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1966/150

GROUNDWATER INVESTIGATION AT PAPUNYA SETTLEMENT. N.T.

by

D. Woolley

5928/65

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CONTENTS

SUMMARY

Groundwater suitable for domestic use occurs in the Papunya area, within Quaternary and Tertiary deposits of fluvial, deltaic and lacustrine origin. Existing production bores have access to water stored in fluvial sediments confined to narrow valleys in the Precambrian basement rocks, and appear to be sufficient to meet the existing requirements of the settlement. Two further production bores have been sited as a result of the drilling programme; in addition, one was completed during the investigation. Further bores, if required, should be located to make use of the widespread aquifers to the north-west of the settlement.

INTRODUCTION

Papunya Native Settlement is located about 150 miles west of Alice Springs (Fig. 1) and several hundred people, mainly aborigines, live there. Water supplies for domestic use and for a small amount of irrigated agriculture have been provided from four bores. Further production bores have been requested by Welfare Branch of Northern Territory Administration (NTA) who operate the settlement. In order to locate these properly and to assess the overall groundwater potential in the area, a programme of investigation drilling was undertaken by Water Resources Branch, N.T.A.. The drilling programme was based on a geohydrological appraisal provided by the Resident Geological Section, N.T.A. (Woolley, 1965) and was carried out in October-November 1965. Results of the drilling are incorporated in this report.

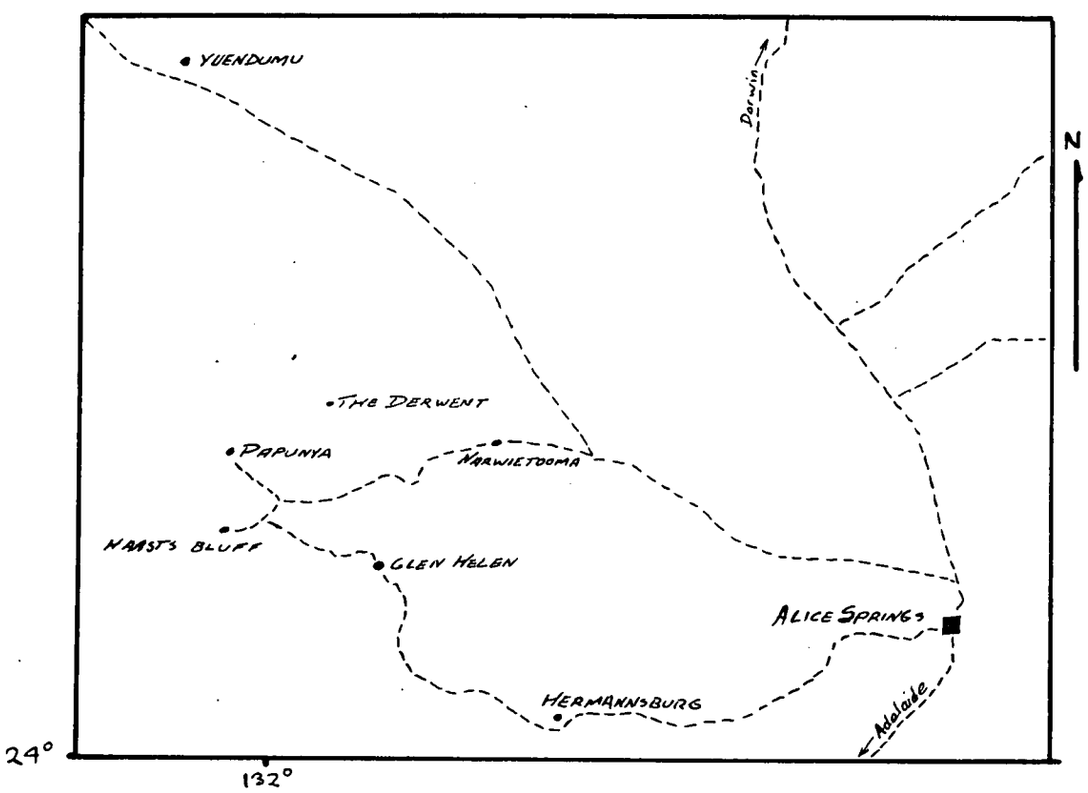

FIG 1 LOCALITY PLAN

To accompany
Record 1966/150

PREVIOUS INVESTIGATIONS

Firman (1956) reported on groundwater prospects at Papunya and selected a number of sites, two of which became the No.1 and No.2 Settlement Bores. Woolley (1965) prepared an appraisal of the area for the present investigation. The Mount Liebig 1:250,000 Sheet area, in which Papunya is situated, was geologically mapped by Wells, Forman and Ranford (1962).

