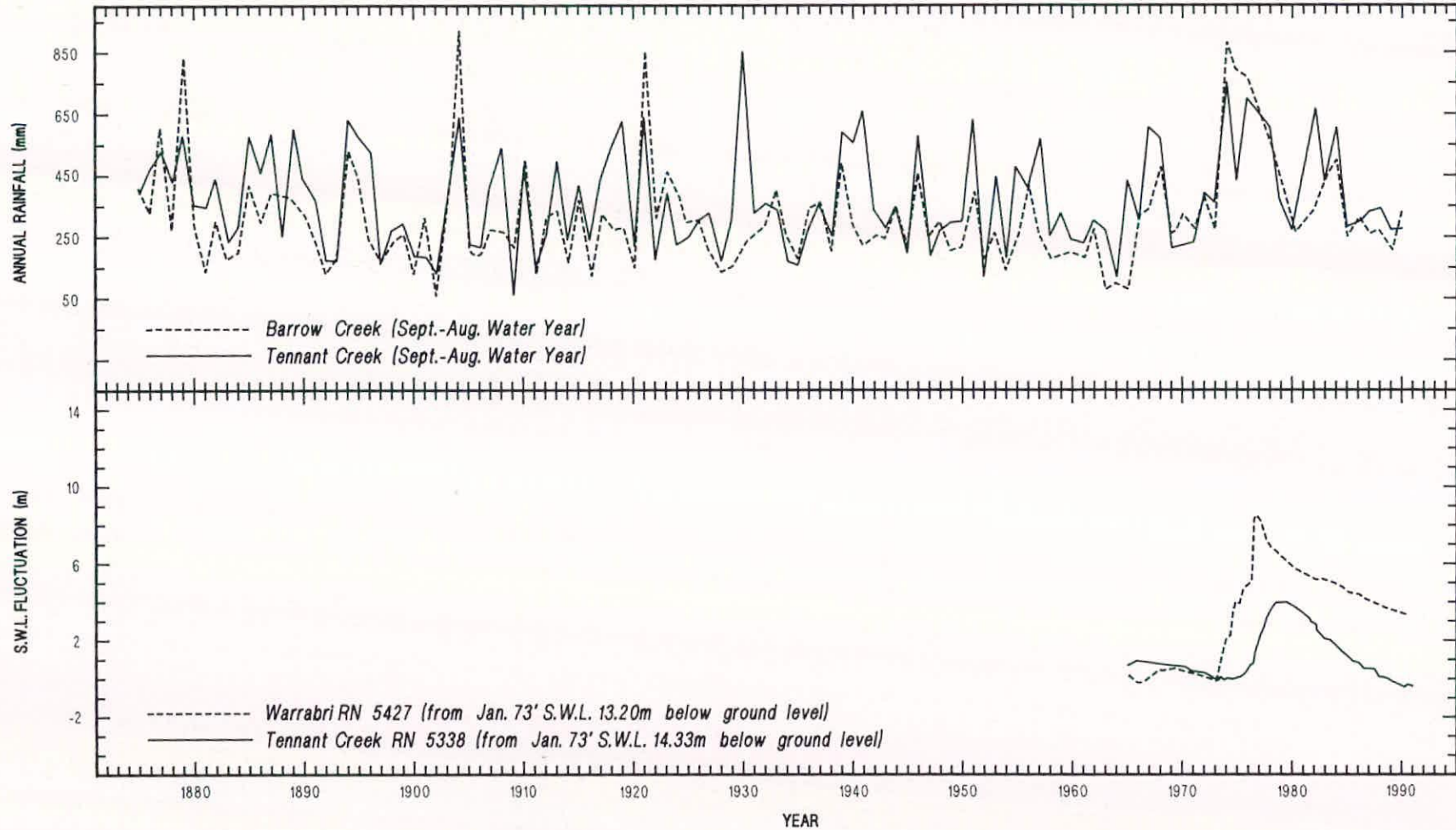
Regional groundwater flow direction in the Anthony Lagoon Beds is to the northwest. Standing water levels vary from 20m (160m AHD) in the north to 75m (180m AHD) in the east around the major recharge area, while in the south, levels are around 50m (175m AHD).

4.1.2 Wiso Basin

The Wiso basin, which contains mainly Palaeozoic rocks, was formerly known as the Wiso Tableland (Randal, 1973). On the Helen Springs map sheet area Middle Cambrian Montejinni Limestone covers about 1% of the total map sheet area and overlies the Helen Springs Volcanics.

Montejinni Limestone (~~Cmm~~).

The Montejinni Limestone is a lateral equivalent of the Tindall Limestone which is a major aquifer in the Daly Basin. Montejinni Limestone consists of limestone, dolomite and siltstone. Yields from the five bores drilled into it on the Helen Springs sheet range from 0.5 to 5.0 L/s (yields of up to 25 L/s are feasible if cavities are intersected). Groundwater flow direction in this aquifer is towards the west and north-west. Recharge is from (a) direct infiltration of rain water, (b) runoff from the Ashburton and Whittington Ranges and (c) Lake Woods (mainly north of this sheet area). Recharge from Lake Woods is considered to be the major source. Standing water levels vary from 24 to 49m (175 to 165m AHD), which are similar to Georgina Basin water levels.



Source : P Jolly and D Chin (1991) - Long Term Rainfall Recharge Relationships within the N.T.

Figure 4 : WATER LEVELS AND RAINFALL DATA FOR BARROW CREEK AND TENNANT CREEK

4.2 Volcanic Rock Aquifers Helen Springs Volcanics (€lh)

Helen Springs Volcanics consist of basalt, basal sandstone and breccia and occur both in the Wiso Basin and on the Tennant Creek Block. The areal extent of this aquifer is limited to about 1% of the total map sheet area. There are 20 bores (9% of the total) in this formation.

In the Wiso Basin, the Helen Springs Volcanics are overlain by the Montejinni Limestone with unconformity. No major aquifer has been intersected in the Volcanics within the Wiso Basin on this map sheet area. On the Tennant Creek Block, however, aquifers in the Helen Springs Volcanics have been found to be productive. Aquifer depths vary from 2m (220m AHD) to 64m (295m AHD). Water levels within the Tennant Creek Block range from about 1m (290m AHD) in the south near Banka Banka Station to about 65m (160m AHD) north of the Helen Springs Homestead. Average yield ranges from 0.5 to 5.0 L/s.

4.3 Fractured Rock Aquifers Tennant Creek Block - Tomkinson Creek Beds (Plt)

Fractured rock aquifers occur in the Tomkinson Creek Beds in the Tennant Creek Block. Rock types consist of quartz sandstone with mud clasts, pebbly sandstone, glauconitic sandstone, calcareous siltstone, siliceous siltstone, dolomite, chert, limestone, minor conglomerate and dolomite breccia and dolerite sills. Groundwater potential in the Tomkinson Creek Beds (Plt) is generally low ranging from 0.1 to 0.5 L/s. Yields may improve if rocks are fractured and/or coarse-grained sandstone and/or carbonaceous rocks are present. Often drilling is very difficult due to the abrasiveness of the fine grained ferruginous sandstone. Aquifer depth generally varies from 2m (147m AHD) to 140m (203m AHD). Standing water levels vary from about 2m (280m AHD) around Banka Banka Station in the south to 85m (194m AHD) around Powell Creek in the north.

