DEPARTMENT OF
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1979/88

PROGRESS REPORT ON HYDROGEOLOGICAL STUDIES IN THE MAGELA AND COOPER CREEK CATCHMENTS, ALLIGATOR RIVERS REGION, NT, 1979

by

J.R. Kellett, W.R. Evans, B. Jones
and D.B. Guy

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SUMMARY

The Bureau of Mineral Resources is undertaking an investigation of the hydrogeology and hydrochemistry of the surficial materials in the Magela and Cooper Creek catchments of the Alligator Rivers Region, NT. This study is part of a program being undertaken by the Office of the Supervising Scientist for the recognition and monitoring of environmental change which may occur as a consequence of the mining of uranium in the catchments. This report is concerned with the progress of the study in 1979; it is mainly a record of the work undertaken and of the results to hand at the end of 1979.

The main aim of the investigation is to establish a network of monitoring bores in the two catchments for the purpose of gathering baseline data on groundwater chemistry and hydraulics of the surficial cover to the bedrock. The data will be used by others as input to computer models of the two catchments.

Fifteen holes were drilled under contract in the Cooper Creek catchment, and twelve holes were drilled in the southern part of the Magela Creek catchment; all but one hole were completed with stainless steel screens and unplasticised PVC casing. Most of the bores have been developed by flushing and pumping and are ready for aquifer tests and water sampling, and the first set of water samples was collected and sent for analysis.

Drilling progress was slow and can be attributed to the poor serviceability of the drill rigs and delays in the supply of materials and equipment; only 27 of the 55 bores planned for the year were completed.

The coordinates of bores and height above sea level were determined for bores in the Magela Creek catchment only.

Infiltration tests were carried out by both the ring infiltrometer and the auger hole permeameter methods on most of the surficial lithologies.

Cooper Creek catchment

In the Cooper Creek catchment the gentle slopes of partly dissected lateritised Proterozoic metasediments and metavolcanics have a cover of clays developed on lateritic detritus. Slopewash sands surround outliers of massive Kombolgie Formation (Carpentarian), and clays and earths in the drainage depressions are derived from alluvium; quartzose sands occupy stream channels and adjacent alluvial terraces.

Water in some bores is odorous and brackish-tasting, and a restriction of the drainage of groundwater from the catchment seems likely. As the quartz sand thicknesses in Tin Camp Creek basin decrease downstream from 9 m to 2.4 m at the junction of Tin Camp Creek and Cooper Creek, drainage would be restricted if the decreasing thickness of sand is associated with a rise in the level of the base of the sand; however, speculation should await the results of levelling in the catchment. The effect of the sewerage treatment plant on the quality of groundwater in the Tin Camp Creek basin during the dry season will be established as water quality information becomes available.

The highest yielding aquifers are the sands of the stream beds and adjacent terraces, where the thickness of sands ranges to over 9 m, with yields from bores ranging to 4.5 L/s, and a saturated hydraulic conductivity determined by infiltration ranging up to 30 mm/hr.

The red and yellow earths overlying the higher lateritised interfluves of the catchment are highly permeable and gave infiltration capacities of up to 50 mm/hr. Lateritised bedrock gave a steady-state infiltration rate of 10 mm/hr that is attributed mainly to the transmission of water through quartzose sand infillings of irregular planes and tubular vughs in the disintegrated laterite.

Magela Creek catchment

The Tertiary landsurface in the catchment is defined by the top of the laterite which, in places, is lateritised detritus and elsewhere is lateritised Precambrian metamorphics and migmatite. Above the dissected laterite, the broad base of the valley is occupied by Quaternary channel deposits of sand and gravel; the sand and gravel has been dissected by the Magela and Gulungul Creeks and quartz sand comprises the present-day stream-channel deposits and alluvial terrace.

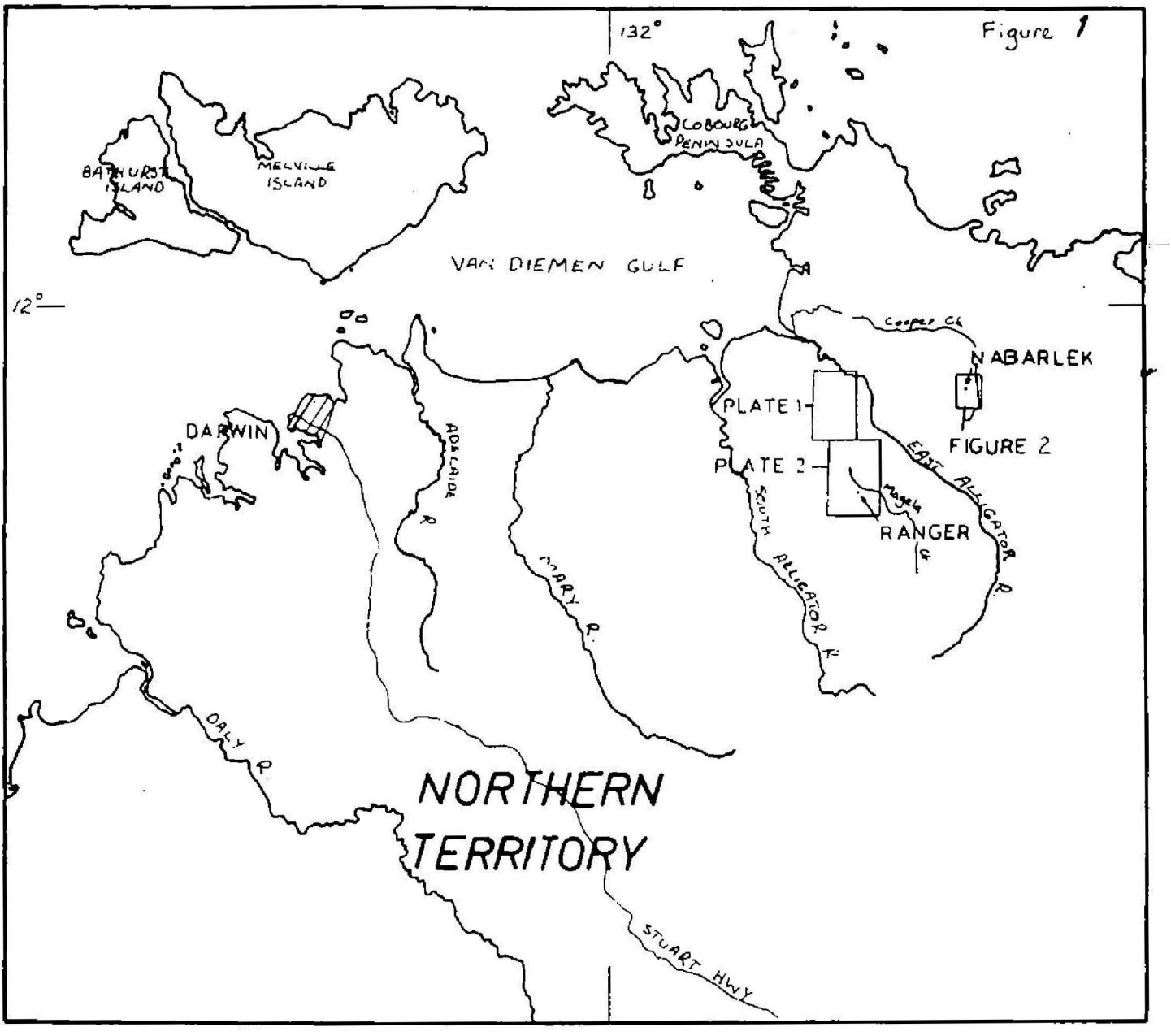
The thickness of Quaternary sand and gravel across Magela Creek ranges from 3 to 6 m overlying lateritised gravel to the west of the main stream channel, up to about 15 m to the east of the channel. The increased thickness to the east may be attributed to movement along the Magela Fault, after deposition of the Quaternary sands and gravel, with downthrow to the east. The thickness of Quaternary sand across Gulungul Creek does not exceed 5 m.

Information is not yet available on water quality from Magela Creek catchment; however, yields from bores range to 2 L/s on Gulungul Creek traverse and to 6.5 L/s on Magela No. 1 traverse. Saturated hydraulic conductivity in siliceous sands determined by infiltration tests ranged from about 14 to 30 mm/hr. Cracking clays in the lower Magela floodplain gave very high infiltration rates that were attributed to large shrinkage cracks, and these would ensure high infiltration rates early in the wet season.

Program for 1980

It is proposed to continue the study in 1980 with a large drilling program that will make up the shortfall in drilling in 1979; 72 holes are proposed for the Magela Creek catchment and six holes for the Cooper Creek catchment. Underflow studies in the stream bed of Magela Creek are planned and will be based on tests made on 18 piezometers in the stream bed sands. Four stratigraphic holes are proposed for drilling by the Bureau of Resources' drill rig in the northern Magela floodplain to link

up with other stratigraphic holes associated with earlier geological studies. Aquifer testing, including water sampling and analysis, and surveying and levelling will continue in 1980, and as time permits a joint analysis will be made of structural domains of the Kombolgie Formation.



LOCALITY MAP, ALLIGATOR RIVERS REGION

INTRODUCTION

Background to the investigation

The Jabiru Workshop, held on 21-25 August 1978 and arranged by the Office of the Supervising Scientist (OSS), was attended by sixty-four representatives of the mining industry, government bodies, scientific disciplines and organisations, and environmental organisations, for the purpose of making recommendations for the detection and monitoring of environmental changes in the Magela and Cooper Creek catchments (Fig. 1) which may occur as a consequence of the mining of uranium in the two catchments.

Recommendations of the Groundwater Committee at the Workshop included proposals for groundwater monitoring in the vicinity of mine operations and for catchment studies and the development of models concerned with the dynamics of groundwater movement and the variables of groundwater chemistry.

A Hydrogeological Committee was convened by the OSS, and its function, as set out in a subsequent meeting, is to discuss and coordinate integrated hydrogeological programs in the Magela and Cooper Creek catchments, and to outline the contribution of the action agencies undertaking the various programs. The Committee first met on 9 April 1979 and monthly meetings were held throughout 1979; the meetings were attended by officers of OSS, and by representatives of the Water Division of the Northern Territory Department of Works and Transport (WD), the Geological Survey of the Northern Territory Department of Mines and Energy (NTGS), and the Bureau of Mineral Resources (BMR), under the chairmanship of WD officers. Representatives of the mining companies have also attended a number of meetings by invitation of the Committee.