RESULTS OF DRILLING

Twenty seven holes, of total length 5300 feet, were drilled on a rectangular grid with a 2600-foot side, and an origin at Settlement No.2 Bore (see Plates 1 and 2). Each hole was numbered according to its distance east or west, and north or south, of the origin, in thousands of feet. Thus the hole 5200 feet west, and 2600 feet north of the origin was labelled W5.2, N2.6. Where a point lies on one of the grid lines passing through the origin giving, for example, a grid reference of W5.2,00 the 00 is deleted for convenience. An arbitrary datum of 1300.0 feet at the top of a concrete block 6 inches above natural surface at No.3 Bore, was used for levelling purposes.

The first fourteen holes were drilled on two lines, one east-west and the other north-south, intersecting at No.2 Bore, with 2600 feet between each hole (except E5.2 and E6.5 which are 1300 feet apart), such that the easterly line was 4 miles long and the southerly line was 2½ miles long. The bedrock topography is more complex than anticipated, and twelve further holes were drilled to obtain further information on bedrock depth and aquifer distribution. One production hole was drilled.

The holes were drilled with mud from about 100 feet depth in most cases, then "blown out" on completion. Presence or absence of water was inferred from the result of the "blowing-out", and an approximate visual estimate of the supply was made by the driller. Water was recorded in the twelve holes for which water levels are given in Table 1, which summarizes the drilling results. The production hole (W6.5, N1.1) was developed with compressed air for several hours continuously, and at the end of this period a supply of 2000 gallons per hour was being airlifted. The hole has not yet been pump-tested (April 1966).

GEOLOGY

The main outcrops are Precambrian metamorphic rocks, but unconsolidated deposits of Tertiary and Quaternary age, which have a total maximum known thickness of 500 feet near Papunya, cover most of the area.

PRECAMBRIAN

Precambrian rocks cropping out in the area shown in Plate 1 are gneiss, schist and quartzite. Gneiss is dominant and is generally of granitic composition; mica schist and quartzite are interbedded with the gneiss. The regional trend of the rocks is east-west, with a steep dip to the north (Firman, 1956). There are two very distinct joint directions, one has a west-north-west strike and the other an east-north-east strike. Faults of major dimensions occur at several localities within the outcrop areas, and some of them are roughly parallel to the two joint directions.

TABLE 1 - RESULTS OF DRILLING

Bore No.	Total Depth (feet)	REDUCED LEVEL OF: Surface	Base of Quaternary	Base of Tertiary	Piezometric Surface	Depth of Aquifers	Salinity (p.p.m.)
W2.6	159	1309.96	1150	N.P.			
W5.2	218	1310.28	1185	1100	1163.1	160-210	1015
W7.8	192	1311.14	1191	1121	1161.1	180-190	
W10.4	190	1309.43	1159	1139	1162.6	*	
W13.0	113	1307.20	1212	N.P.			
E2.6	192	1307.26	1117	N.P.	1160.7	*	
E5.2	165	1304.92	1205	N.P.			
E6.5	84	1313.45	1238	N.P.			
S2.6	150	1313.31	1163	N.P.			
S5.2	216	1321.74	1172	1132	1173.5	180-189	1266
N5.2	172	1295.68	1186	1124-			
E0.06	320		1140	1090	1163	150-190	
N2.6	152	1301.12	1226				
W5.2, S2.6	155	1318.26	1168	N.P.			
W5.2, N2.3	203	1301.09	1186	1101-	1157.9	170-190	
S7.8	142	132.87	1194				
W5.2, N5.2	243	1294.57	1175	1060	1155.9	170-180	1047
W3.9, S1.3	154	1315.25	1208	1168			
W7.8, N2.6	561	1303.15	1133	810	1156.3	(150-170	1185
						(240-250	
No.4 obs.	224	1304.27	1164	1080	1159.3	*	
W2.6, N2.6	181	1300.01	1190	1120			
W3.9, N1.3	157	1303.96	1214	1154			
W6.5, N1.3	308	1306.21	1186	1056		200-210	
W6.5, S1.3	193	1326.11	1156	N.P.			
W6.5, N1.1	250		1160		1158.5	170-200	
E5.2, S2.6	100		1220	N.P.			
W7.15, S0.65	332		1180	1030		200-210	

N.P. Not present

* Small supply only; aquifer indefinite

Datum: Top of concrete block at No.3 bore, arbitrarily assumed to be at RL 1300 feet.

Most holes were drilled to bedrock, which was sometimes difficult to identify by examination of the samples, because either

(a) an abrupt change into hard unweathered rock caused large amounts of shallower material to cave into the hole, thus obscuring the few chips which were drilled from the rock, or

(b) deeply weathered bedrock was penetrated. In some holes the rock had weathered completely to clay (e.g. W6.5, N1.3).