5. GROUNDWATER QUALITY

Chemical analysis results of the Helen Springs sheet area have been summarised and shown in a modified Durov Diagram (refer Hydrogeological Map and Figure

5). Groundwater quality in the Helen Springs Region varies from one formation to another. This can be related to both their depositional environments and the distance from a major recharge source. A comparison of water quality for the different formations is shown in Table 4.

5.1 Georgina Basin

In the Georgina Basin, the groundwater is usually alkaline and of moderate salinity. Contours of TDS, SO₄ and Fluoride (Figure 6) and of SAR and HCO₃/Cl ratio (Figure 7) indicate the general chemical trend in the area.

Gum Ridge Formation

Salinity and hardness in the Gum Ridge Formation are normally within the acceptable limits for potable water of the guidelines of the National Health and Medical Research Council (NHMRC). Sulphate (SO₄) values range up to 240 mg/L and average about 100 mg/L and the average TDS is around 500 mg/L. Higher concentrations of Sulphate (SO₄) and TDS are normally found along the boundary with the Anthony Lagoon Beds (viz. Bores 1198, 20445 and 21119). Concentrations of Fluoride (F) are generally below 1.0 mg/L.

Anthony Lagoon Beds

Concentrations of TDS and SO₄ in the groundwater of the Anthony Lagoon Beds are usually high on this map sheet area. This is due to evaporites (mostly gypsum) developed during the depositional period. Salinity is lower (TDS <500 mg/L) around Lake Tarrabool, where SO₄ values are also lower (<200) indicating that this is a major recharge area (Figure 6). In this recharge area the SAR value is also lower (2), while HCO₃/Cl ratio is also higher (Figure 7). Water in the central region is brackish to moderately saline. Concentration of Fluoride ranges from 0.5 to 3.9 mg/L.

Water sampling for the analysis of Tritium (TU) and Deuterium (D) and Oxygen¹⁸ (O¹⁸) was carried out during June 1990 within the Anthony Lagoon Beds. Analysis was carried out by ANSTO (Australian Nuclear Science and Technology Organisation) and results are given in Table 5.

The plot of D% vs O¹⁸% (Figure 8) shows two different groups of data exist in the area. The first group was obtained

TABLE 4 A COMPARISON OF WATER QUALITY

| AQU | NA | TDS
mg/L | pH | SO ₄
mg/L | HCO ₃
mg/L | F
mg/L | SAR
Ratio | Hardness
(CaCO ₃) | HCO ₃ /Cl
Ratio |
|-----|----|-------------|---------|-------------------------|--------------------------|-----------|--------------|----------------------------------|-------------------------------|
| €my | 78 | 500-5160 | 7.0-8.9 | 100-1861 | 67-756 | 0.5-3.9 | 0.4-15 | 216-820 | 0.1-15 |
| €mg | 15 | 360-1430 | 7.0-8.5 | 7- 240 | 151-605 | 0.1-1.0 | 1.0-3.3 | 236-720 | 0.5-2.0 |
| €mm | 2 | 340- 510 | 7.8-8.2 | 14- 87 | 178-400 | | | 222 | |
| €lh | 16 | 35-2433 | 6.9-8.0 | 2- 800 | 6-583 | | | 279-500 | |
| Plt | 24 | 35-5095 | 5.1-8.3 | 5- 604 | 5-165 | | | 13-4100 | |

AQU - Aquifer Unit. NA - Number of analyses

Note: Data where available for each bore is available in tabulated form as a supplement to this commentary.

TABLE 5 WATER ANALYSIS RESULTS OF TRITIUM, DEUTERIUM AND OXYGEN¹⁸

| RN | Tritium
(TU) | D
% | O ¹⁸
% | SO ₄
(mg/L) | SWL
(m bgl) | Aquifer Depth
(m bgl) |
|-------|------------------|--------|----------------------|---------------------------|----------------|--------------------------|
| 104 | 0.5±0.3; 0.2±0.3 | -35.4 | -7.51 | 165 | 55.8 | 73, 82.3 |
| 22862 | 0.0±0.3; 0.0±0.3 | -37.6 | -8.16 | 98 | 51.0 | 57 - 70 |
| 5947 | 0.0±0.3; 0.0±0.3 | -36.6 | -7.72 | 160 | 54.9 | 79.2 |
| 1291 | 0.0±0.3; 0.0±0.3 | -37.9 | -8.03 | 192 | - | - |
| 21708 | 0.0±0.3; 0.3±0.3 | -27.1 | -6.05 | 42 | 52.0 | 60 |
| 393 | 0.0±0.3; 0.4±0.3 | -27.2 | -5.97 | 341 | 51.8 | 82 |
| 1288 | 0.4±0.3; 0.2±0.3 | -29.1 | -6.10 | 380 | - | - |
| 7672 | 0.3±0.3; 0.3±0.3 | -38.2 | -8.16 | 167 | 68.6 | 77.5 |
| 25562 | 0.1±0.3; 0.4±0.3 | -27.9 | -5.99 | 1185 | 51.0 | 63, 91 |
| 376 | 0.3±0.3; 0.3±0.3 | -27.4 | -6.24 | 908 | 45.7 | 53 |
| 7887 | 0.0±0.3; 0.2±0.3 | -37.3 | -7.75 | 360 | 68.6 | 91.4, 115.8 |
| 140 | 0.2±0.3; 0.1±0.3 | -25.2 | -5.35 | 1267 | 44.2 | - |
| 21756 | 0.3±0.3; 0.1±0.3 | -35.1 | -6.41 | 860 | 42.0 | 70,73 |
| 25560 | 0.5±0.3; 0.3±0.3 | -27.6 | -6.01 | 849 | 34.0 | 42 - 55 |
| 26266 | 0.0±0.3; 0.6±0.3 | -27.9 | -6.07 | 185 | 19.0 | 36, 58 - 64 |
| 2330 | 0.0±0.3; 0.2±0.3 | -28.9 | -6.08 | 65 | - | - |

Deuterium (D) and Oxygen¹⁸ (O¹⁸) in % rel VSMOW (Vienna Standard Mean Ocean Water); RN - Bore Registration Number; Depths in metres and below ground level.

from bores 104, 1291, 5947, 7672, 7887 and 22862, located on the western margin of the Anthony Lagoon Beds. Recharge occurs due to infiltration of floodwaters from creeks draining the Ashburton and Whittington Ranges. These floodwaters infiltrate through sands beneath the floodouts of these creeks and recharge the aquifers in the Anthony Lagoon Beds.

The second group of data was from bores 376, 393, 2330, 1288, 21708, 25560, 255562 and 26266, located further to the east. Recharge occurs due to ponding of floodwaters in ephemeral lakes on the black soil Downs Country. Recharge to aquifers in the Anthony Lagoon Beds occurs through infiltration through the bottom of these lakes over periods of months. The resultant evaporation results in a water that is isotopically higher in both Deuterium and Oxygen¹⁸. The graph (Figure 8) shows that the Local Meteoric Waterline lies to the right of the above data

points. This significant deviation could be due to infiltrating water percolating through gypsum contained in the Anthony Lagoon Beds. Isotopic exchange results in data points lying above the Local Meteoric Water Line (IAEA Report, 1983). Gypsum occurs in significant amounts within the Anthony Lagoon Beds.

For age determination of groundwater, Tritium (TU) data over a number of years, possibly ten years, is required. At present, the data collected is from a single point in time, which indicates that the age of groundwater in this region is greater than 50 years (pre-nuclear testing in the Pacific region).