In February 1979, the OSS requested BMR to provide hydrogeological advice and, where appropriate, to undertake hydrogeological field work.

Following approval for the mining of the uranium deposits at Jabiru and Nabarlek, a coordinated hydrogeological program was agreed upon for 1979 at the Hydrogeological Committee Meeting on 9 April 1979, and a description of the BMR contribution to the program is attached to this report as Appendix 1. It may be briefly summarised under the headings of the three projects of its contribution:

Hydrology of the alluvial aquifers,
Surficial geology and infiltration capacities, and
Joint analysis in the Kombolgie Formation.

Planning for the 1979 field season went ahead from this time; the main tasks were to arrange a drilling contract for investigation of the surficial geology and establishment of water bores and piezometers suitable for hydrogeological investigations, and to acquire suitable equipment for aquifer pumping tests and for infiltration studies. Estimates were prepared and submitted to the OSS. Members of the party with their equipment started moving into the field from Canberra on 29 June 1979 and the field party assembled in Darwin on 16 July and proceeded to Jabiru where they occupied accommodation arranged by the OSS. The members of the field party were:

J.R. Kellett, Party Leader (Geologist)
W.R. Evans (Geologist)
B. Jones (Technical Officer)
D.B. Guy (Technical Assistant)
D.S. Lamont (Field Hand) and
F.J. Pritchard (Field Hand).

BMR provided salaried staff and the use of BMR vehicles and other equipment as its contribution to the project; the OSS funded the drilling contract, the operational expenses of the field party including the field hand wages, and the purchases of equipment specifically required for the project.

Program for 1979

The most important task of the field party in 1979 was to set up a network of 40 monitoring bores in the southern Magela Creek catchment and 15 monitoring bores in the Cooper Creek catchment, for the purposes of gathering baseline data on groundwater chemistry and hydraulics of the surficial cover. This information is required to define the initial conditions in a predictive model to be developed by WD.

The establishment of the bore networks was dependent upon contract drilling which should have finished by the end of September 1979 in the initial timetable, and during the following month it was proposed to determine hydraulic conductivities and effective porosities of the alluvium by pump testing the bores, and to determine dispersion coefficients by dye tracing.

The program also included infiltration testing of each of the major soil groups of the Magela Creek catchment, particularly the soils of the flood plain.

If time permitted, it was also proposed to investigate groundwater storage and transmitting capacity of the Kombolgie Formation.

CONTRACT DRILLING

Location of bores and their objectives

The proposed bores and those bores completed in 1979 in the Magela Creek catchment are shown in Plates 1 and 2, and those in the Cooper Creek catchment are shown in Figure 2.

In the Magela catchment the holes are set out in 9 traverses. Traverse 1 (Plate 2) intersects Magela Creek, its flood plain, and the higher lateritised landsurface southeast of the Ranger Project Area, and traverse 4 intersects Gulungul creek and its flood plain to the south of the Ranger Project Area. These two traverses are upstream from the Ranger Project Area and should define groundwater chemistry of the major surficial aquifers free from any possible pollution by mining at Ranger.

Traverses 2 and 3 lie to the north of the Ranger Project Area; traverse 2 is designed to provide early warning of possible groundwater contamination downstream from Ranger, and traverse 3 near Mudginberri Lagoon should contribute to the study of the dilution of polluted groundwater before reaching the permanent waterholes of the Magela Plain.

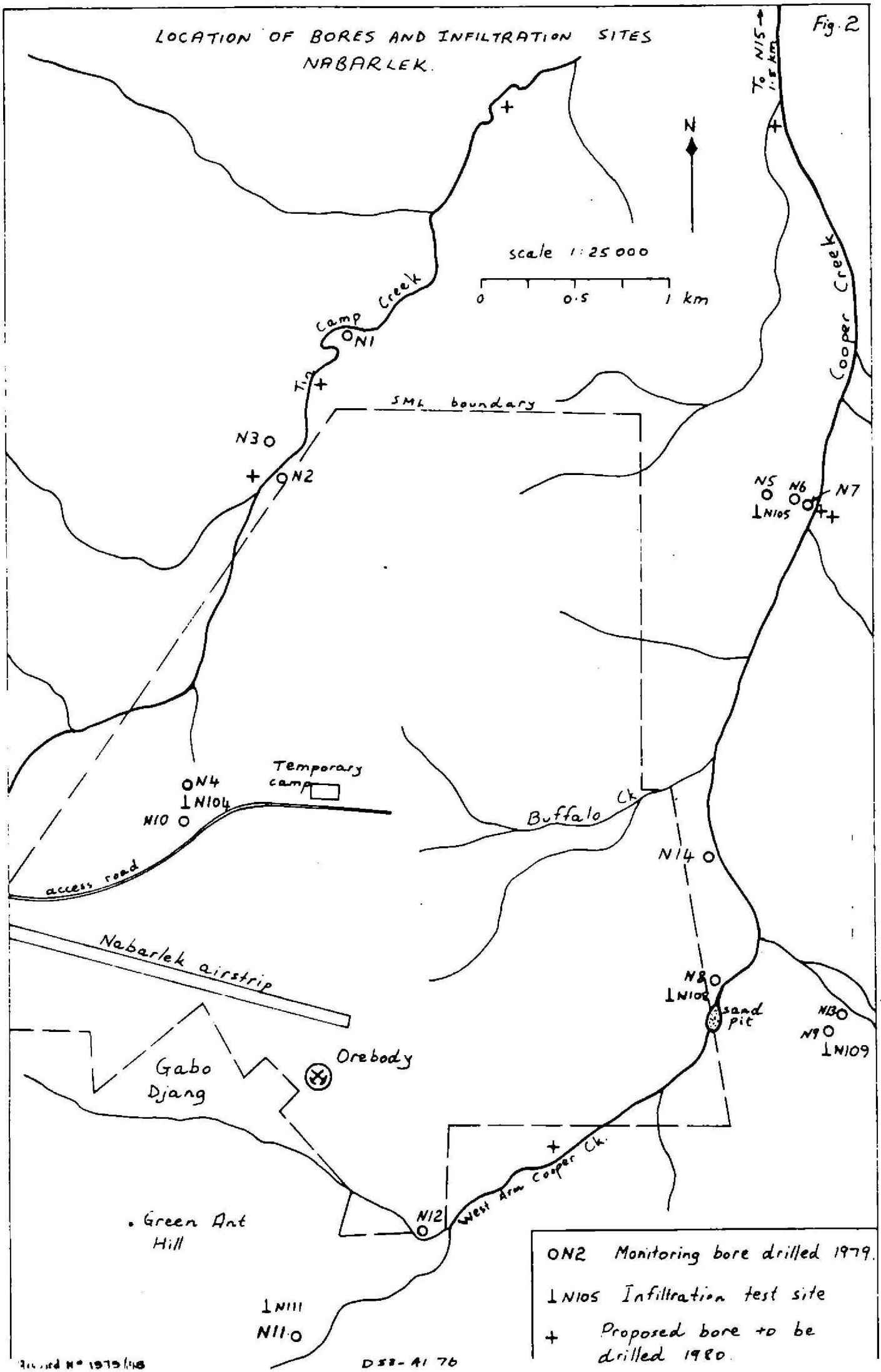
An additional part of the drilling program is to set shallow piezometers into the Magela creekbed so that the dynamics and groundwater chemistry of bed underflow during the dry season can be studied. Five shallow piezometers are planned for the Magela creekbed at its intersection with traverse 1, seven holes are planned for traverse 2, and six holes for traverse 3.

Traverse 5 across Hades Flat is designed to determine the characteristics of subsurface flow fed by the 7-J Creek catchment before mixing with waters of the Magela system.

Traverse 6 near Ja Ja Billabong and other drillholes in the Jabiluka area, including those along the Oenpelli Road, will provide information on groundwater chemistry after exchange with the surface waters of the billabongs and will also give baseline data in the event of future mining activities in that area.

Traverses 7, 8, and 9 span the Magela Plain to the north of Jabiluka; they will monitor groundwater upstream of the wetlands that lie to the north, and should pollutants be identified, they will monitor the effect of remedial work that might be undertaken.

The Nabarlek holes in the Cooper Creek catchment (Fig. 2) are designed to ascertain baseline groundwater chemistry of the principal surficial aquifer in the area, namely the alluvium and terrace soils of Cooper Creek and Tin Camp Creek. From these holes it will be possible to calculate the stream underflow discharges during the dry season, which is the time when groundwater pollution would be most likely to occur. Possible pollutants would be detected well before they reach wet areas near the confluence of the two streams.


LOCATION OF BORES AND INFILTRATION SITES
NABARLEK.
Fig. 2
To N15
1.5 km
N
scale 1:25 000
0
0.5
1 km
Camp Creek
N1
T.3
SML boundary
N3
N2
Cooper Creek
N5
N6
N7
N105
Temporary camp
N4
N104
N10
Buffalo Ck.
access road
N14
Nabarlek airstrip
N8
N108
sand pit
N13
N9
N109
Orebody
Gabo Djang
West Arm Cooper Ck.
N12
Green Ant Hill
N111
N11
ON2 Monitoring bore drilled 1979.
⊥N105 Infiltration test site
+ Proposed bore to be drilled 1980.
Revised N° 1975/118
DSS-AI 76

Borelogs of the holes put down in 1979 are shown in Appendix 2.

Calling of tenders

The OSS requested that BMR arrange a contract for drilling, and be responsible for the calling of tenders, awarding of the contract, and supervision of the drilling on behalf of the OSS. The Superintendent of Stores for the Department of National Development was requested on 5 June 1979 to arrange for the calling of tenders. The Purchasing Division of the Department of Administrative Services called tenders on 25 June, and tenders closed on 19 July. The contract was awarded on 29 August 1979 to F.A. Kelly Pty Ltd of Broadmeadow, NSW.