Bedrock is generally a fine to medium grained quartz biotite gneiss. In several holes (E0.06; W7.15, S0.65; W6.5, N1.3; W7.8, N2.6) bedrock is highly weathered and consists largely of greenish clay, with various proportions of quartz-biotite aggregates in small chips. The maximum thickness of this material penetrated was in bore E0.06 (observation hole at No.2 bore), where 100 feet was found. Probably highly weathered material has been formed along fault or shear zones. The inferred position of the zones (which are no doubt much wider than is shown) is indicated on Plate 2.

A further indication of faulting in the vicinity is the considerable and abrupt increase in depth of unconsolidated sediments at W7.8, N2.6. This relief on the bedrock surface could be the result of a fault-influenced topography.

TERTIARY

One area of outcrop of piedmont conglomerate, thought to be of Tertiary age (Wells, Forman and Ranford, 1962) occurs to the south of Papunya Settlement (see Plate 1). The conglomerate is poorly sorted and unconsolidated, and is composed mainly of clasts of silicified sandstone and quartzite. The maximum known exposed thickness is fifty feet.

Within the area investigated by drilling Tertiary sediments occur to a maximum depth of just under 500 feet below surface (beneath Quaternary deposits) and the maximum known thickness is 300 feet. There are two broad types of sediment, one of which is older than the other.

(a) Pale grey sandy clay. These deposits are fairly uniform in character, although varying slightly in the proportion of sand and in size of the sand grains. Colour is also somewhat varied, with mottling of yellow, brown, orange, purple and khaki, but pale grey is the basic colour and the other colours occur in minor amounts. No aquifers have been found within this part of the stratigraphic section. At W7.8, N2.6, 200 feet was penetrated, and between 20 and 50 feet occur at W2.6, N2.6; W3.9, S1.3; and W7.15, S0.65. This is the oldest part of the Tertiary sequence preserved in the area, and was probably deposited in a lacustrine environment. It is comparable with the Tertiary sediments in the Alice Springs Farm Basin.

(b) Brown clayey silt and sand. This has a diverse section, but is mainly brown silt with various amounts of clay. Colour ranges between chocolate brown, yellowish brown, and purple, with some pale grey mottling. Sand bodies up to fifty feet thick occur in the unit. The sand in them is generally poorly sorted, polymict, subangular to sub-rounded, and medium to coarse grained; there are some gravel lenses. Some purplish-brown, friable, highly ferruginised, silt has been noted in a number of holes. It appears to be an incipient ferricrete. The unit reaches a maximum known depth of 250 feet at W7.8, N2.6, and the greatest known thickness is 130 feet at W6.5, N1.3. It is thought to be

of fluvial origin, and is probably comparable with the Tertiary deposits at Willowra. It is probably of youngest Tertiary or Pleistocene age. The deposits are probably deltaic in the north-western part of the area.

QUATERNARY

Deposits of Quaternary age are of fluvial origin, except for the top 10-20 feet of wind-blown sand. Most are red to red-brown and yellow-brown, and consist of silt, clayey silt, sandy clay and silty sand. The sands are medium to coarse, commonly gravelly, polymict and subangular.

A notable feature of these deposits is the very widespread occurrence (in nearly every hole) of a coarse quartzite gravel at 10-20 feet, rarely deeper, below present surface. It must have been deposited by large-scale sheet flow, and indicates a fairly recent pluvial period.

GEOMORPHOLOGY

The Tertiary and Quaternary deposits occupy a valley system eroded into the Precambrian basement rocks. Contours on the pre-Tertiary surface are shown in Plate 2. The valleys appear to have been controlled by faults or joints and by the strike of the foliation, and their maximum depth is about 300 feet. In the north-west part of the area there is an abrupt increase in depth to bedrock; it is probably due to topographic relief caused by faulting.

Probably the area around Papunya Settlement is within a fault-controlled shoreline zone in which Tertiary rivers debouched into a large lake. South of the shoreline, deep Tertiary sediments are probably confined to narrow valleys, but to the north they are thought to occur extensively. Faults with both easterly and northerly strikes appear to influence the shape of the shoreline zone (Plate 2) which is therefore likely to be rather irregular. From the information available it is thought that an extensive deposit of deep Tertiary sediments occurs to the north, west and north-west of grid point W7.8, N2.6.

The main aquifers located by the drilling are presumed to be fluvial sand deposits within the upper part of the Tertiary sequence, mostly associated with one river system. Table 2 shows the reduced levels of the base of the main aquifers(s) in each hole which yielded a substantial supply. The levels are not very accurate because of the ten foot sampling interval and the unknown degree of lag and mixing in the samples. However they indicate a graded sand deposit along the eastern valley, through S5.2; No.2 Bore; No.4 Bore; W5.2; W6.3, N1.3; W6.3, N1.1 and W7.8, N2.6. A sand with a similar base level occurs in the western channel at W7.15, S0.65, and the two presumably coalesce.