5.2 Wiso Basin Montejinni Limestone

The best groundwater quality in this map sheet area is found in the Montejinni Limestone, due to the very low concentrations of sulphate (SO₄), calcium carbonate (CaCO₃) and salinity

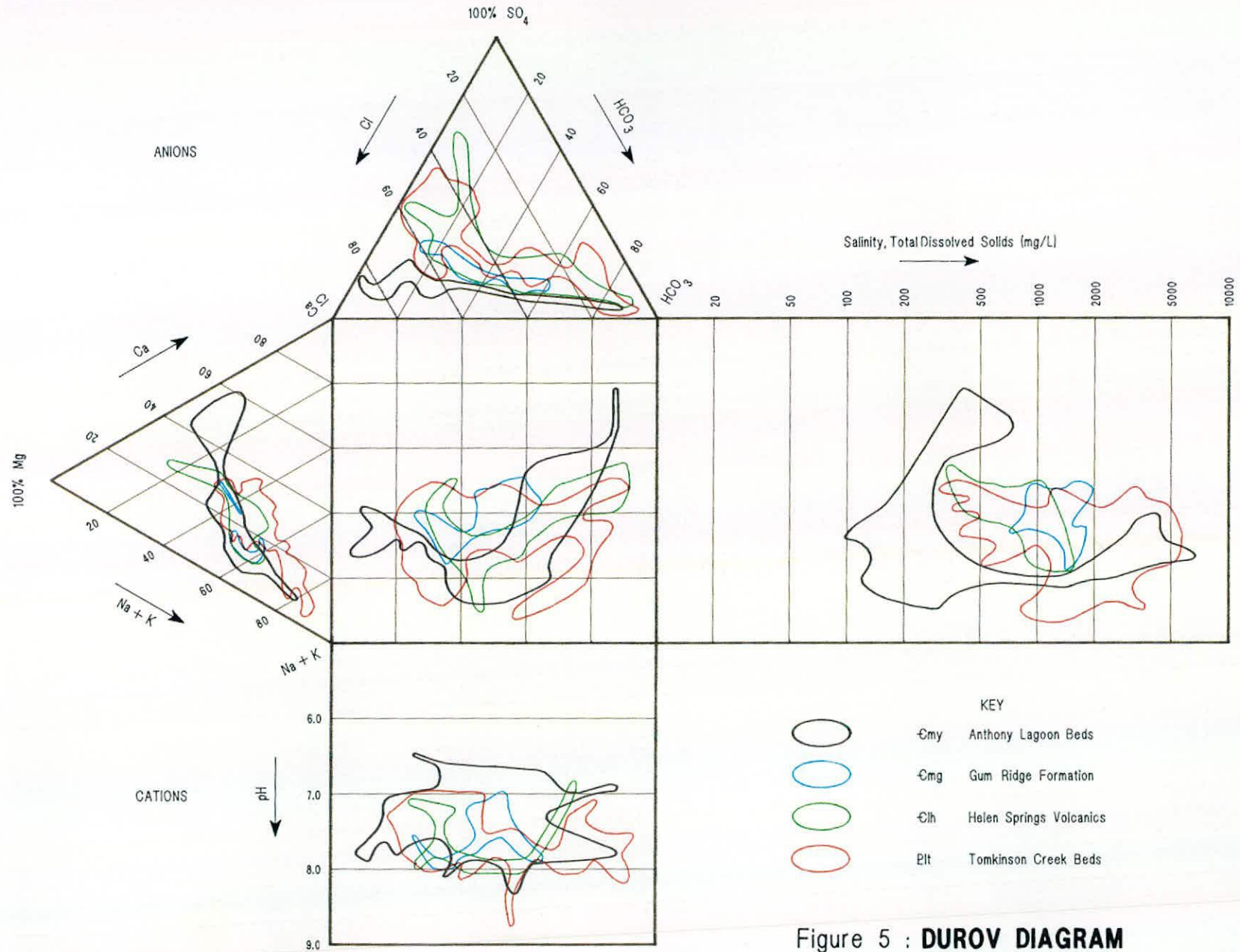


Figure 5 : DUROV DIAGRAM

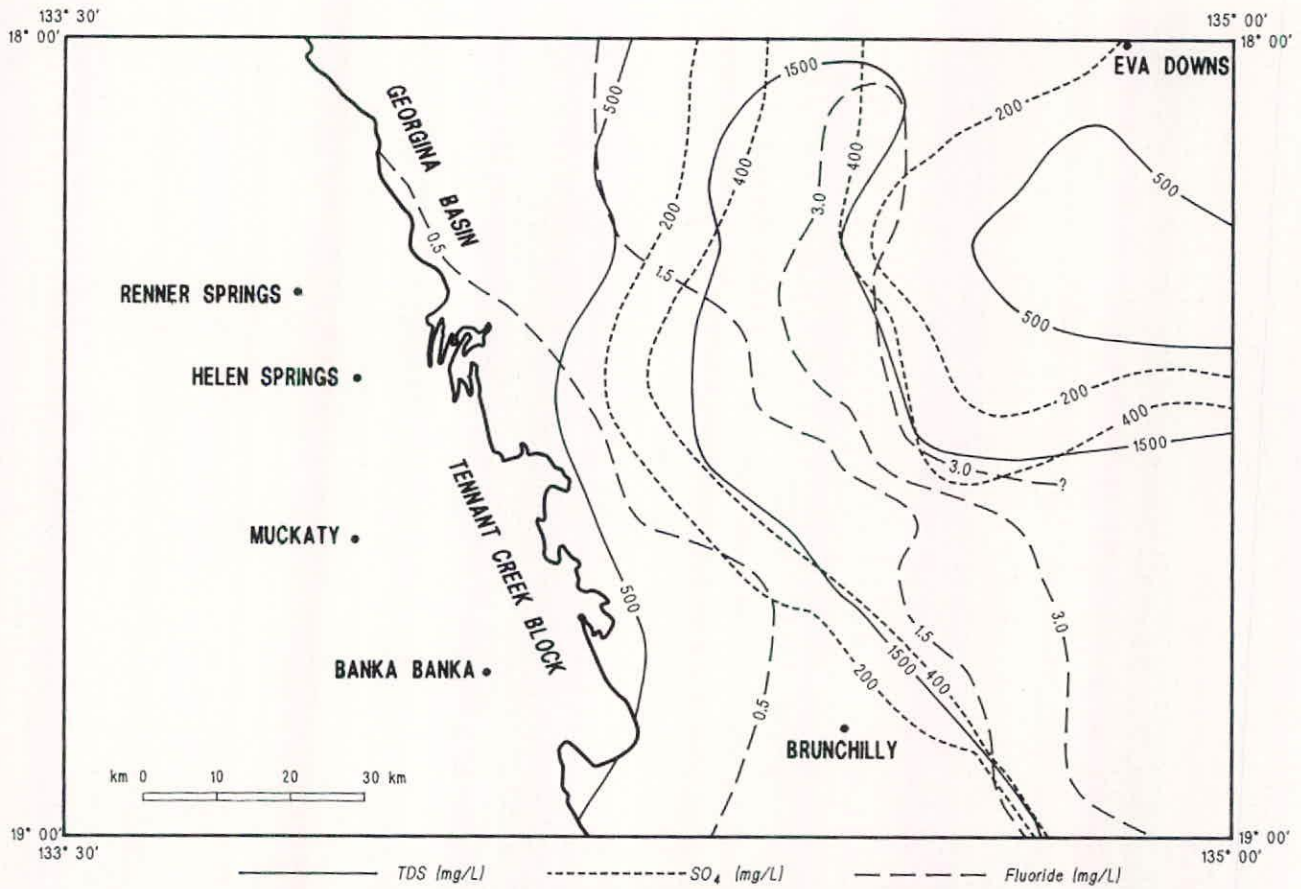


Figure 6 : TDS, SO_4 AND FLUORIDE CONTOURS FOR GEORGINA BASIN

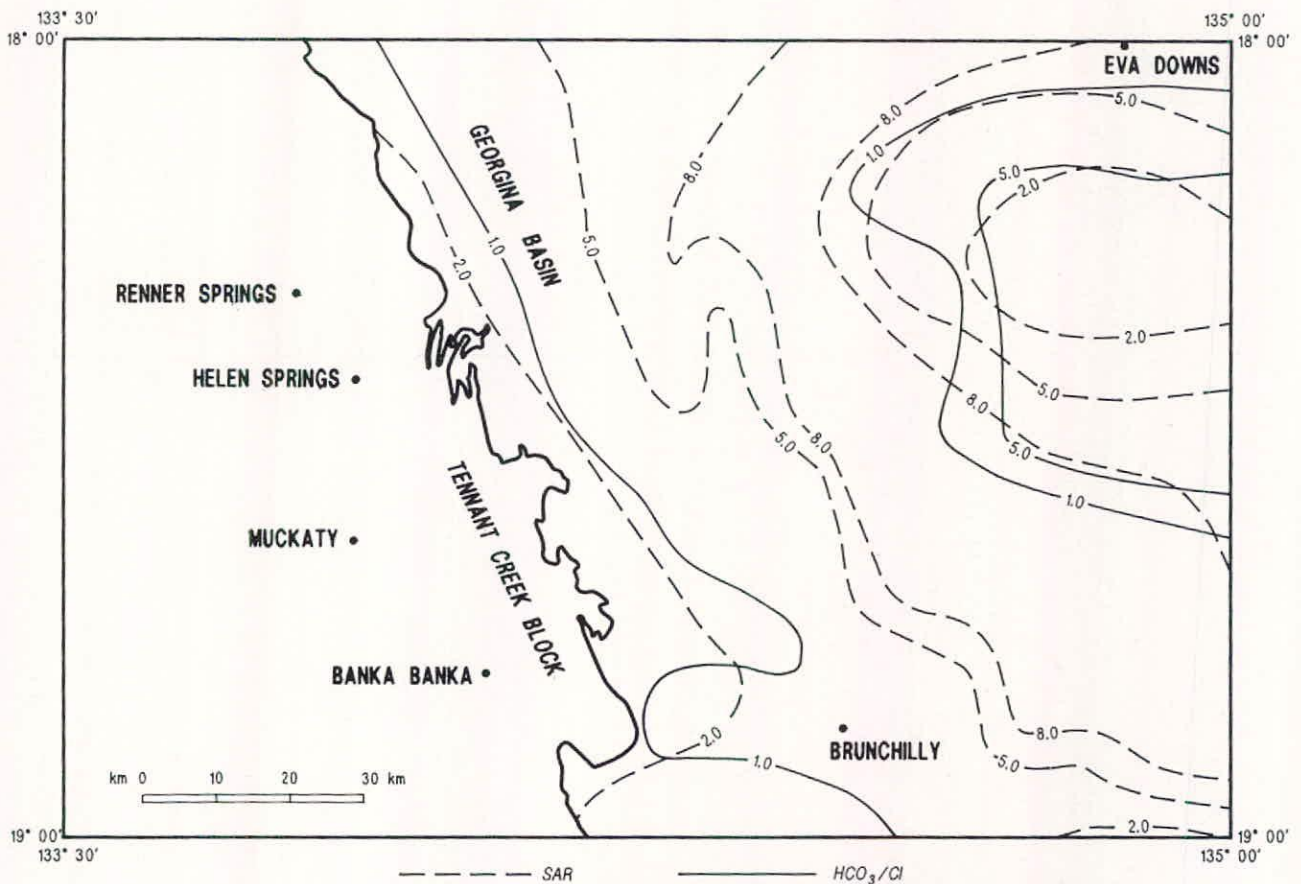


Figure 7 : SAR AND HCO_3/Cl CONTOURS FOR GEORGINA BASIN

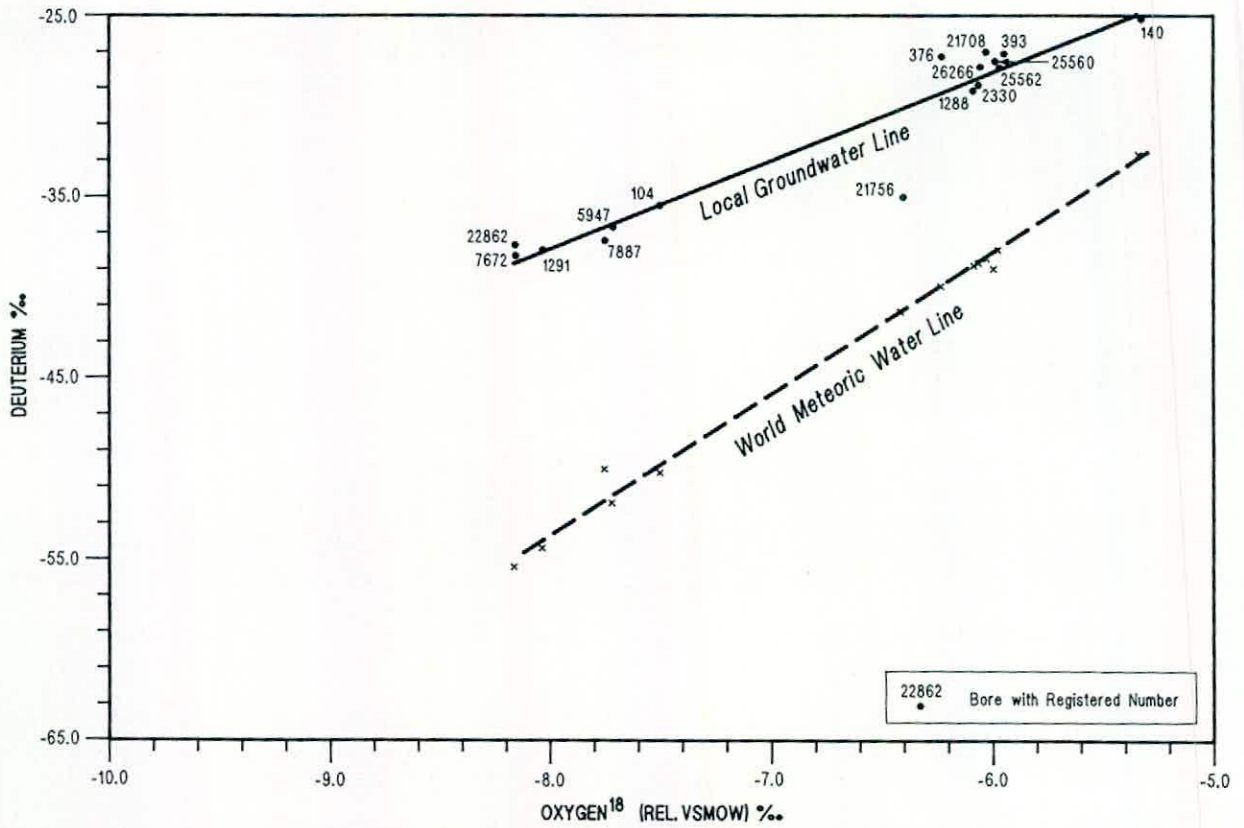


Figure 8 : DEUTERIUM - OXYGEN ¹⁸ GRAPH FOR GEORGINA BASIN

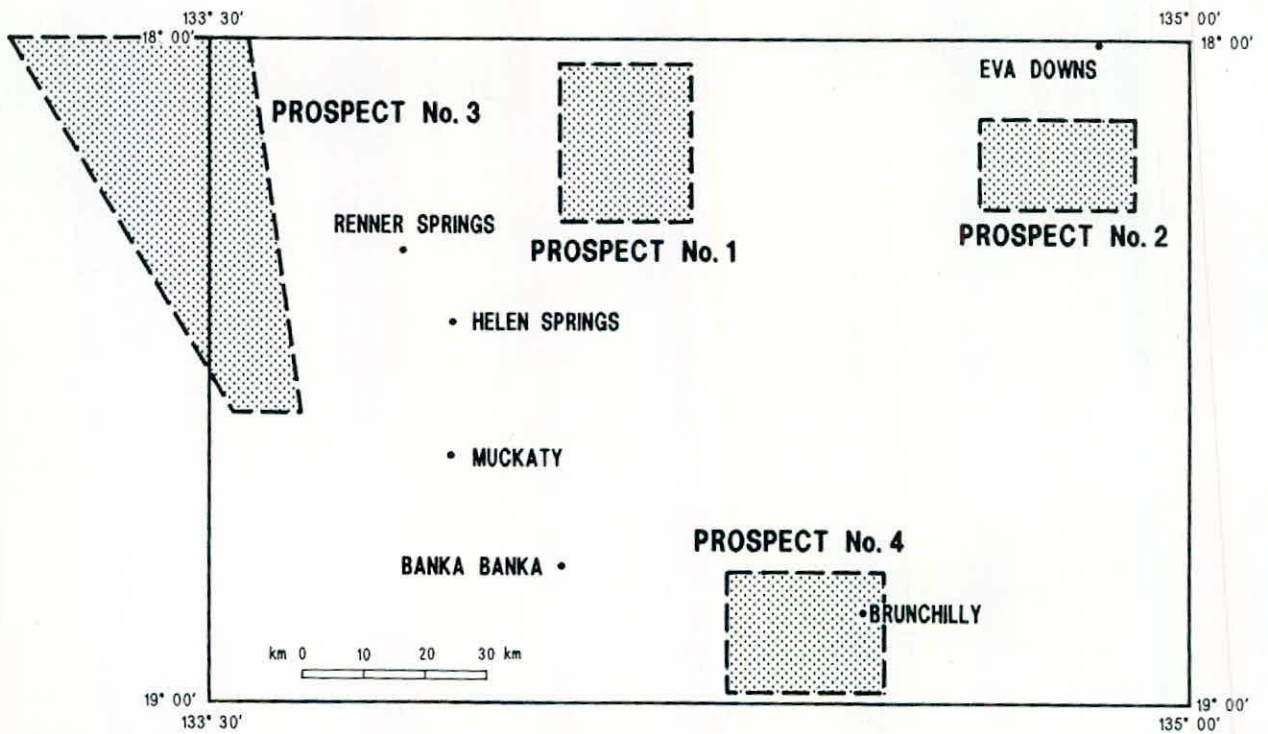


Figure 9 : POTENTIAL AREAS FOR HORTICULTURAL DEVELOPMENT

(Refer Domahidy, 1989)

(TDS). These low concentrations may be attributed to the depositional environment, which was similar to the Gum Ridge Formation, and also to location as the bores are in close proximity to recharge (at the edge of the Wiso Basin).

Groundwater recharge eventuates primarily when a large volume of runoff from the Tennant Creek Block occurs. Significant groundwater recharge also results from the infiltration of water from Lake Woods.

The quality of water from this aquifer is within acceptable limits of guidelines for potable water of the National Health and Medical Research Council (NHMRC).

5.3 Volcanic Rock Aquifers

Helen Springs Volcanics

Water quality in the Helen Springs Volcanics varies depending on its location and is highly influenced by either overlying or underlying formations. However, a typical groundwater in this rock is generally potable. This aquifer is most exploited in the Helen Springs Station area.