Drilling operations

Drilling commenced in the Magela catchment on 10 September with one rig. On 15 September when only one hole had been completed and another was part drilled, it was decided that the rigs should move to the Cooper catchment and remain there until all holes in that catchment were completed.

Drilling in the Cooper catchment commenced on 20 September with one rig; a second rig commenced drilling on 23 September. The 15 holes planned for the catchment were completed on 6 October, and both rigs returned to the Magela catchment.

One rig recommenced drilling hole M2 in the Magela catchment on 10 October, but the second rig did not become operational until 18 October.

The date for completion of the contract had initially been set at 19 October, later than originally planned because of the delay in the initial calling of tenders; however, because of the slow drilling progress, it was decided to continue drilling beyond that date. Drilling ceased on 26 October after the completion of only 12 of the 20 holes that were considered the minimum requirement in the Magela catchment for the 1979 field season.

Over the seven week period of the drilling contract, 42 working days, only 41 operational rig-days out of a possible 84 rig-days for the two rigs was achieved.

The members of the field party assisted the contractor beyond the normal limit of responsibility for supervision of the contract in an endeavour to speed up the drilling rate, generally in the tasks associated with the completion and development of the bores; the removal of mudcake in particular proved time-consuming because the contractor was obliged to use a highly viscous mudcake owing to his inability to drive casing with the rigs assigned to the project. A rig with a top drive is essential for this work and will be specified in future contracts of this nature.

Delays encountered during the drilling and completion of the bores can be attributed to the poor serviceability of the drilling plant and equipment, the lack of spare parts, and failure to provide reasonable quantities of screens and other materials at the drill sites when required. Despite the problems encountered, it should be stated that the relations between the members of the BMR field party and the drill crews were friendly and cooperative throughout the project.

Other factors contributing to the shortfall in drilling

Delay in the calling of tenders until 5 June, and a further delay in the final awarding of the contract, were due to the budgetary constraints on the OSS, and this probably was the main reason for attracting so few contractors to tender for the work. By the time tenders were called, those contractors who were prepared to operate in the area already had signed contracts for the season, and the limited time available for drilling was a further restriction.

Because of the late start and limited funding for the contract, the original requirement of 125 holes was reduced to 56 holes; a further reduction to 35 holes was made when it became clear that the required amount of drilling could not be carried out during the field season under this contract, and the holes planned for the lower Magela catchment were deferred until 1980.

Drilling contract for 1980

It is proposed that tenders for a contract for drilling in the Magela and Cooper Creek catchments during the 1980 field season be called in early February 1980. The contract should be awarded by the end of March, and drilling should commence during the last week of May.

The amount of drilling that is recommended for 1980 has been set out in the section "Program for 1980" at the end of this report.

SURFICIAL GEOLOGY

General

The oldest rocks of the area are a series of Archaean-Lower Proterozoic sedimentary formations deposited over 2000 million years ago. These sedimentary rocks were metamorphosed about 1800 million years ago to produce a variety of schistose, gneissic, and granitic rocks. The gneiss and granitic rocks have been mapped as the Nanambu migmatite complex in much of the Magela catchment, migmatite being rock formed by extreme metamorphism involving partial or complete melting of the original rock. A later sequence of Lower Proterzoic sediments was then deposited and these were also metamorphosed, the high-grade rocks being mapped as the Nimbuwah migmatite complex that is present in much of the Cooper Creek catchment.

Between 1800 and 1400 million years ago these formations were covered by Carpentarian deposits - the Kombolgie Formation which is predominantly sandstone with some interbedded volcanic members.

About 100 million years ago, sand and silt covered large parts of the area during the Cretaceous period, giving rise to the siltstone and sandstone of the Bathurst Island Formation.

The regional geomorphology and Cainozoic geology to the west of the East Alligator River have been described by Storey et al. (1969); the Cobourg Peninsula to the north has been investigated

by Hughes & Senior (1973) and Hughes (1978). These workers established that Miocene epeirogenic uplift and gentle tilting about an east-west axis close to the present coastline stripped the Cretaceous sediments of the Bathurst Island Formation from the area, and exhumed Carpentarian and Lower Proterozoic rocks. The closest known sediments of the Bathurst Island Formation are in the northern end of the Magela flood plain (Needham, 1976).

Extensive lateritisation occurred on the exposed surfaces of the upper Cooper Creek and Magela Creek catchments during a quiescent period in the late Miocene and Pliocene. Falling sea levels during the Pleistocene induced rejuvenation of Cooper Creek and Magela Creek, and much of the Tertiary laterite surface was removed. Several smaller scale climatically controlled erosional-depositional phases with minor movement along faults occurred intermittently throughout the Quaternary.

Nabarlek area

The surficial geology of the Nabarlek area is shown in Figure 3. Distribution of soil types is based on airphoto interpretation, on the logs of 15 shallow drill holes by BMR, and on drillers' logs from Australian Groundwater Consultants Pty Ltd (AGC). The Cooper catchment is currently being mapped by the Northern Territory Land Conservation Unit, and publication of their soils map at 1:25 000 scale is imminent (Wells, 1979).

Remnants of the Tertiary lateritised surface around Nabarlek are preserved in small footslopes around outliers of Kombolgie Formation (Fig. 3). The deposit above the northwest arm of Buffalo Creek is delineated on the basis of AGC drillers' logs which indicate 6 to 9 m of sand indurated by sesquioxide, overlying a strongly mottled clay and pallid zone. Lateritic remnants should also occur beneath footslopes of Kombolgie Formation to the west of Tin Camp Creek because of the similar geomorphic setting.

The oldest Quaternary soils are massive clays and earths developed on reworked laterite on the southern part of the interfluve between Cooper Creek and Tin Camp Creek.

SURFICIAL GEOLOGY - NABARLEK

Fig 3

Quartzose alluvium

Slopewash sands

Clays and earths developed on immature alluvium

Polygenetic soils - layered clays developed on lateritic detritus

Laterites overlain by rock rubble

Rock outcrop

Record No 1979/88

DS3-A1-77

Figure 4. Disintegrated laterite showing sand infills in vughs. Location: Cutoff trench in Ranger No. 1 Retention Pond. Negative No. M/2373/18

The next youngest unit is a solodic soil which occurs on the highest terrace of Cooper Creek and Buffalo Creek. Near hole N12, on the west arm of Cooper Creek, the clay is yellow-brown and blocky with abundant carbonate nodules in the B2 horizon; the hydromorphic equivalent is a dark grey cracking clay which is exposed in the eastern bank of the Cooper Creek sand pit. The Buffalo Creek clay is more strongly structured, which reflects its predominantly dolerite provenance.

Weakly indurated sheetwash and alluvial sands are either contemporaneous with or younger than the solodic soils described above. These soils were derived mainly from reworking of Kombolgie Sandstone and consist of poorly sorted quartz grains cemented together by clay. The plasma colour grades from pale grey or white in the southern part of the area to pronounced yellow and grey mottling towards the confluence of Tin Camp Creek and Cooper Creek.

The youngest soil is the uncemented quartzose alluvium in low terraces and beds of all major streams. Median grainsize is about 0.3 mm and sorting ranges from moderate to poor.

Magela Creek catchment

The top metre of the surficial cover in the catchment has been mapped at 1:25 000 scale by the Northern Territory Land Conservation Unit.

At the Ranger mine site, tailings dam, and retention pond No. 1 a yellow earth up to 2 m thick overlies truncated lateritised alluvium/colluvium on bedrock. The Tertiary landsurface is defined by the top of the lateritised zone, whether it is lateritised detritus or lateritised bedrock. The laterite has disintegrated, with quartzose sand infilling irregular planes and tubular vughs (Fig. 4).

Traverse 1 (Plate 2) extends across the laterite pavement to the Magela flood plain, and a cross-section is shown in Figure 5. Holes M1, M2, and M3 intersected a buried lateritised

surface developed on immature gravel and sand, which may represent slopewash and fluviatile facies of sediments of the Bathurst Island Formation.

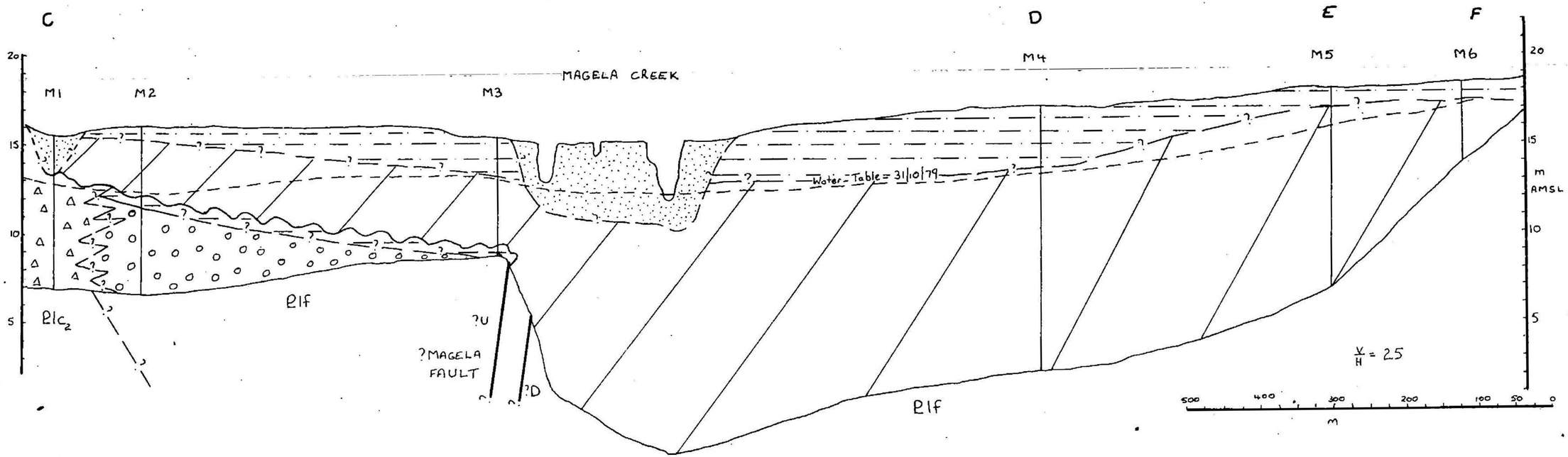
In the southern part of the catchment, the course of Magela Creek is controlled by the Magela Fault, which appears to have undergone Cainozoic movement. Upthrown sediments to the southwest of the fault were bevelled and lateritised; downthrown sediments to the northeast of the fault were extensively channelled, particularly near the fault alignment. Holes M4, M5, or M6 did not recover any remnants of lateritised material and are considered to be on the downthrown side of the fault; however, the core losses in these holes were such that lateritised material could have been present. An extensive lateritic pavement is known to occur to the northeast of hole M6. A buried fault scarp is inferred further downstream on Magela Creek where Ranger bores bottomed on bedrock at 2 m on the upthrown side and at 60 m on the downthrown side (Sarmed, pers. comm.).