The erosional surface on which the Quaternary deposits were laid down is difficult to define because of the difficulty in distinguishing between Quaternary and younger Tertiary sediments. An interpretation of the shape of the surface is shown in Plate 3. For most of the area the thickness of saturated Quaternary sediments is less than 30 feet. The sediments deepen to the northwest, however, and the main aquifer at No.3 Bore and the upper aquifer (see Table 2) at W7.8, N2.6, are thought to be within Quaternary deposits. The distribution of Quaternary deposits does not seem to have any great influence on groundwater supplies

TABLE 2

LEVELS AT BASE OF AQUIFERS

Hole Number	Reduced Level at Base of Aquifer	Age of Aquifer
S5.2	1132	Tertiary
E0.06	1110	Tertiary
No.4 obs.	1114	Tertiary
W5.2	1100	Tertiary
W6.5, N1.3	1096	Tertiary
W6.5, N1.1	1106	Tertiary
W7.15, S0.65	1100	Tertiary
W7.8, N2.6	1053	Tertiary
W7.8, N2.6	1133	Quaternary
No.3 Bore	1130	Quaternary

to the south of the settlement, but could be quite important, particularly in determining recharge, to the north-west.

HYDROLOGY

AVAILABILITY OF GROUNDWATER

Tertiary

Within the area investigated, the most important aquifers below the piezometric surface occur within the Tertiary sequence. Only one main sand body seems to be present in the sequence (Table 2) and its maximum known thickness is about 40-50 feet at W5.2. The overall proportion of aquifer to total sediments is not known, either in the valley area or in the widespread area to the north-west. However, the drilling results tend to indicate that the proportion is quite small, probably less than, or at least no more than, that in the Alice Springs Town Basin. The production hole at W6.5, N1.3, produced 2000 g.p.h. of water from the main aquifer during air lifting while the bore was being developed. The water available to existing production bores (other than No.3) is restricted to that which flows down the main Tertiary aquifer within the two valleys shown in Plate 2. Farther to the north-west, more extensive aquifers are presumed to exist, in both upper and lower Tertiary sequences, and bores drawing from these aquifers should be able to utilize recharge water from additional sources. Any such aquifers are likely to be much thinner than the aquifers within the valleys.

Quaternary

No.3 bore may obtain water from an aquifer within Quaternary deposits, and the upper aquifer at W7.8, N2.6, is almost certainly Quaternary in age. It may be possible to locate other similar aquifers in the north-western area, but they may be hard to find, as they are probably long narrow bodies (shoe-string sands). The overall proportion of permeable sand to total sediment is probably slightly higher than in the Tertiary sediments, but individual aquifers are not as thick.

The total volume of saturated sediments in the two valleys is very approximately 5000 million cubic feet. Assuming a conservative storage co-efficient of 0.03 (cf. Alice Springs Town Basin 0.05 - Quinlan and Woolley, 1962), the volume of water stored is roughly 1000 million gallons. Of this, a little under half is upstream from No.4 bore. It is all upstream from W6.5, N1.1 production hole.

PIEZOMETRIC SURFACE AND GROUNDWATER MOVEMENT

Contours drawn on the piezometric surface are shown in Plate 4. Control on the contours is poor, and a considerable amount of interpretation has been used in constructing them.

Groundwater moves in a general northerly direction, along zones restricted to the valley-filling sediments, until it reaches the extensive deltaic and lacustrine deposits where it maintains a northerly movement with a reduced gradient and in a much broader zone.

The peizometric surface in the eastern channel appears to be a shallow mound, with a distortion at the northern end due to the shallow bedrock bar (Plate 4). This bar, which is possibly a buried strike ridge, is believed to have been caused by erosion along the east-south-east fault (Plate 2), and has a marked effect on the shape of the pre-Tertiary surface. It deflects to the west water flowing along the eastern channel, along the deepest part. However, unless true artesian conditions apply, a small amount of water must flow over the bar as its crest is below the piezometric surface (i.e. it is below some saturated sediments). Bores drilled at W3.9, N1.3; N2.6 and W2.6, N2.6 failed to intersect aquifers and were thought to be dry. However, if only two or three feet of water was present in the bottom of the hole, as may have been the case, it could have escaped detection. Pumping from the production bores No.2 and No.4, appears to have had little effect on the shape of the peizometric surface.

Where the water flows west out of the eastern channel (between W3.9, N1.3 and W3.9, S1.3) a trough occurs in the peizometric surface. This is to a large extent only an apparent trough, caused by the flow of water from the western channel.