5.4 Tennant Creek Block

Tomkinson Creek Beds

Groundwater in the fractured rocks of the Tomkinson Creek Beds (Plt) is generally potable, except in two small areas where it is more saline due to higher concentrations of TDS and SO_4 . Three distinct ranges of TDS have been noted which depend on the location, aquifer depth and yield of the bore. They are: (a) Along the Morphett Creek about 11km (along the Stuart Highway) south of Banka Banka. TDS ranges from 2580 to 3370 mg/L and aquifer depths range from 35 to 42m. (b) Bores along the Tomkinson Creek near the western edge of the Tennant Creek Block (bore 7147) have a TDS range from 3710 to 4790 mg/L with aquifer depths between 23 and 25m. (c) The remainder of the areas underlain by this formation have TDS values ranging from 35 to 1410 mg/L and aquifer depths are deeper than for the other two areas. Low concentrations of TDS and SO_4 in the majority of the areas indicate that generally the groundwater in the Tomkinson Creek Beds is of good quality.

6. PROSPECTIVE AREAS FOR HORTICULTURE

In the Helen Springs map sheet area, extensive aquifers of moderate to high permeability occur in the Georgina and Wiso Basins, although there are local variations in porosity and permeability. Four prospective areas for water supplies for horticultural development have been identified in the Helen Springs map sheet (Domahidy, 1989) and are shown in Figure 9. Groundwater quality is the main factor in selection of these areas. The upper limit of salinity (TDS) tolerance for most crops is in the range of 700 to 2000 mg/L. However, allowance must be made for the infiltration and recycling