Quaternary deposits of channel sands and overbank deposits are up to 14 m thick at Traverse 1 and are known to attain thicknesses of 60 to 70 m on the Magela flood plain south of Mudginberri.

A silty sand layer with minimal pedogenetic organisation blankets the whole flood plain. This layer is incised and filled with alluvium of the present Magela Creek and abandoned channel deposits (refer to hole M1).

Traverse 4 (Fig. 6) indicates that Gulungul Creek is similarly superimposed onto a buried early Quaternary braided stream system with two discrete palaeo-channels, one filled with fine silty sand and the other containing fine sand and lateritic gravel; both are covered by a similar silty sand layer with minimal pedogenetic organisation.

Figure 5



CROSS-SECTION ALONG TRAVERSE 1, MAGELA CREEK
MAGELA CATCHMENT

RECENT — Sands, Silts, Lateritic Gravel — Channel Deposits

QUATERNARY — Silty Sands
Sands, Silty Sands, Organic Sands, Minor Gravel — Channel Deposits

TERTIARY –?CRETACEOUS — Clayey Gravels — Laterite
Clayey Sands, Silty Sands — Mild Induration, Lateritised
Clayey Sandy Gravels

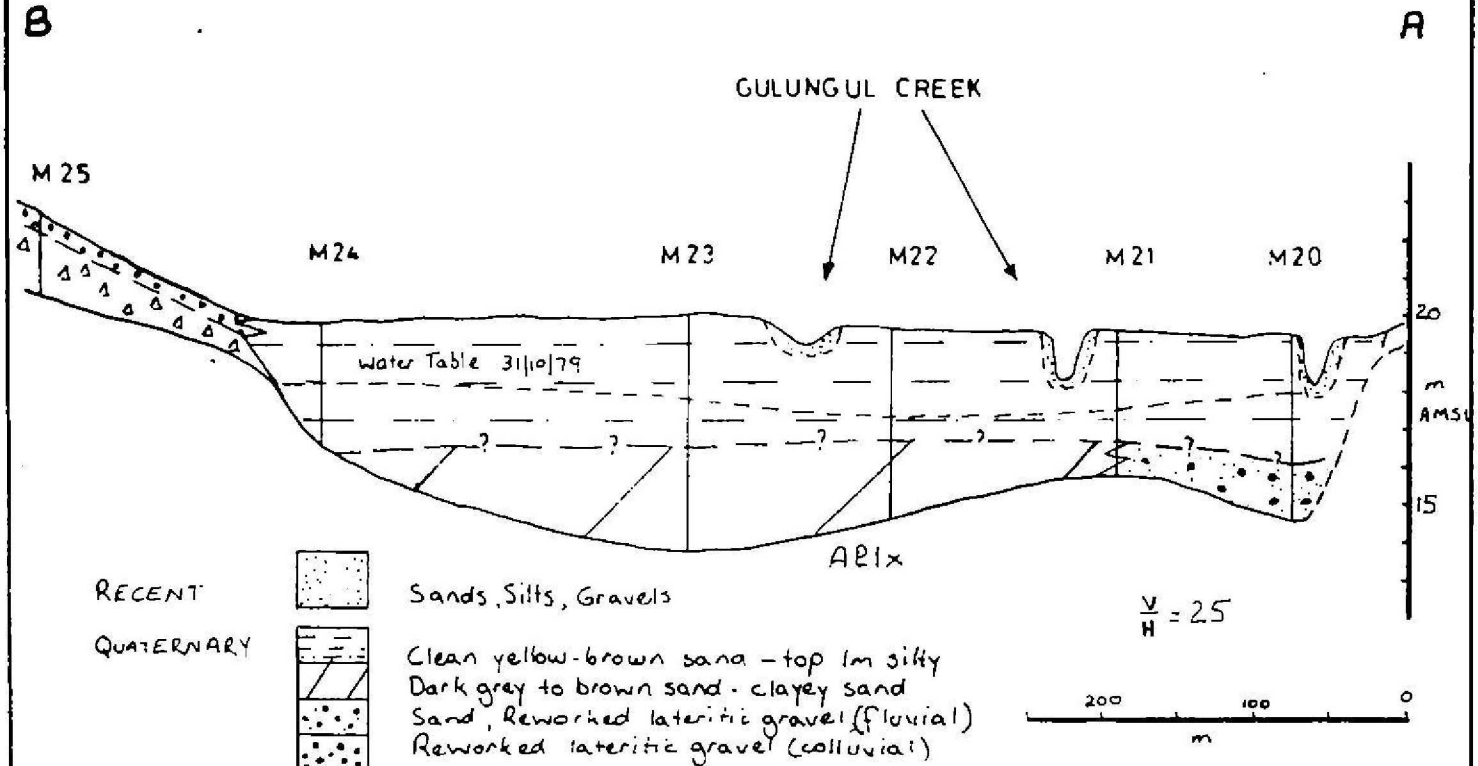
LOWER PROTEROZOIC — Plf Fisher Creek Siltstone
Plc_2 Cahill Formation

Facies change

M4 B.M.R. Drillhole, 1979

Record Nº 1979/88

Figure 6



RECENT		Sands, Silts, Gravels
QUATERNARY		Clean yellow-brown sand – top 1m silty
		Dark grey to brown sand - clayey sand
		Sand, Reworked lateritic gravel (fluvial)
		Reworked lateritic gravel (colluvial)
TERTIARY		Laterite
LOWER PROTEROZOIC - ARCHEAN	ABIx	Nanambu Complex
		Facies change
	M21	B.M.R Drillhole, 1979

CROSS-SECTION ALONG TRAVERSE 4, GULUNGUL CREEK AREA
MAGELA CATCHMENT

HYDROGEOLOGY OF THE SURFICIAL COVER

Nabarlek area

Casing schedules of the fifteen boreholes are included in Appendix 3. Boreholes N2, N3, N6, N7, N9, N11, and N13 were developed over the two weeks following drilling and are considered to be suitable for water quality monitoring. All other holes were either dry or of low seepage and therefore it was not possible to properly flush the aquifers, but the gravel pack was cleaned by forcing water through the screens and up through the gravels.

Table 1 shows steady yields of the bores, ascertained after 2 to 3 hours' pumping during the final bore development program.

The Recent alluvial terraces of Tin Camp Creek and Cooper Creek form the highest-yielding superficial aquifer. Chemical analyses of groundwater from the Nabarlek bores are not yet available, but water from bores N11 and N12 (Cooper Creek) was odorous and foul-tasting. This is attributed to the very low seepage rates through the sub-sola in this area. Groundwater from N2 and N3 (Tin Camp Creek) was slightly odorous and tasted brackish.

Sand thicknesses in Tin Camp Creek decrease from over 9 m at N3 to 5.5 m at N1, which is 700 m downstream, and at the junction with Cooper Creek the thickness of sand is only 2.4 m. If the reduction in thickness of sand downstream is due to a rise in the level of the base of the aquifer, groundwater will be ponded in Tin Camp basin sediments, and groundwater movement in the latter part of the dry season is likely to be very slow. In prolonged dry seasons, it is reasonable to expect groundwater movement to cease. Such stagnation points should be predicted by the model being developed by the Northern Territory Water Division. The Tin Camp Creek area is sensitive because it lies downslope from the Nabarlek sewerage effluent pond. Seepage from the pond into the sands would be maximised during the dry season because this is the time of the maximum potential difference in

TABLE 1

STATUS OF NABARLEK BORES

Bore No	Interval screened (m)	Aquifer	Yield	Status
N1	1.5 - 5.5	Medium sand	Seepage	Flushing required before chemical sampling
N2*	2.9 - 7.0	Sand, gravel	4.5 L/s	Passed for sampling
N3*	3.7 - 9.3	Sand, gravel	1.5 L/s	Passed for sampling
N4	2.4 - 5.0	Lateritic gravel	Seepage	Further flushing required
N5	0.9 - 2.9	Slopewash	Dry	Flushing required
N6	1.7 - 3.7	Fine sand	2 L/s	Passed for sampling
N7	1.1 - 3.1	Medium sand	1 L/s	Passed for sampling
N8	1.0 - 3.0	Clayey gravel	Dry	Flushing required
N9	5.8 - 9.8	Weathered dolerite	0.5 L/s	Passed for sampling[x]
N10	3.5 - 5.5	Lateritic gravel	Seepage	Flushing required
N11**	2.1 - 6.1	Lateritic gravel	0.05 L/s	Passed for sampling
N12**	2.0 - 4.0	Lateritic gravel	Dry	Flushing required
N13	0.9 - 4.9	Gravel	Less than 0.05 L/s	Passed for sampling
N14	0.0 - 2.0	Medium sand	Dry	Flushing required
N15	0.5 - 2.5	Fine sand	Seepage	Flushing required

x Brass footvalve wedged on welding slag at join of screens at 7.8 m

* Slightly odorous, brackish

** Strongly odorous, brackish

water-levels between the pond and groundwater, and pollutants would be concentrated in the alluvium. Pollutants would be diluted with aquifer recharge and flushing during the following wet season.

Although yields in the alluvium of Cooper Creek are relatively high, groundwater movements during the dry season are very slow because of the downstream drainage constriction and the very low hydraulic gradient. Assuming a hydraulic conductivity of about 10 m per day, it is estimated that the subsurface discharge across Cooper Creek at holes N6 and N7 was no greater than 20 m^3/day during September–October 1979.