Flow along the western channel seems to be fairly uncomplicated in a north-north-easterly direction. The apparent mound at W5.2 tends to indicate that a substantial amount of water is flowing north between W6.5, S1.3, and W5.3, S2.6. The bores at both of these locations were thought to be dry when drilled, and the latter is certainly outside the area of saturated sediments.

Apparently therefore either there is an aquifer (previously unsuspected) between the two points or the contours have been incorrectly drawn. Insufficient information is available to resolve the question. One possibility is that the peizometric surface contours continue regularly across the area near W2.6 implying major movement of groundwater past the shallow bedrock ridge. It may be advisable to check for breaches in the bedrock ridge by drilling one or two holes along it.

If the contours shown in Plate 3 accurately represent groundwater movement, the production hole at W6.5, N1.1 is well sited to intercept water moving along both valleys. A bore at W5.2 would also have similar access to water from both known sources.

GROUNDWATER SALINITY

The salinity of groundwater in the region investigated is remarkably uniform; the total dissolved salts content (TDS) ranges from 1000 to 1200 parts per million (ppm). The water type is also quite uniform. The two bores producing water entirely from Tertiary aquifers, for which analyses are available (W5.2 and S5.2), have water containing less Mg than Ca, but in bores where there is a contribution from a Quaternary aquifer, Mg is greater than Ca. Apart from this distinction there is no apparent difference between water from Quaternary and Tertiary aquifers.

The quality of water is uniformly suitable for human consumption both with regard to TDS and content of individual ions. Sulphate varies between 50 ppm and 200 ppm, chloride between 150 ppm and 400 ppm, calcium between 30 ppm and 60 ppm and magnesium between 10 ppm and 50 ppm.

Salinities quoted have been measured by Animal Industry Branch, N.T.A..