of irrigation water, thereby increasing salt concentrations. The sodium hazard to plants is very high where sodium adsorption ratios (SAR) are greater than 15 in irrigation water of marginal quality (Linsley and Franzini, 1972). The four prospective areas (Nos. 1, 2, 3 and 4) are briefly summarised in the following paragraphs.

It should be noted that prospective yields as high as 25 L/s should be achievable at sites within each of these prospects. Low yields airlifted to date can be attributed to the fact that groundwater development methodology has been targetted at the location of low yielding (1 to 2 L/s) bores for the watering of cattle. With appropriate hydrogeological investigation work being undertaken for each prospect, supplies of 25 L/s per bore are achievable.

Prospect No 1

This Prospect is located north-east of Helen Springs Station and covers an area of about 25km (north-south) by 20km (east-west) on the 'black soil plains'. The surface is covered by deep grey and yellow-grey cracking clays underlain by carbonate rocks of the Anthony Lagoon Beds. There are four (4) existing bores within this area and all are in operation. Standing water levels in this prospect vary from 50 to 56m. Two of the bores near the eastern and western edges yield water of marginal quality, around 1100 mg/L TDS. The others yield water of less than 800 mg/L TDS. Sodium adsorption ratios (SAR) are generally low, except for water from the northern most bore. Aquifers are recharged by infiltration of water from the

floodouts of Renner, Koo-Nana, McKinlay and Jaromah Creeks, as well as throughflow from the Gum Ridge Formation aquifers.