Magela Creek catchment

Casing schedules of eleven boreholes are included in Appendix 3. Boreholes M3, M4, M20, and M22 are considered to be developed sufficiently for regular water quality monitoring. Boreholes M1, M6, and M23 require a small amount of flushing before they are suitable for sampling. Boreholes M2, M5, M21, and M24 still require further development.

Steady yields of the bores, ascertained after 2 to 3 hours' pumping during final bore development, are shown in Table 2.

Boreholes M1 to M6 were drilled on traverse 1 (Plate 2) and M21–M25 were drilled on traverse 4 across Gulungul Creek (Plate 2).

Along traverse 1 the highest yielding surficial aquifers are in the Quaternary alluvium of the Magela flood plain. Yields greater than 6.5 L/s were sustained in M4 on the flood plain 600 m northeast of the present Magela streambed. Lateritised gravels on the southwest side of Magela Creek are low producers.

At Gulungul Creek a yield of 2 L/s was obtained from Quaternary sand and reworked lateritic gravel near the present eastern arm of the creek. No water was found on the broad lateritised plain to the west, but laterite elsewhere at Ranger is known to contain significant amounts of groundwater. During construction

TABLE 2

STATUS OF MAGELA BORES

Bore No	Interval screened (m)	Aquifer	Yield	Status
M1	6.9 - 8.9	Lateritic gravel	Seepage	Requires minor flushing
M2	1.4 - 9.4	Sand and gravel	Seepage	Requires major development
M3	2.1 - 6.5	Medium to coarse sand	3 L/s	Passed for sampling
M4	3.0 - 15.0	Medium to fine sand	More than 6.5 L/s	Passed for sampling
M5	1.5 - 11.5	Fine sand with basal gravel	Seepage	Requires major development
M6	2.5 - 4.5	Fine sand with basal gravel	Seepage	Requires minor flushing
M20	2.4 - 5.0	Sand, lateritic gravel	2 L/s	Passed for sampling
M21	1.8 - 3.0	Sand, lateritic gravel	Seepage	Requires major development
M22	4.1 - 6.5	Fine sand	0.5 L/s	Passed for sampling
M23	2.6 - 6.6	Fine sand	Seepage	Requires minor flushing
M24	1.3 - 3.3	Coarse sand with basal gravel	Seepage	Requires major development
M25	Not screened	Lateritic gravel	Dry	Not assessed

of the cut-off trench for Ranger No. 1 retention pond, the laterite exposed in the trench walls took at least a week to drain. All the groundwater was contained within the sand infilling of vughs.

Dry season groundwater discharge through the Magela and Gulungul flood plains cannot yet be estimated, but the results given above indicate that the flood-plain sediments constitute a major aquifer of the hydrological system, with the greatest flow subparallel to the present streams.

Water quality sampling

A groundwater quality sampling run was done on the fully developed bores in late October 1979. Bores M3, M4, M20, M22 (Magela) and N2, N3, N6, N7, N9, and N11 (Nabarlek) were pumped for a minimum of 20 minutes and three samples from each bore were sent to AMDEL for chemical analysis. Borehole N13 was not sampled because it was dry. No results have been received at the time of writing this report.

Samples were contained in acid washed plastic bottles which had been thoroughly rinsed at each bore. A list of elements requested for analysis is given in Table 3.

TABLE 3

WATER QUALITY SAMPLING, OCTOBER 1979

Container	Sample pre-treatment	Parameters & elements requested for analysis
1 litre plastic bottle	Acid washed bottle	pH, elect. conductivity. Ca, Mg, Na, K, Cl, SO_4, HCO_3, NO_3.
1 litre plastic bottle	Acid washed bottle	Al, Cd, Cu, Fe, Mn, Pb, Zn, Hg, As, P_2O_5, SiO_2.
1 litre plastic bottle	Acid washed bottle	U, Rn, Ra.

As a result of discussions with AMDEL, new methods have been adopted for future sampling. Sampling for cations and anions remain unchanged. The sample for heavy metals is to be acidified and filtered. The sample for radon should only occupy

375 mL in a 500 mL glass bottle and be unacidified and unfiltered. The modified sampling procedures are set out in Table 4.

The next sampling run is set down for January 1980, with another run to follow during the initial groundwater recession about May 1980.

TABLE 4

FUTURE WATER QUALITY SAMPLING

Container	Sample pre-treatment	Parameters and elements requested for analysis
1 litre plastic bottle	Acid washed bottle	pH, elect. conductivity. Ca, Mg, Na, K, Cl, SO_4, HCO_3, NO_3, SiO_2, P_2O_5.
1 litre plastic bottle	Acid washed bottle Filtered and acidified with 5 mL 1:1 HNO_3	Al, Cd, Cu, Fe, Mn, Pb, Zn, Hg, As, U, Ra.
500 mL glass bottle with glass stopper	Acid washed bottle Fill only to 375 mL	Rn

INFILTRATION

General

Infiltration tests were run at 13 sites in the Magela Creek catchment (Plates 1 and 2) and at five sites at Nabarlek. The Magela sites were chosen as representative of soil groups in the catchment mapped by the Northern Territory Land Conservation Unit. The Nabarlek sites were located next to BMR boreholes (Fig. 2).

Two methods of constant-head (ponding) infiltration testing were employed: the ring infiltrometer method and the auger hole permeameter method. The apparatus used was based on equipment designed by Dr T. Talsma, CSIRO Division of Forest Research.

Ring infiltrometer

The equipment consists of a ring, a constant-head permeameter, and a stand. The rings are constructed of mild steel with a diameter of 304 mm and a height of 150 mm. There is a reinforcing ring on the upper edge and a bevelled edge to the other end.

The permeameter is used to monitor the flow of water required to maintain a constant head on the sample. The permeameter consists of two concentric perspex tubes, a perforated base plate, and a scale for measuring the head of water. The stand is of either wood or metal construction, and is covered by a permeable gauze to allow free flow of water out of the bottom of the sample.

Soil samples are obtained by digging a pit down to the top of the sample, and the exposed soil surface is carefully levelled with a blade. The ring is then driven into the soil until the upper edge is horizontal and approximately 20 mm above the sample surface. The ring containing the sample is excavated and the bottom of the sample is trimmed. The ring and sample are then placed on the stand and the permeameter is filled and placed on the ring. Testing is continued until the infiltration rate reaches steady state, which is generally attained within six hours of starting the test.

Tests were carred out for several different soil antecedent moisture contents (AMC), and up to four comparison runs were done simultaneously.

Auger hole permeameter

In this method, water is infiltrated from a constant-head permeameter into an auger hole of slightly greater diameter. The apparatus consists of a constant-head permeameter and a set of adjustable legs; equipment and procedures are described by Talsma (1980).

The constant-head permeameter is the same type as that used with the ring infiltrometer, except that the base plate is replaced by adjustable legs, which are set so that the base of the concentric tubes is below the top of the desired soil horizon. The tubes are then filled with water and infiltration continues until steady state conditions are attained, usually within one to two hours in a borehole of 50 mm diameter.

Results

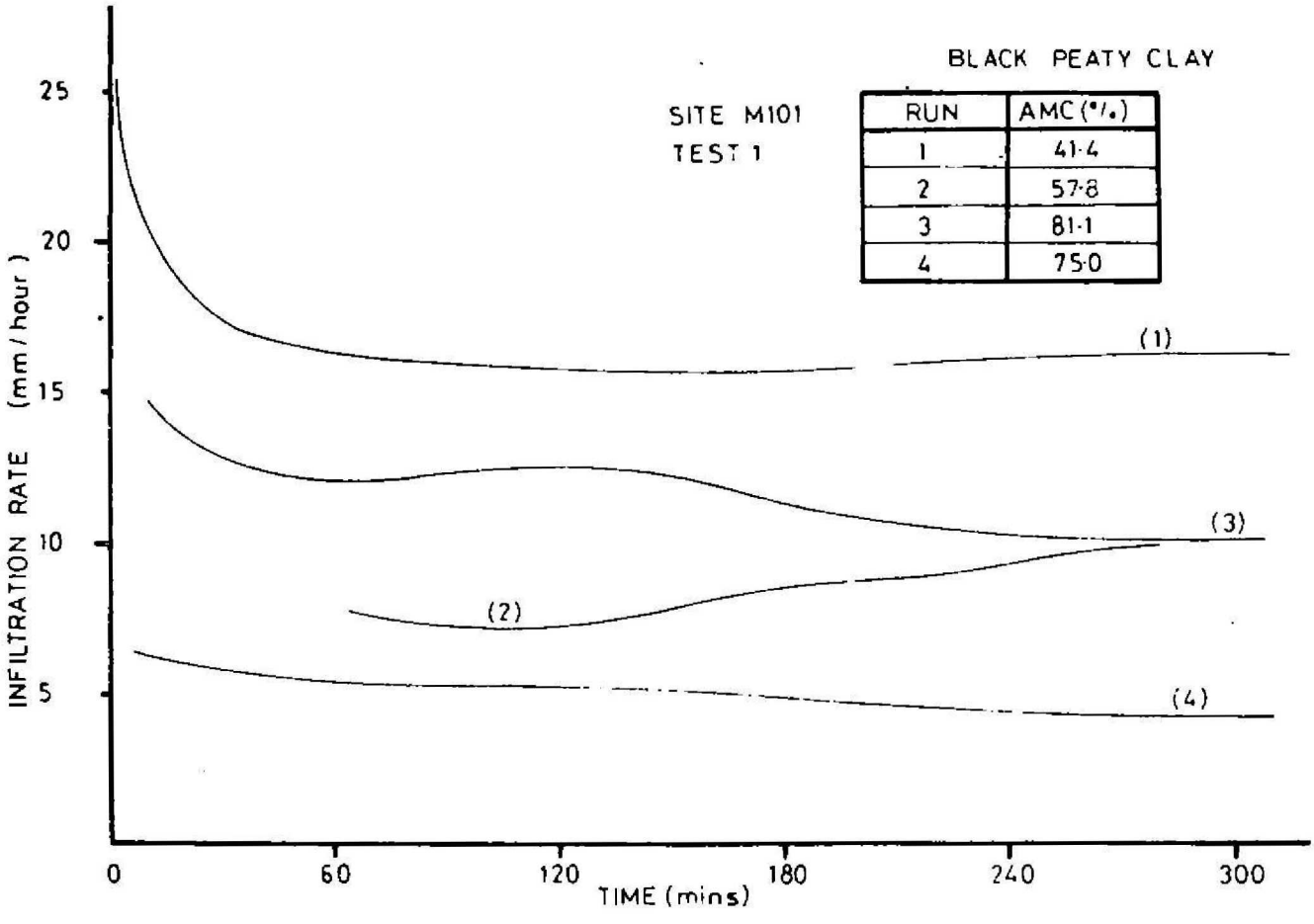
Saturated hydraulic conductivities of soils from Nabarlek and the Magela Creek catchment are shown in Table 5.