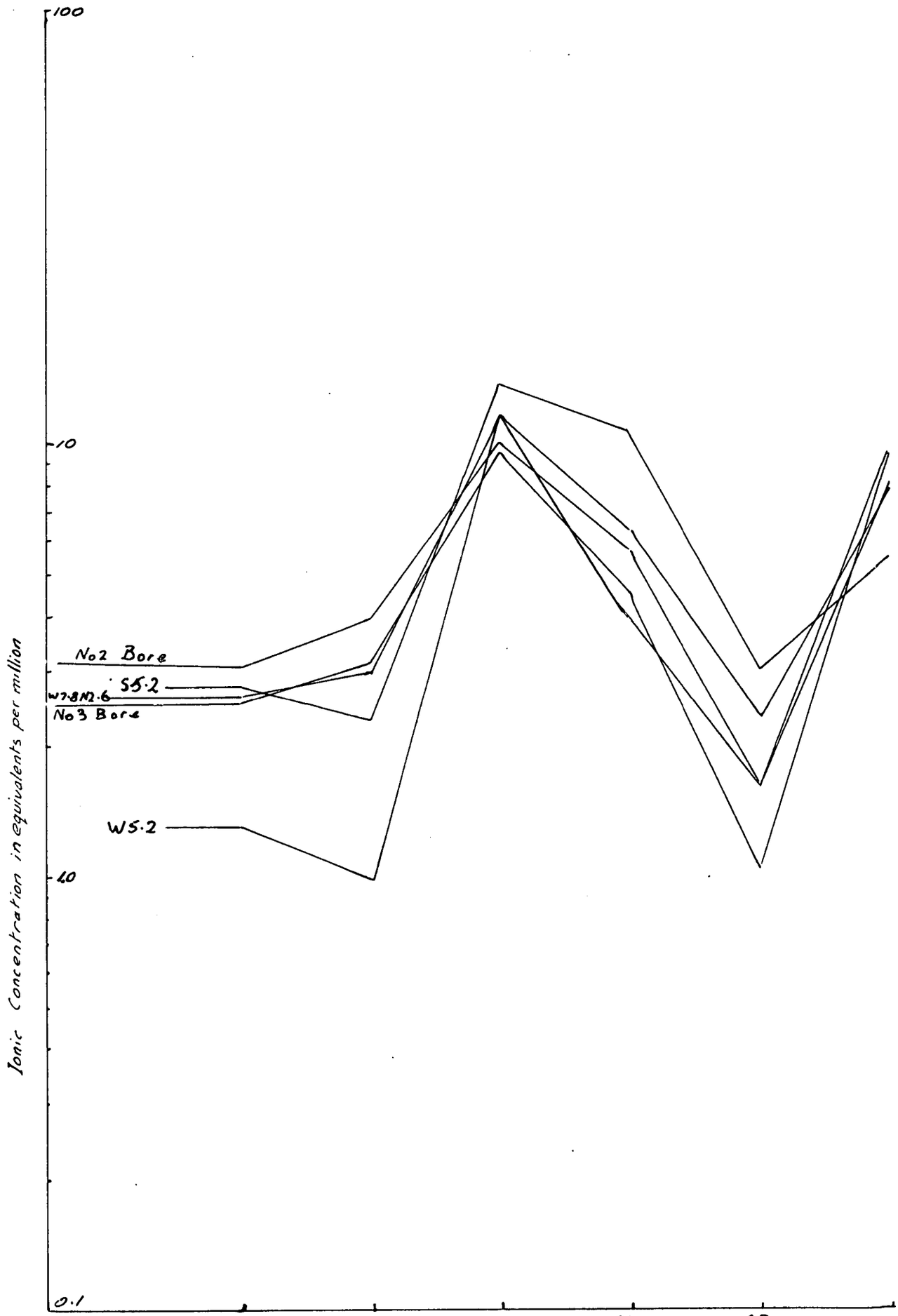

FIG 2 Groundwater types F52/A16/23

To accompany Record 1966/150

CONCLUSIONS

Groundwater occurs in Quaternary and Tertiary sediments in the Papunya area. To the south the water-bearing sediments are restricted to narrow valleys, but a substantial amount of water is stored within the sediments upstream from existing production bores. To the north-west, thinner but laterally more extensive aquifers are thought to occur in deposits with a total depth probably exceeding 500 feet. None of the existing production bores obtains water from this province.

Existing production bores appear to have access to sufficient water to satisfy the present requirements of the settlement. Further production bores within the shallow areas developed to date may be justified when the need for more water arises, but this will be influenced by the results of pump tests on production bores. Scope for additional production from the deeper sediments to the north-west appears to be considerable. Only one hole has so far been drilled in these sediments (W7.8, N2.6) but this intersected aquifers below the piezometric surface in both Quaternary and Tertiary deposits.

Quality of the groundwater in the area is uniformly suitable for human consumption.

One production bore has been completed successfully, and locations for at least two more are available.

RECOMMENDATIONS

1. Sites for two future production holes can be recommended at this stage;

   (a) At W5.2, where there is a thick sand, and access to recharge from both valleys is available.

   (b) At W7.8, N2.6, where two aquifers (one Quaternary and one Tertiary) are available. A production bore at this locality should be able to draw on more extensive aquifers than bores situated within the valley system.

2. In order to confirm the presence of the shallow bedrock ridge which constricts the downstream end of the eastern valley, one or both of the following should be undertaken.

   (a) Drill two holes to bedrock along the postulated strike of the ridge.

   (b) Pump No.3 bore while No.4 bore is not being pumped and measure any reflection in No.4 bore (in a non-pumping condition).

3. Further investigation of the western valley may be warranted. The main need here is to redrill W7.8, where it is suspected that bedrock was not reached.

4. Aquifer performance tests should be undertaken at all production bores, to determine the optimum spacing of bores.

ACKNOWLEDGEMENTS

Water analyses used in this report were carried out by Animal Industry Branch, N.T.A..

