REPORT ON GROUNDWATER EXPLORATION

AT MULGA ROCK PROSPECT, 1985

FOR PNC EXPLORATION (AUSTRALIA) PTY LTD

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CONTENTS

1. INTRODUCTION

In late 1984 Groundwater Resource Consultants were commissioned by PNC Exploration (Australia) Pty Ltd to assess the groundwater resources in the vicinity of the Mulga Rock Uranium Prospect, about 250 km east-northeast of Kalgoorlie.

A report was submitted to PNC in September 1984, entitled 'Lake Minigwal Uranium Prospect, Groundwater Study'. A drilling and test pumping programme was recommended with the aim of establishing a process water-supply of 2000 tonnes/day, and of assessing the dewatering requirements for open-pit mining.

The programme was carried out in November-December 1984, and the required process-water supply was proved. A hydrogeological reconnaissance was made to the north of the prospect, and six sites were selected for test-drilling in an attempt to locate potential sources of fresher groundwater, suitable for treatment to provide a domestic water-supply of 100 tonnes/day. A report on this work was submitted in February 1985, entitled ‘Mulga Rock Prospect, Stage 2 Hydrogeological Investigation'.

The six sites were drilled in July 1985 under the supervision of PNC. The results of the drilling are assessed in this report. Although the required domestic supply has been shown almost certainly to be obtainable 21 km northeast of the PNC camp, closer prospects have not yet been completely tested, and further test-drilling of three areas is recommended.

Water-levels in uncased bores in the area of the Ambassador Deposit, in the eastern part of the prospect, were measured during 1985. The implications of these levels are assessed in this report.

A programme of radioactive dating, although feasible, is not considered warranted at present.

2. TEST-DRILLING

The six sites were drilled by reverse-circulation, mainly using air, but with the addition of water where necessary.

Details of all bores, as supplied by PNC, and shown on Table 1 below:

Table 1 Borehole Details

Borehole No.	Reduced Level (m)	Total Depth (m)	Depth to Basement (m)	Water Level (m)	Salinity mg/L TDS	Airlift Yield	Drilling Water Used	Casing
1327	353.6	71	49.2	63.7	-	Nil	No	Nil
1328	359.0	65	40.0	57.4	-	Nil	Yes	Cased to Total Depth
1329	349.2	77	73.5	60.5	39,700	Small	Yes	Cased to Total Depth
1330	323.3	101	99.2	-	57,160	Small	Yes	Cased to Total Depth
1331	331.4	59	38.5	-	6,909	$13m^3$/day	Yes	Cased to Total Depth
1332	~326	53	35.0	22.8	1,390	$21m^3$/day	No	Cased to Total Depth

Water-levels were not recorded in Bores 1330 and 1331.

3. WATER-QUALITY

Samples of groundwater were submitted for analysis from bores 1329, 1330, 1331 and 1332, and from three other uranium exploration bores in the vicinity of site 1330.

The results are given in Table 2 below:

Table 2 Chemical Analyses of Groundwater, 1985 Drilling Programme

Bore No.	pH	Milligrammes per Litre									Sum of Conductive Ions	Remarks
		Na	K	Ca	Mg	Cl	HCO_3	SO_4	NO_3	Soluble Fe		
1329	7.9	12350	250	710	1200	21160	165.9	3870	12.3	<0.05	39718	Composite depth sample
1330	7.0	17600	450	985	1700	30100	31.7	6285	8.6	<0.05	57160	101m depth
1331	7.8	2060	105	117	180	3266	80.5	1100	3.0	<0.05	6912	59m depth
1332	6.8	392	32	26	43	653	9.8	235	4.4	<0.05	1395	53m depth
1346	5.5	7100	225	432	725	11640	6.1	2665	6.1	<0.05	22799	87m depth
1347	7.0	8100	250	447	800	13630	97.6	2925	5.8	<0.05	26255	41m depth
1351	4.4	13600	245	760	1350	22440	<0.6	4455	6.1	<0.05	42856	87m depth

Analyst: Analabs

4. ASSESSMENT OF RESULTS

The results from site 1332, next to the pre-existing BP Bore, have confirmed that this area, about 21 km northeast of the PNC camp, should be capable of supplying the required domestic supply of 100 m^3/day, without further treatment of the water.

The measured airlift yield of 21 m^3/day could almost certainly be increased by a factor of at least 2 or 3 by pumping from a properly constructed production bore. Yields measured by airlifting through reverse-circulation drilling-rods are unreliable: for example, although the yield of 21 m^3/day was airlifted from a saturated thickness of 12m of poorly sorted clayey sand in Bore 1332, only a very small intermittent yield was obtained from a saturated thickness of 13m of clean, well-sorted sand in Bore 1329.

Site 1331 yielded an appreciable supply of brackish water from a 2m thick layer of silty medium-grained sand overlying Permian basement. The area between this bore and site 1332, 4km to the northeast, warrants further exploratory drilling in the hope of obtaining a fresh groundwater supply slightly nearer to the PNC camp. Two sites for exploratory drilling are shown on Figure 1.

At sites 1327 and 1328, the basement was encountered at a shallower depth than the water-table level, so that the groundwater yield was negligible. Both these areas warrant further investigation however, as there may be locations nearby where the bedrock is deeper. Three sites recommended for test-drilling are shown on Figure 1, one about 1km west of site 1327, and the other two 3-3.5km southeast of site 1328.