Prospect No 2

This Prospect is located in the northeast corner of the Helen Springs map sheet, west of Lake Tarrabool, and covers an area of 25km (east-west) by 15km (north-south). It has similar soils to Prospect No.1. There are four existing bores within this Prospect, of which three are in operation, and all of them are in carbonate rocks of the Anthony Lagoon Beds. Airlift yields were up to 2.3 L/s. Standing water levels are approximately 30m and aquifer depth ranges between 60 and 80m. Groundwater salinity varies from 320 to 650 mg/L TDS and SAR values range from 4 to 14. Recharge to this area is from the east from Lake Tarrabool.

Prospect No 3

Prospect No 3 is on the eastern margin of the Wiso Basin covering an area of about 62km by 30km. On the Helen Springs map sheet area it is located in the north-west. Standing water levels are 40 to 50m and depths to major water yield varies between 45 and 75m. Airlift yields have been up to 3.8 L/s. Groundwater quality is suitable for the irrigation of crops and ranges from about 340 to 510 mg/L TDS. The low salinity suggests relatively high rates of recharge from water discharging from seasonal creeks on the western side of the Ashburton Range and also recharge from Lake Woods. Aquifers are in the Montejinni Limestone. Its thickness increases to the west.

Prospect No 4

Prospect Number 4 is located east of Brunchilly Station in the southeast corner of the Helen Springs map sheet and covers an area of about 25km (east-west) by 20km (north-south). There is an outlier of the Tomkinson Creek Beds in this prospect area. Most of the area is underlain by the Gum Ridge Formation with a small part covered or interfingered by the Anthony Lagoon Beds. Airlift yields range from 1.3 to 2.3 L/s. Aquifers are in the carbonate rocks of the Anthony Lagoon Beds or Gum Ridge Formation and large cavities may be intersected in this area (as encountered in bore 23908). A large yield from these cavities is expected

when they occur below the water table. Due to the occurrence of Lower Proterozoic outliers, aquifer depths in this prospect area vary between 78.0 and 144.0m and standing water levels range from 73.0 to 91.4m. Groundwater is of variable salinity, and marginal quality for irrigation use. Salinities range from 980 to 1430 mg/L TDS, and SAR values range from 14 to 32.

6.1 Sustainable Yield of Each Prospective Horticultural Area

The sustainable yield for each prospect area has been estimated. The estimate has been based on both groundwater throughflow and groundwater storage calculations. The values utilised for the relevant hydraulic parameters required to determine these estimates are based on work in similar rock types (and ages). These values are:

T= Transmissivity - ranges from 500 to 2000m²/day

i= Hydraulic gradient - ranges from 5x10⁻⁵ to 20x10⁻⁵

Sy= Specific yield of 3%.

Based on these values, the upper (Qu) and lower (Ql) bounds for the estimate of groundwater throughflow for each prospect are:

Prospect No 1:

Qu= 10,000 m³/d (120 L/s)

Ql= 600 m³/d (7 L/s)

Prospect No 2:

Qu= 8,000 m³/d (90 L/s)

Ql= 500 m³/d (6 L/s)

Prospect No 3:

Qu= 24,000 m³/d (280 L/s)

Ql= 1,500 m³/d (17 L/s)

Prospect No 4:

Qu= 12,000 m³/d (140 L/s)

Ql= 750 m³/d (9 L/s)

Based on the estimated specific yield value of 3% (0.03), the volume of water held in storage per metre of aquifer thickness is :

Prospect No 1:

Q/m = Area x Sy
= 1.5x10⁷m³

Prospect No 2:

Q/m = 1.1x10⁷m³

Prospect No 3:
Q/m = $1.9 \times 10^7 \text{m}^3$

Prospect No 4:
Q/m = $1.5 \times 10^7 \text{m}^3$

Work by Jolly and Chin (Jolly, 1991) in a similar hydrogeologic environment indicated recharge rates of the order of 3m every 15 years. This equates to an average annual recharge (equivalent average daily continuous recharge rate given in brackets) for each prospect of:

Prospect 1:
 $3.0 \times 10^6 \text{m}^3$ (8,000m³/d)

Prospect 2:
 $2.2 \times 10^6 \text{m}^3$ (6,000m³/d)

Prospect 3:
 $3.8 \times 10^6 \text{m}^3$ (10,000m³/d)

Prospect 4:
 $3.0 \times 10^6 \text{m}^3$ (8,000m³/d)

It would be expected that recharge rates for Prospects 2 and 3 may be greater, due to the influence of adjacent ephemeral freshwater lakes, Lakes Tarrabool and Woods. Further studies of these lakes are required to quantify their impact on the sustainable yields of Prospects 2 and 3.

7. SUMMARY OF GROUNDWATER RESOURCES

The groundwater resources of the hydrogeological units shown on the Helen Springs Map are:

Gum Ridge Formation (Cmg)

Bore yields in the range of 0.5 to 5.0 L/s are available from moderately permeable aquifers in siltstone, chert, silicified limestone and calcareous sandstone. Yields of 25 L/s are possible if cavities are intersected. TDS ranges from 360 to 1430 mg/L and SO₄ concentrations from 7 to 240 mg/L.

Anthony Lagoon Beds (Cmy)

Sustainable bore yields in the range of 5.0 to 15.0 L/s can be obtained from this highly permeable unit in sandstone, dolomite, dolomitic siltstone and dolomitic limestone, which covers about 50% of this map sheet. Yields of 25 L/s are possible if cavities are intersected.

Water quality in this formation is variable, due to the presence of gypsum

and other evaporites with concentrations of TDS from 500 to 5,160 mg/L and SO₄ from 100 to 1861. Values of pH are between 7.0 and 8.9.

Montejinni Limestone (Cmm)

This aquifer unit on this map sheet covers only a very limited area. It consists of limestone, dolomite and siltstone in which sustainable yields range from 0.5 to 5.0 L/s. Yields of up to 25 L/s are feasible if cavities are intersected. Water quality in this formation is the best in the area. Concentration of TDS ranges from 340 to 510 mg/L and SO₄ values range from 14 to 87 mg/L.

Helen Springs Volcanics (Clh)

This aquifer unit consists of basalt, basal sandstone and breccia. Bore yields range from 0.5 to 5.0 L/s. TDS values range from 35 to 2433mg/L and SO₄ values range from 2 to 800 mg/L. This aquifer unit is limited to 2% of the map sheet area.

Fractured Rock Aquifers

Tomkinson Creek beds (Plt)

Fractured rock aquifers occur in the Tomkinson Creek beds which consist of coarse to fine grained quartz sandstone with mud clasts, siltstone, some thin interbeds of fine grained carbonate rocks, chert, siliceous siltstone (largely surface alteration of underlying carbonate bearing rocks), pebbly sandstone, minor conglomerate, dolomite breccia and dolerite. Bore yields are generally very low, ranging from 0.1 to 0.5 L/s. Water quality of this aquifer unit is variable, due in part to the lithological diversity from carbonaceous to non-carbonaceous rocks. TDS values range from 35 to 5095 mg/L and SO₄ values range from 5 to 604 mg/L. This aquifer unit covers about 33% of the map sheet area.