The k_{SAT} values were computed from the recession curves of the highest AMC values. Ring tests showing the dependence of infiltration rate on AMC are shown in Figures 7 to 10. It was not possible to determine AMC values in the auger hole tests because the soils required wetting before an auger hole could be dug.

In the ring infiltrometer method, evaporation losses from the water surface inside the ring were measured at an average of 0.012 mm/hr for the duration of the tests, and the figures have been adjusted by that amount.

In the auger hole method, difficulties were experienced in the sands and earths with slumping from the walls of the hole. When this happened, the test was aborted because the boundary conditions had changed. This problem could be overcome in the future by the installation of a fine screen in the section of the auger hole being infiltrated.

Table 5 shows very high infiltration capacities of around 20 mm/hr in the sands and earths of the upper Magela flood plain, indicating that groundwater recharge from rainfall will be rapid. The red and yellow earths which cover the higher lateritised interfluves of the upper catchment also gave infiltration capacities of up to 50 mm/hr indicating that significant interflow will occur on top of the laterite during the wet season (Mill).


BLACK PEATY CLAY
SITE M101
TEST 1
RUN | AMC (%)
1 | 41·4
2 | 57·8
3 | 81·1
4 | 75·0
INFILTRATION RATE (mm / hour)
25
20
15
10
5
0
60
120
180
240
300
TIME (mins)
(1)
(2)
(3)
(4)

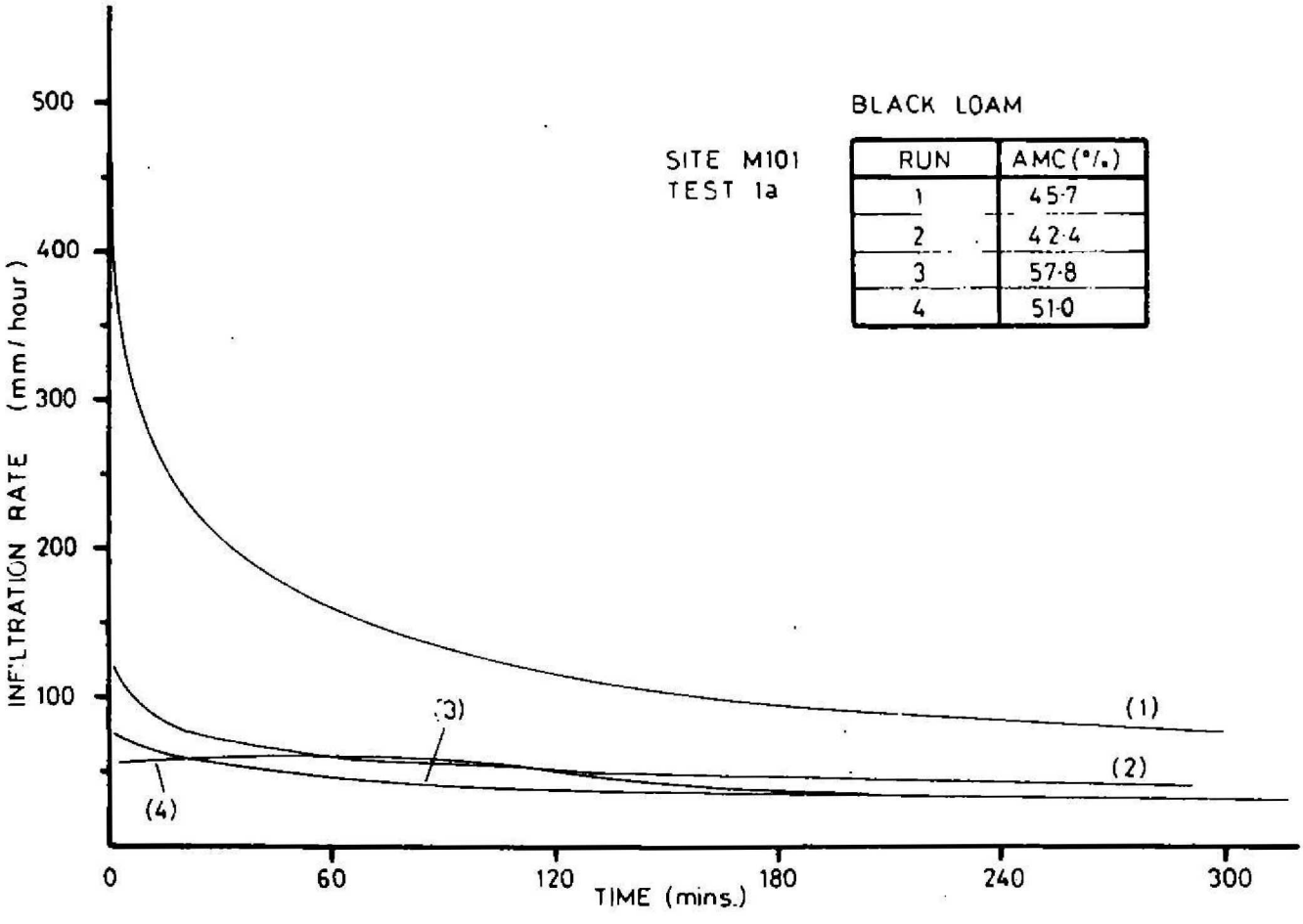
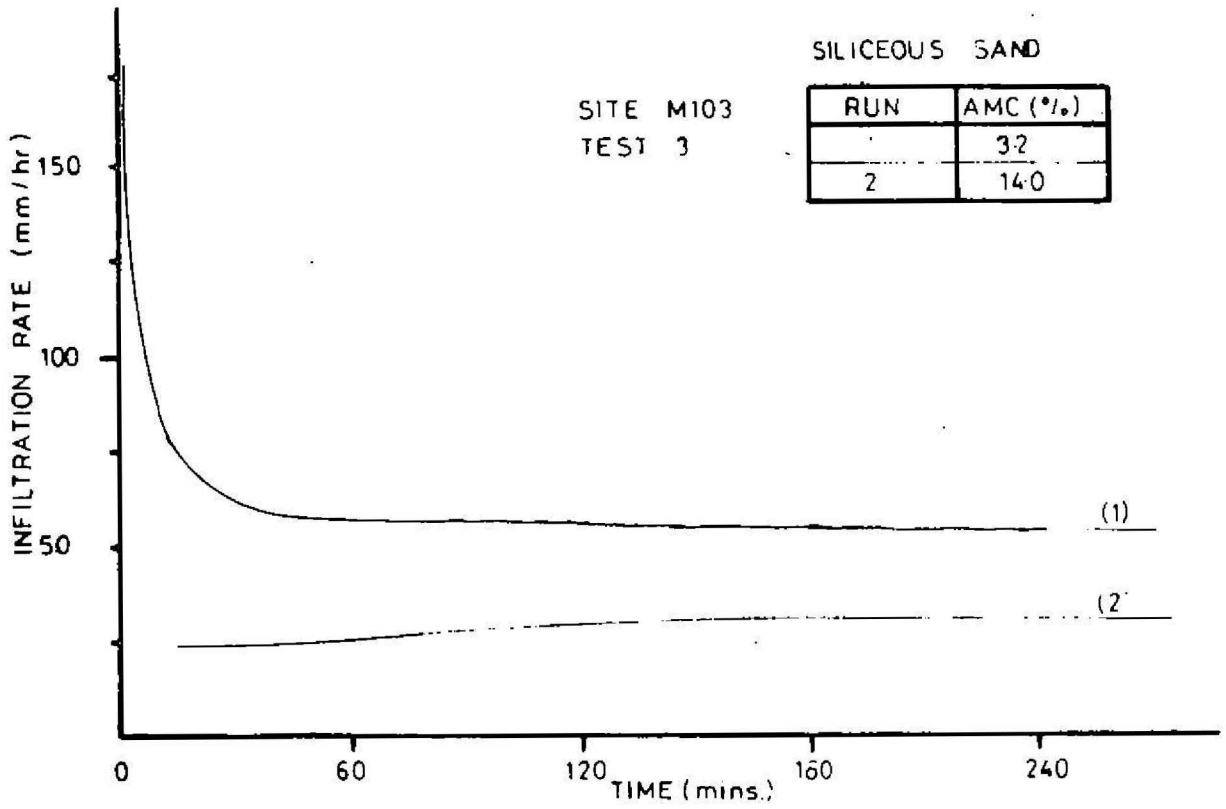

BLACK LOAM
SITE M101
TEST 1a
RUN | AMC (%)
1 | 45·7
2 | 42·4
3 | 57·8
4 | 51·0
INFILTRATION RATE (mm / hour)
500
400
300
200
100
0
60
120
180
240
300
TIME (mins.)
(1)
(2)
(3)
(4)

FIGURE 8


SILICEOUS SAND
SITE M103
TEST 3
RUN | AMC (%)
1 | 3·2
2 | 14·0
INFILTRATION RATE (mm/hr)
150
100
50
0
60
120
160
240
TIME (mins.)
(1)
(2)