At sites 1329 and 1330, although thick sequences of saturated Tertiary sediments were encountered, the water was apparently very saline. The water-sample taken from Bore 1330 may have been contaminated by drilling water, as the measured salinity is more than double that of samples from Bores 1346 and 1347 on either side; the samples from Bores 1346 and 1347 were taken at a higher level, however, and may not have represented the same groundwater zone as that sampled in Bore 1330. No further exploratory drilling is recommended in the vicinity of these two sites (nos. 1329 and 1330).

5. GROUNDWATER-LEVELS, AMBASSADOR AREA

Groundwater levels for the Ambassador area are shown on Figure 2. Levels measured in 1985 are distinguished from those recorded in previous years; levels are thought to vary little from year to year, as indicated by past levels measured in successive years in the same borehole.

Although there appears to be a general southward decrease in levels, no meaningful water-level contours can be drawn. Most of the levels are measured in uncased boreholes, so it is not certain that they reflect the same aquifer horizon.

6. ORIGIN OF GROUNDWATER

The groundwater is contained in a Tertiary palaeochannel infilled with fluviatile-lacustrine sediments of Late-Lower to Middle Eocene age.

In the September 1984 report it was noted that the chemistry of the groundwater was generally similar to that of seawater, and it was postulated that much of the groundwater may have had a marine origin.

Accordingly water-samples from production bores 5, 6 and 7 were submitted to CSIRO for oxygen isotope analysis. The results were communicated to PNC by letter on 25th March 1985, and are documented below:

Table 3 Oxygen Isotope Analyses

Bore	Delta Sample / SMOW	2-Sigma
5	- 4.063	+ 0.018
6	- 2.843	+ 0.024
7	- 3.466	+ 0.018
7 (Repeat)	- 3.673	+ 0.029

Analyst: CSIRO

The results are expressed in relation to the SMOW (Standard Mean Ocean Water) standard; the negative values indicate that the samples are depleted in heavy isotopes compared with ocean water. The 2-sigma column lists twice the standard deviation of each of the quoted values.

Meteoric water is depleted in heavy isotopes compared with SMOW, the amount of depletion increasing with distance from the coast, and with increasing altitude. In arid regions the original heavy isotope composition of the meteoric water may be enriched by evaporation.

Groundwater generally preserves its original isotope composition unless it is subjected to temperatures above 60°C. In arid areas the heavy isotopes may be enriched by interaction with minerals in the aquifer, because the rate of groundwater movement is generally very slow.

The negative values for the samples from Mulga Rock indicate that the groundwater is mainly of meteoric origin, as all the samples are depleted in heavy isotopes.

The different values may indicate a different age range for recharge from rainfall at each site, or a variable degree of evaporation at the recharge sites. In any case there is commonly a variation in isotope ratio for groundwaters in arid regions, because of the irregular and infrequent nature of rainfall events, each of which may differ in isotope ratio.

The negative values do not preclude the possibility that the groundwater may contain some palaeoseawater, mixed with younger groundwater of meteoric origin.

The indication that the groundwater is at least partly of meteoric origin is confirmed by water-level and salinity differences at Water-Bore Site No.5, as discussed in the February 1985 report.

Exploration by PNC in 1985 has provided further evidence that the groundwater may also contain a component of palaeoseawater. Spongolite, and deposits containing marine fossils of probable Late Eocene age, have been discovered at a general elevation of about R.L. 325m. These deposits would correlate with the Late Eocene transgression reported by Bunting et a1 (1974).

This suggests that the Tertiary sediments in the palaeochannel, which had been laid down in a fluvio-Iacustrine environment in the late-Lower to Middle Eocene, were subsequently inundated by the sea in Late Eocene times.

A mixed marine and meteoric origin for the groundwater is therefore probable.

The meteoric component probably could be dated by radioactive methods, either Carbon-14 or Chloride-36.

For a meaningful programme to be drawn up for sampling to carry out radioactive dating, accurate groundwater-levels would be required, so that groundwater flow-directions and rates of movement could be defined in detail. This would require a network of cased monitoring bores to be constructed as water-levels from uncased bores do not provide a coherent pattern.

The expense of monitor bore construction, and a comprehensive programme of sampling and analysis, is not warranted at the present time. Such a programme would be unlikely to add much of practical use to the present concept of a mixed marine and meteoric origin for the groundwater.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 The domestic requirement of 100 tonnes/day of groundwater should be obtainable from the vicinity of Bore 1332, about 21 km northeast of the PNC camp.

This water would require no treatment to make it potable.

7.2 There are three other locations where a useful supply of fresh or slightly brackish groundwater may be obtained nearer to the PNC camp.

Five sites are recommended for exploratory drilling down to Permian or Proterozoic basement; the sites are shown on Figure 1.

7.3 Water-samples for chemical analysis should not be taken before a volume of water has been airlifted from the bore equal to at least five times the volume of water injected during drilling; this should ensure that the samples are uncontaminated.

7.4 After drilling the exploratory drill-sites a larger diameter production bore should be drilled and test pumped at the site which offers the best economic combination of distance, potential supply and water-quality.

7.5 The groundwater is probably of mixed marine and meteoric origin. Radioactive dating of the groundwater is not warranted at present as groundwater flow-directions and rates of movement are not sufficiently defined to enable a meaningful sampling programme to be drawn up.

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R E F E R E N C E S

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