8. USE AND APPLICATION OF THE MAP

The 1:250 000 scale hydrogeological map of the Helen Springs map sheet can be used to :

- Provide a basic understanding of the hydrogeology of the region.
- Assist the planning of groundwater resource development and management
- Identify areas of groundwater resource potential to aid future

developments, particularly for pastoral and horticultural industries.

- Obtain hydrogeological data for application to land-use planning related to pastoral, horticultural and mining activities.
- Highlight areas of underdeveloped groundwater resources potential, where further expansion of pastoral and horticultural industries may be viable.

It is strongly recommended that users who are not familiar with the principles of hydrogeology utilise the map in combination with this commentary and specialist groundwater guidance.

9. REFERENCES

- Bultitude, R.J. (1972) - Geology and Petrology of the Helen Springs, Nutwood Downs and Peaker Piker Volcanics, B.M.R. Rec. 1972/74, Canberra.
- Bureau of Meteorology (1988) - Climatic Atlas of Australia, Bureau of Meteorology, Dept. of Science, Canberra, 1988.
- Domahidy, G. (1989) - Horticultural Water Supply Investigation, Tennant Creek, N.T. Rockwater Pty Ltd and Power and Water Authority, 1989.
- Hays, J. (1967) - Land Surfaces and Laterites in the Northern Territory, In Jennings, J.N. and Mabutt, J.A. LANDFORM STUDIES IN AUSTRALIA AND NEW GUINEA. Canberra, A.N.U. Press.
- IAEA (1983) - Isotope Techniques in the Hydrogeological Assessment of Potential Sites for the Disposal of High-Level Radioactive Wastes, International Atomic Energy Agency Technical Report No. 228, Vienna, 1983.
- Jolly, P. and Chin, D. (1991) - Long Term Rainfall-Recharge Relationships within the Northern Territory, Australia -The Foundations for Sustainable Development, Int. Hydrology and Water Resources Symposium, Perth, October 1991, pp824-829.
- Linsley, R.K. and Franzini, J.B. (1972) - WATER RESOURCES ENGINEERING, 2nd Edition, McGraw Hill, New York.
- National Health and Medical Research Council (1987) - Guidelines for Drinking Water Quality in Australia, Aust. Govt. Pub. Serv., Canberra, 1987.
- Randal, M.A. (1966) - Brunette Downs, N.T., Geological Series B.M.R. Explanatory Notes SE/53-11.
- Randal, M.A. (1967) - Groundwater in the Barkly Tableland, N.T. B.M.R. Bull No.91.
- Randal, M.A. (1969) - Groundwater in the Northern Wiso Basin and Environs, B.M.R. Record No. 1969/16.
- Randal, M.A. and Brown, M.C. (1969) - Helen Springs, N.T., 1:250 000 Geological Series Map and Explanatory Notes SE/53-10, Bureau of Mineral Resources, Canberra, 1969.
- Randal, M.A. (1969) - Hydrogeology of Southern Georgina Basin and Environs, Qld. and N.T., Geol. Survey of Qld. Publ.366, Dept. of Mines and Energy, Brisbane, April, 1978.
- Shergold, J.H. and Druce, E.C. (1980) - Upper Proterozoic and Lower Palaeozoic rocks of the Georgina Basin, In Henderson, R.A. and Stephenson, R.J., (Editors), The Geology and Geophysics of North Eastern Australia, Geol. Soc. of Aust. Inc., Qld.Div., 149-174, July, 1980.
- Ward, D.F. (1982) - Report on Geological Mapping and Geochemical Surveys, E.L. 2835 and E.L. 3607, Helen Springs, N.T., Esso Australia Ltd. - Mineral Dept.

10. ACKNOWLEDGEMENTS

The Hydrogeological Map of the Helen Springs Region and accompanying Explanatory Notes and Bore Data Base are the product of a combined effort by the Staff of Power and Water Authority (PAWA) of the Northern Territory. The Project Team comprised:-

P B Jolly Project Coordinator

M N Verma Project Manager

L J Fritz Cartographer

P Schober Technician

H Lino Technician

N Kato Technician

Special thanks to L Fritz for his work on PAWA Intergraph Computer Aided Drafting System, to H Lino and N Kato for their combined effort on data compilation and the development of the bore data base and to P Schober for assistance in water sampling and other technical works during the field work.

Special thanks to Paul and Val Dawson of Helen Springs Station and John and Pat Hagan of Brunchilly Station for the help and information from which this project substantially benefitted. Particular thanks to Rodney Mangel (Banka Banka Station), Dick Wilson (Powell Creek Station/Newcastle Waters) and Ken Roach (Eva Downs Station) for their kind support during the field work for the project during 1990. Thanks to D F Ward, Consultant Geologist, for discussions on the geology of a part of this area. Thanks to the Department of Mines and Energy Library for providing mining/geology reports.

APPENDIX A

MAP PREPARATION METHOD

COLLATION OF DATA

The data on which the map is based comprised:

- 1:100 000 scale - three digitised topographic map sheets of a) Helen Springs, b) Muckaty and c) Brunchilly, available from the AUSLIG (Australian Surveying And Land Information Group), Canberra.
- 1:250 000 scale topographic map available from AUSLIG (Australian Surveying and Land Information Group), Canberra.
- 1:85 000 scale geological compilation sheets available from the Bureau of Mineral Resources, Canberra.
- 1:250 000 scale geological map and the Explanatory Notes published by the Bureau of Mineral Resources, Canberra, 1965 (based on above compilation sheets).
- Bore information from Power and Water Authority records and data from Helen Springs Station Manager (Paul Dawson) obtained during field work.
- Rainfall and evaporation data from the Bureau of Meteorology.
- Landsat MSS Imagery.

DATA PROCESSING

The basis of the hydrogeological map are the twelve BMR 1:85 000 scale compilation sheets used to produce the 1969 1:250 000 Helen Springs Geological Map. These were modified around the southeast corner and the eastern margin of the Wiso Basin using Landsat imagery and field checks. Geology of the Tomkinson Creek Beds and Helen Springs Volcanics have been simplified for reproduction at 1:250 000 scale. Groundwater resource potential of the various formations was assessed using bore data. Bore data was plotted on four different cross-sections through the region to assist in establishing geologic units intersected by bores, and to provide an overview of the data.

REMOTE SENSING - LANDSAT MSS IMAGES

To cover the Helen Springs Region, two quarter scenes (at a scale of 1:100 000) of a single full scene (1:250 000) were obtained. Bands 4, 5 and 7 were chosen to provide data that could assist the geological interpretation.