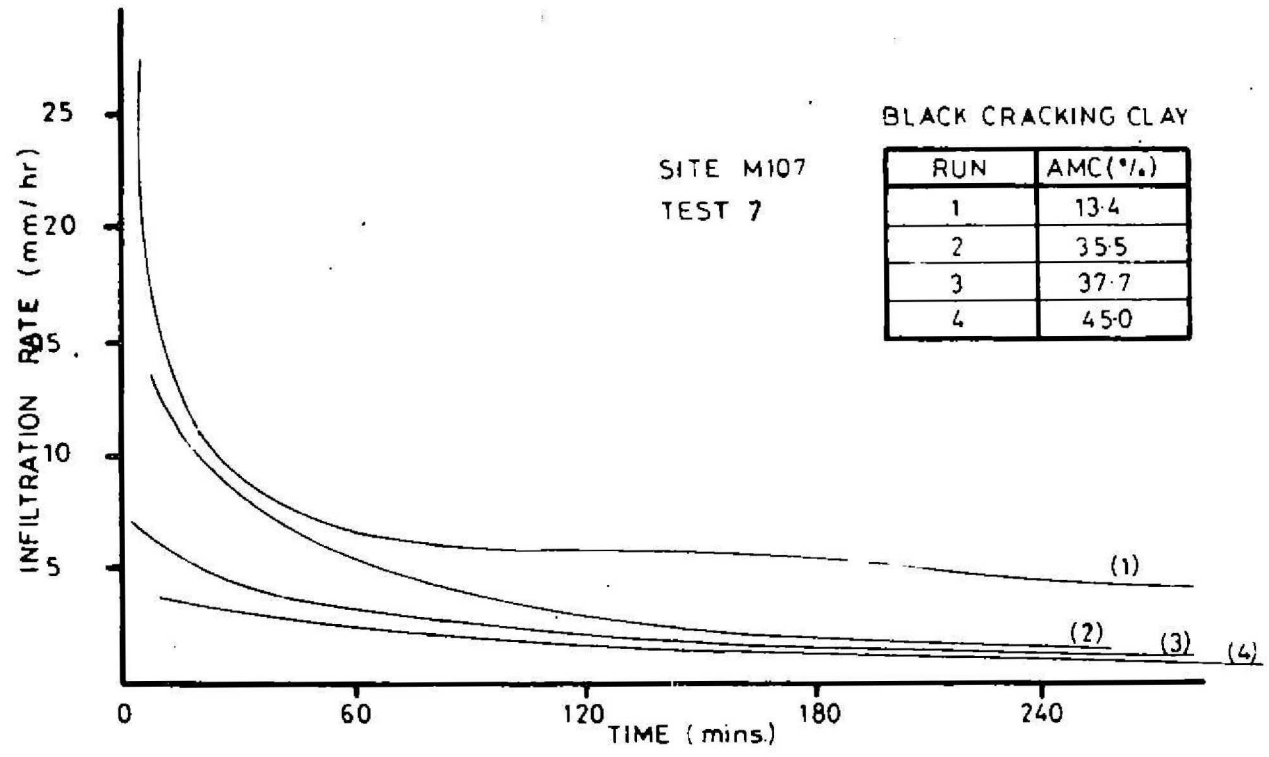
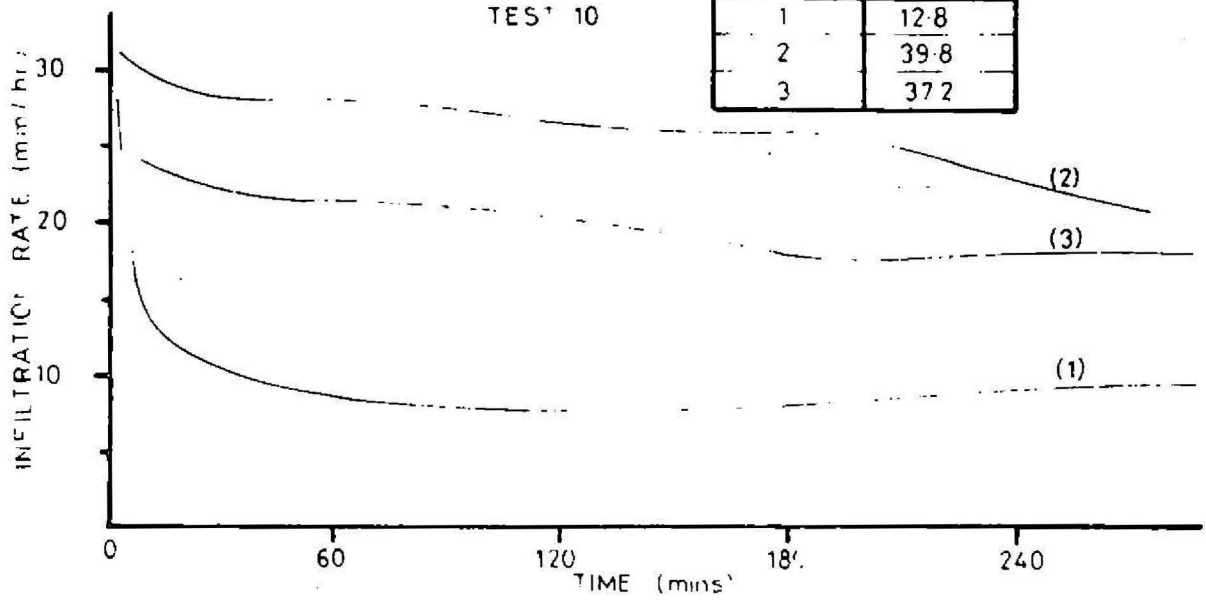

BLACK CRACKING CLAY
SITE M107
TEST 7
RUN | AMC (%)
1 | 13·4
2 | 35·5
3 | 37·7
4 | 45·0
INFILTRATION RATE (mm/hr)
25
20
15
10
5
0
60
120
180
240
TIME (mins.)
(1)
(2)
(3)
(4)