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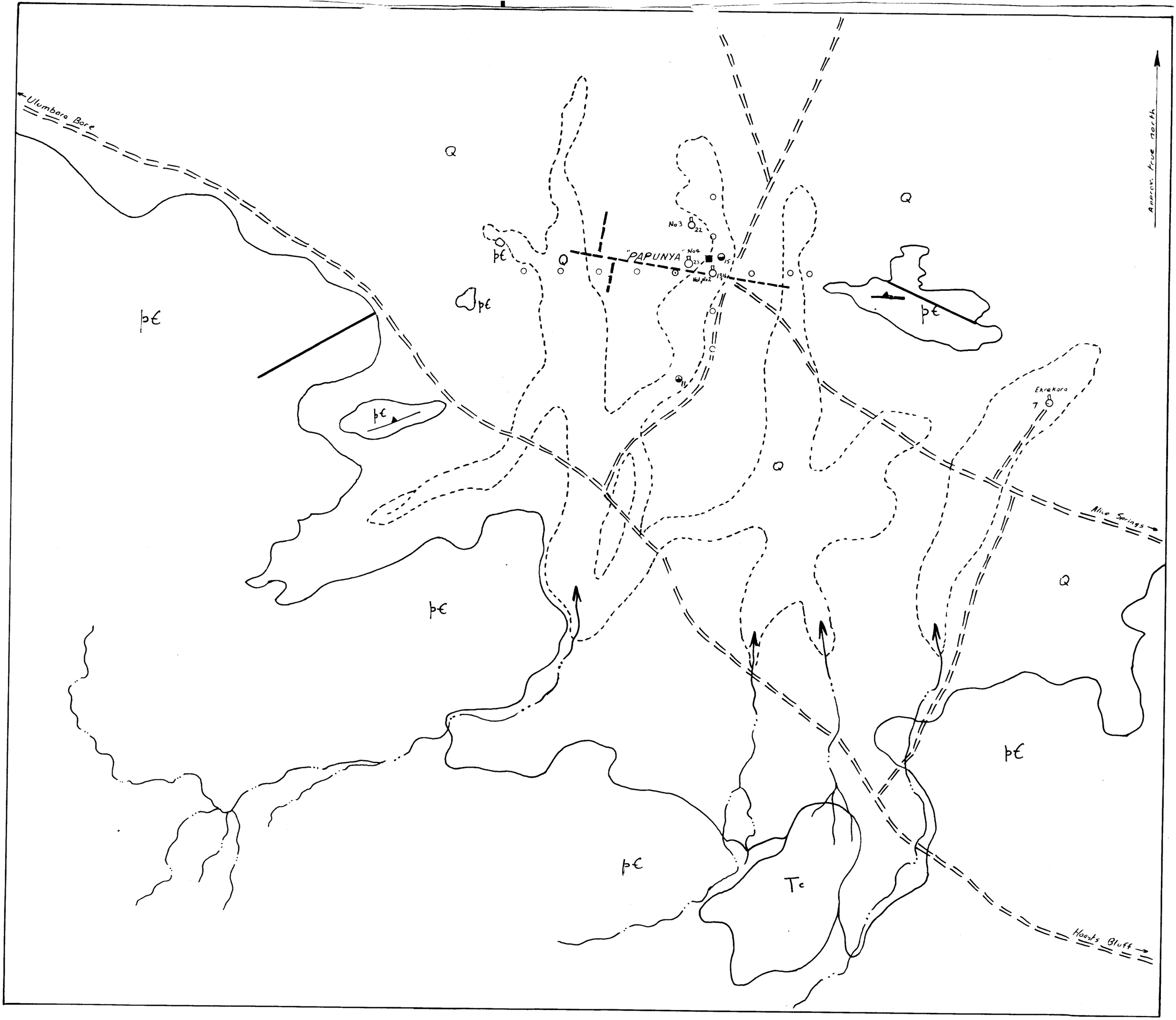


PLATE 1 GEOLOGICAL SKETCH MAP OF AREA SURROUNDING PAPUNYA SETTLEMENT

Fault; concealed where dashed
Geological boundary
Dip and strike of foliation
Boundary of floodout area
Stream (non perennial)
Bore, equipped
Bore, small supply
Proposed site for investigation bore

1 ½ 0 1 2 3
SCALE (MILES)

Q Quaternary; superficial deposits
Tc Tertiary; conglomerate
pE Precambrian; metamorphics

To accompany Record 1966/150

Resident Geologists Office, Alice Springs
F52/A16/22
August 1965

GROUNDWATER INVESTIGATION PAPUNYA

PLATE 2 : CONTOURS ON PRE-TERTIARY SURFACE

LEGEND

- 1175 — Invest hole with reduced level to bedrock
- Settlement production bore
- Grid points
- W6S N26 — Grid reference of hole in relation to N°2 bore which is the origin point for this grid.
- Origin of grid at N° 2 Bore. Arbitrary Datum 1300' at No 3 Bore
- 1150 — Bedrock Contour
- Fault (inferred)

Magnetic North

Drawn by G Squire, October 1965.

To accompany Record 1966/150

SCALE 1300 0 1300 2600 3900 5200 FEET

F 52/1916/19

Resident Geologists Office, Alice Springs, Oct 1965

GROUNDWATER INVESTIGATION PLATE 3 : CONTOURS ON PRE-QUATERNARY SURFACE
PAPUNYA

LEGEND

1133 Invest. hole with reduced level of pre-Quaternary surface

Settlement product on bore

Grid points

W6.5 Grid reference of hole in relation to N° 2 bore which is the origin point for this grid

Origin of grid at N° 2 Bore
Arbitrary Datum 1300' at No. 3 Bore

1175 Contour on pre Quaternary surface

Magnetic North

1133 W7·8 N2·6
1175 W5 2N5·2
1186 W5·2 N2·6
1190 W2·6 N2·6
1186 N5·2
No. 3 Bore
1226 W2·6
1186 W6·5 N1·3
W6·5 NN
1214 W3 9N1·3
SETTLEMENT
No. 4 Bore
COMPOUND
No 2 Bore
1140
1212 W13·0
1159 W10·4
1191 W7·8 1180
W7·15 50 E5
1156 W6·5 S1·3
1185 W5 2
W2·6
1117 E2·6
1205 E5·2
1238 E6·5
E7·8
1200
1175
1150
1225
1168 W5 2 S2·6
W3·9 S1·3
1163 S2·6
1220 E5 2 S2·6
1200
1175
1225
1172 S5·2
1194 S7·8