APPLICATION OF GIS

The data for the production of the hydrogeological map is held on various levels in numerous design files in the Intergraph GIS. The information contained on each level used in each design file is as follows:

HELTEXT.DGN -

- Level 1-Map Border
- Level 5-Australia/NT/Note
- Level 6-Rainfall/Evaporation Map
- Level 7-Tectonic Map
- Level 14-Bore Density
- Level 18-Pattern for Level 7
- Level 19-Pattern for Level 7

HSLEGEND.DGN -

- Level 2-Hydrologic Legend
- Level 3-Topographic Legend
- Level 4-Durov Diagram - Physiographic Map
- Level 7-Boundary/Legend
- Level 9-Sand Plains
- Level 10-Downs Country
- Level 11-Contours
- Level 12-Ranges
- Level 14-Groundwater Flow
- Level 15-SWL

HELSECT4.DGN

- Level 1-Section Text
- Level 2-Section Linework
- Level 3-Patterns
- Level 4-Patterns
- Level 5-Patterns
- Level 6-Patterns
- Level 7-Patterns
- Level 9-Bores
- Level 10-Faults
- Level 11-Form Lines
- Level 12-SWL
- Level 13-Aquifers

HELTOPO1.DGN

- Level 6-Buildings
- Level 7-Mine Symbols
- Level 8-Major Drainage
- Level 9-Roads/Tracks
- Level 10-Swamp Pattern
- Level 11-Waterhole/Dams

HELTOPO2.DGN

- Level 6-Buildings
- Level 7-Mine Symbols
- Level 8-Major Drainage
- Level 9-Roads/Tracks
- Level 10-Swamp Pattern
- Level 11-Waterhole/Dams

MAPTEXT.DGN

- Level 1-All text on map face

HELBORE.DGN

- Level 18-Bores

HELGEOL.DGN

- Level 1-Geological Boundary
- Level 55-AMG Border
- Level 56-Geographical Boundary
- Level 57-AMG Grid

HELGEOL1.DGN

- Level 1-Strike and Dip
- Level 2-Fault Lines

HSGEO1.DGN

- Level 1-Pattern for €mg

HSGEO2.DGN

- Level 2-Pattern for €my

HSGEO3.DGN

- Level 1-Pattern for €lh

HSGEO4.DGN

- Level 1-Pattern for €mm

HSGEO5.DGN

- Level 1-Pattern for Plt

The process of digitising all the data is time consuming, but once installed on the GIS provides great flexibility in finalising the information to be shown on the map.

Initial experience guided the level of detail used for digitising the rest of the data. In complex areas considerable editing was required to maintain visual clarity for the 1:250 000 scale map.

Durov Diagrams for different aquifer types were digitised on different levels so that the data could be available separately if required in the future.

APPENDIX B

BORE DATA BASE

DESCRIPTION

The bore data base is held on the Power and Water Authority Vax mainframe computer, which may be transferred for use on PC-based word processing software. The data was input using the Vax mainframe computer of Power and Water Authority.

ACCESS

The complete bore data base, in both stratigraphical and lithological versions, is available in bound hard copy format as a supplement to these notes or separately. The chemical data base is also available in bound hard copy format. The data is also transferable on PC-based word processing software and includes stratigraphy (stratigraphic version) for quick reference to geological sequence. The bore data base incorporates information on 218 bores detailing:

RN- PAWA's Registration Number of the Bore

Grid Reference - Australian Map Grid (A.M.G.) Reference in full to the nearest 100m.

Bore Name - Name of the bore.

Date Drilled - Month and year of completion of drilling.

Construction Details - Simplified information giving dimensions of cased and 'perforated' or open sections.

Depth Drilled - Depth below the natural surface to which bore was drilled, rather than base of bore as completed.

Aquifer Depth - Depth at which a significant quantity of water was intersected.

SWL (m) - Standing water level in metres below natural surface, usually from date when drilled unless shown as otherwise.

Yield (L/s) - Usually airlift yield, unless pumping test indicated.

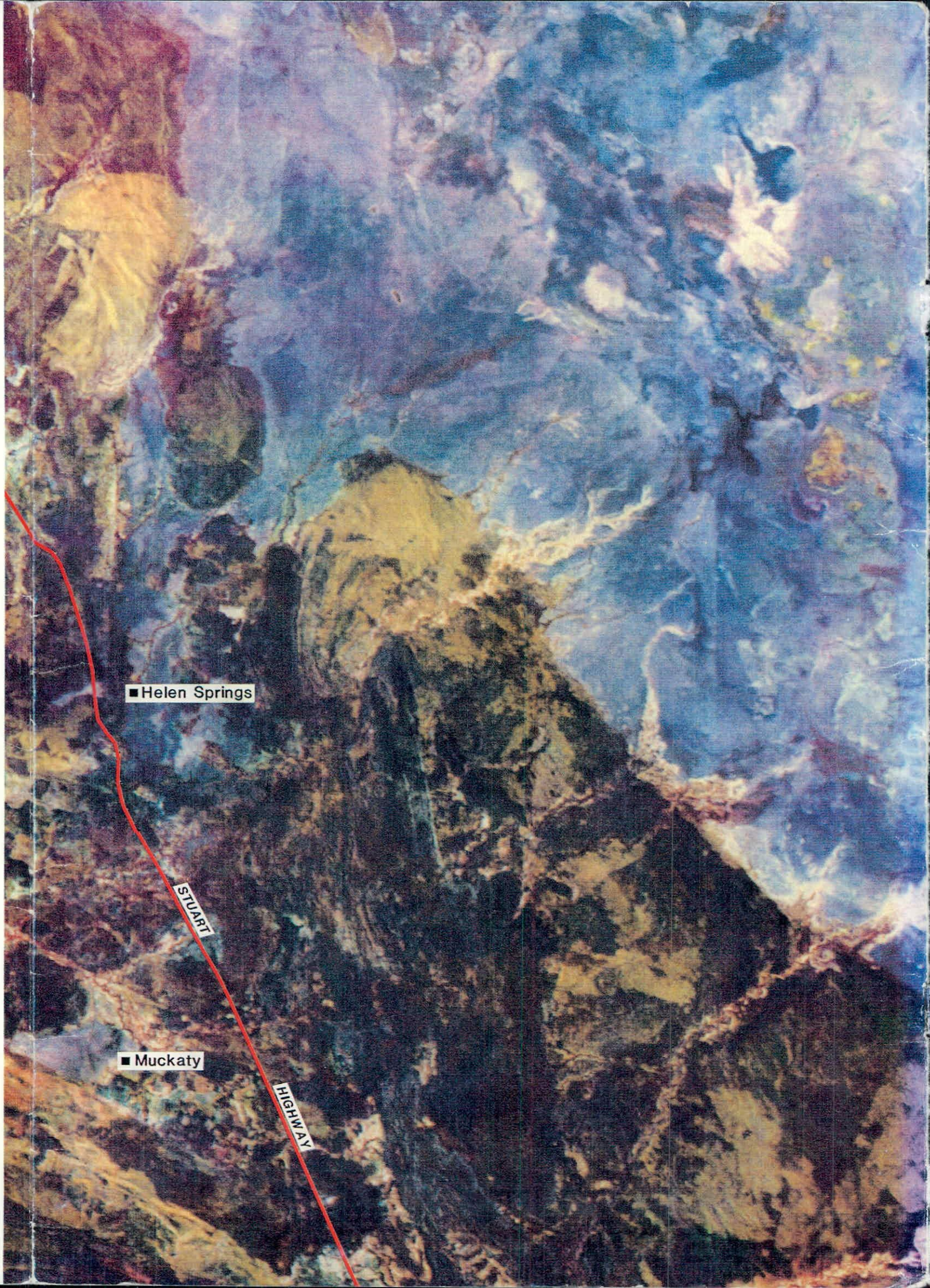
Driller's Log - Driller's version of lithology of strata samples (Lithologic Version).

Lithology - Interpreted geology (Stratigraphic Version) based on driller's log and knowledge of local rock types.

Stratigraphy - (Stratigraphic Version) - Geologic formation symbol. Summary in main text.

Chemical Results - A summary of all chemical analysis results.

Remarks - Additional details as available on bore status, data on SWL, availability of geophysical log and/or geological log, whether test pumped etc.



■ Helen Springs

STUART

■ Muckaty

HIGHWAY