SCALE
1300 0 1300 2600 3900 5200 FEET

To accompany Record 1966/150

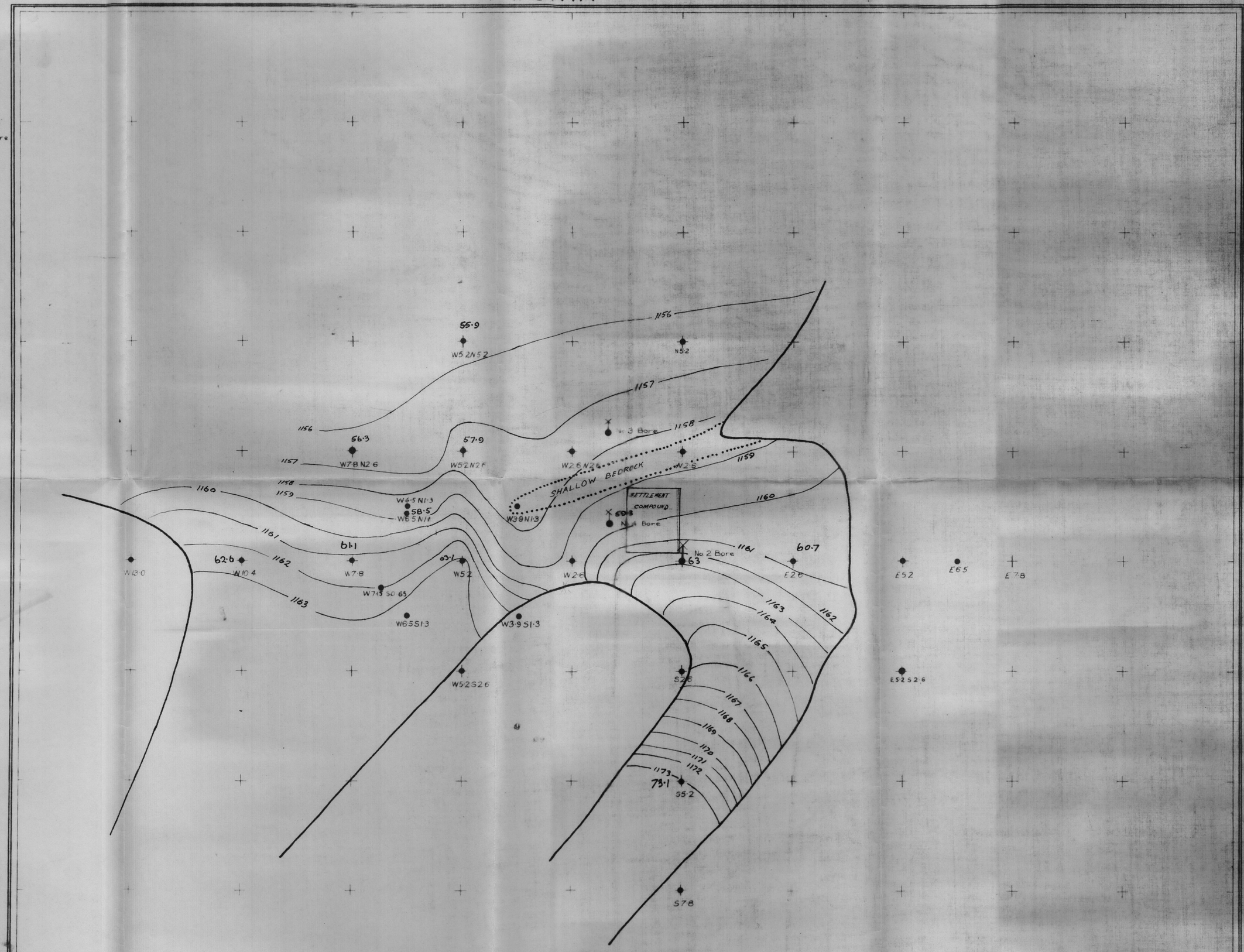
F52/A/16/20

GROUNDWATER INVESTIGATION PLATE 4 : PIEZOMETRIC SURFACE CONTOURS
PAPUNYA

LEGEND

- 61·1 — Invest hole, with reduced level of piezometric surface
- Settlement production bore
- Grid points
- W65 — Grid reference of hole in relation to N°2 bore which is the Origin point for this grid
- Origin of grid at N°2 Bore. Arbitrary Datum 1300' at No 3 Bore
- 1171 — Contour on piezometric surface
- Boundary of saturated sediment

Magnetic North



Drawn by G Squire October 1965

To accompany Record 1966/150

SCALE 1300 0 1300 2600 3900 5200 FEET

FS2/A16/21

Resident Geologists Office, Alice Springs, Oct 1965