FIGURE 9

MASSIVE GLEYED CLAY

SITE M110
TEST 10

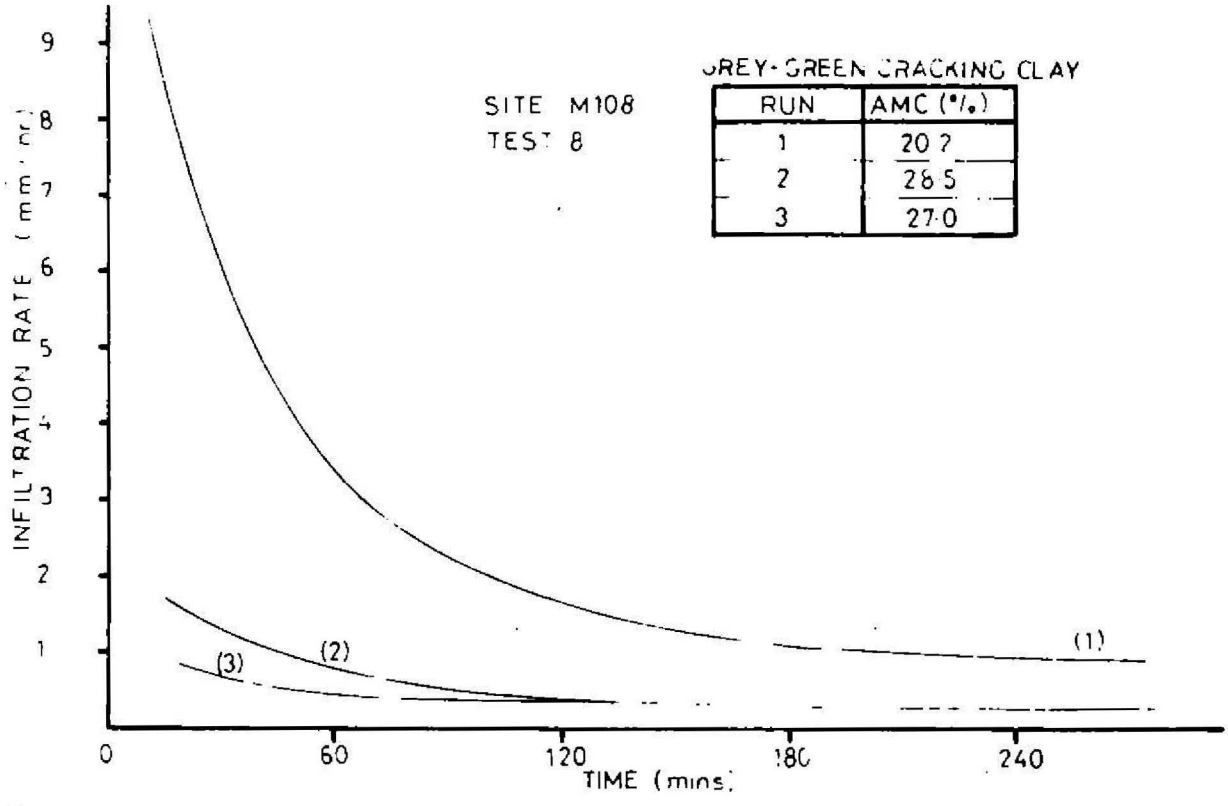
RUN	AMC (%)
1	12·8
2	39·8
3	37·2



GREY-GREEN CRACKING CLAY

SITE M108
TEST 8

RUN	AMC (%)
1	20·7
2	26·5
3	27·0



MASSIVE RED GRAVELLY EARTH

SITE M109
TEST 9

RUN	AMC (%)
1	6·4
2	22·5
3	20·5
4	20·1

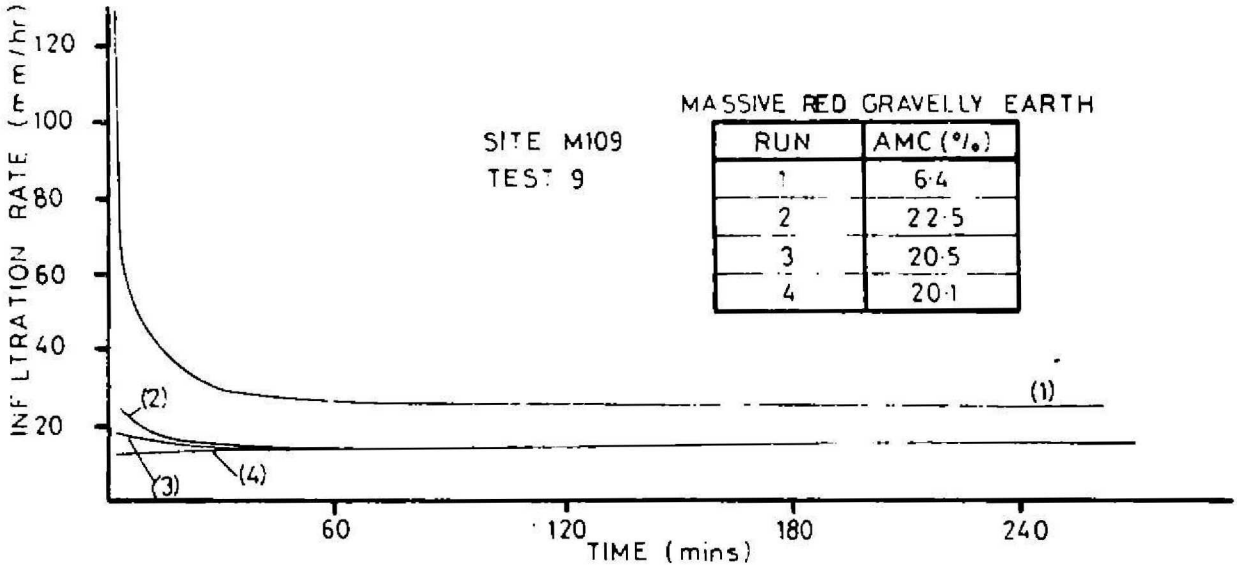
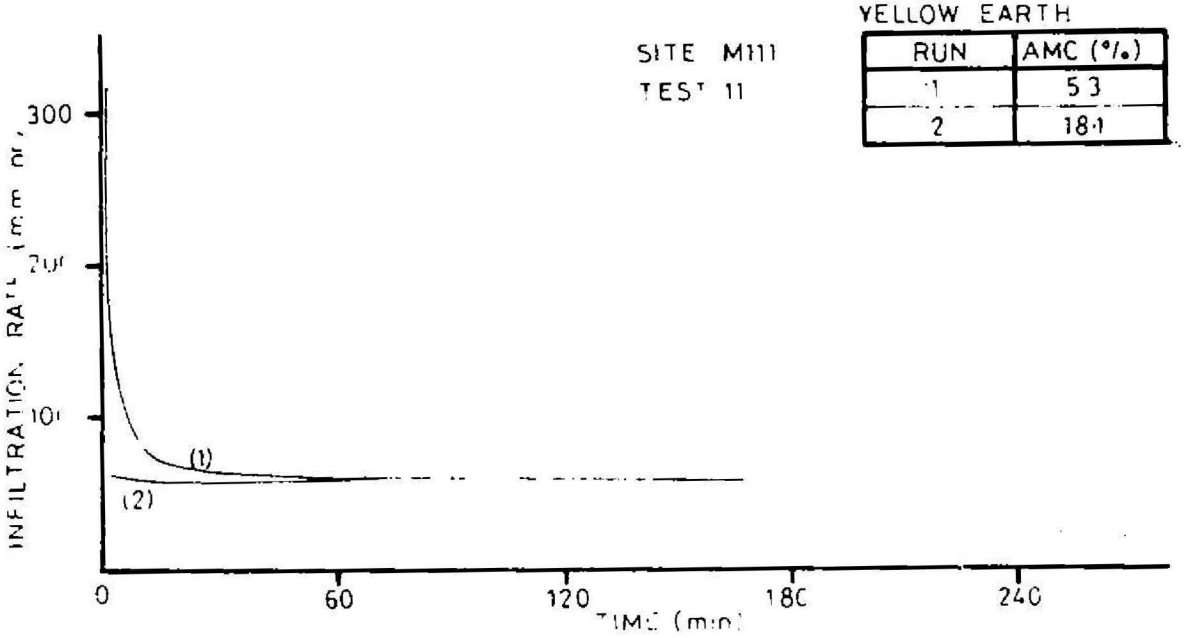
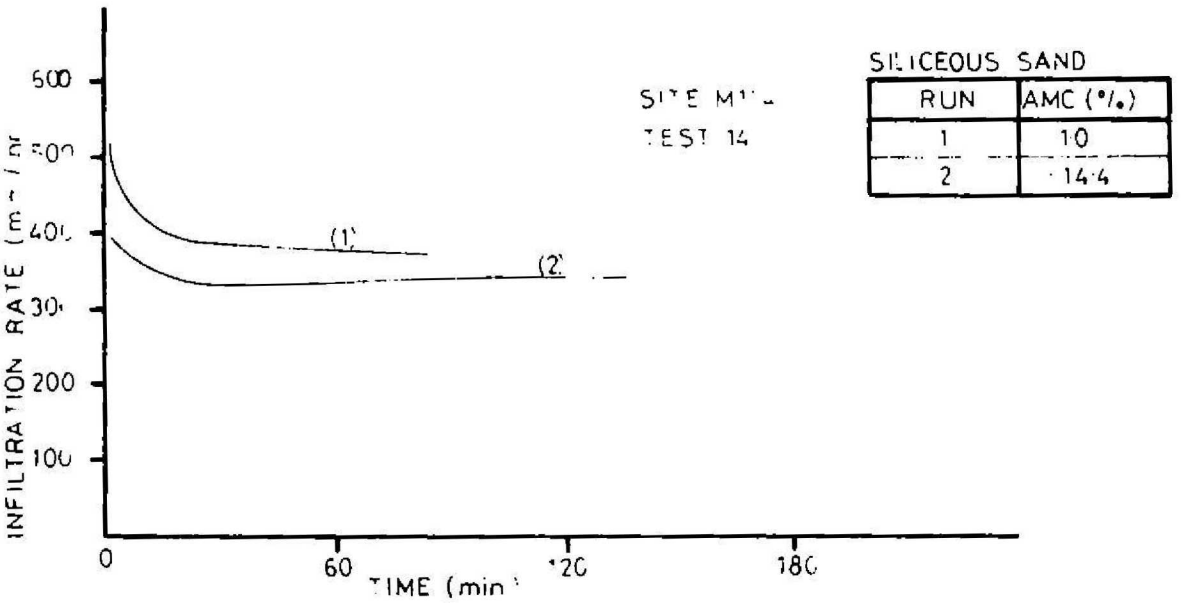
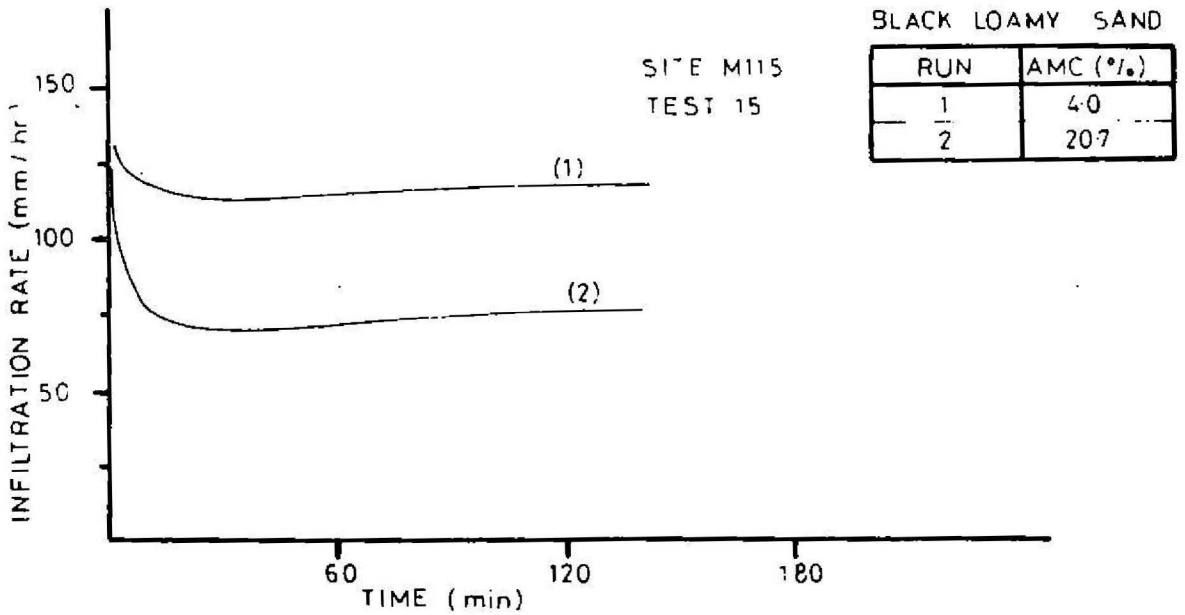


FIGURE 10


SITE M111
TEST 11
YELLOW EARTH
RUN | AMC (%)
1 | 5·3
2 | 18·1
300
100
(1)
(2)
0
60
120
180
240
TIME (min)


SITE M11
TEST 14
SILICEOUS SAND
RUN | AMC (%)
1 | 10
2 | 14·4
600
400
300
200
100
(1)
(2)
0
60
120
180
TIME (min)


SITE M115
TEST 15
BLACK LOAMY SAND
RUN | AMC (%)
1 | 4·0
2 | 20·7
150
100
50
(1)
(2)
60
120
180
TIME (min)

Lateritised bedrock (M104) gives a steady-state infiltration rate of around 10 mm/hr showing that hydraulic continuity exists within the vugh network, but admittance rates are very high and erratic until the vughs fill with water. The vesicular lateritised alluvium/colluvium was not tested because it proved impossible to obtain a ring sample or to put down an auger hole without disturbing the fabric of the sample.

The cracking clays around the billabongs of the lower Magela flood plain (M107) gave very high initial infiltration rates when the AMC was below the shrinkage limit. Open cracks up to 2 cm wide permit large volumes of water to gravitate through the soil before the clay absorbs water and swells to close off the transmission planes. Volume changes of up to 20 percent were observed in the clays after wetting at sites M101, M107, M108, and M110.

In some clay soils (M101, M107, M110) an apparent increase in infiltration rate was measured after 1 to 2 hours. This phenomenon is probably caused by delayed air expulsion and changes in atmospheric pressure during the tests.

The infiltration testing of the clays of the lower Magela flood plain (M101, M107, M108) indicated that the first rainstorm of the wet season will produce very little runoff. Thereafter the combined effects of higher soil moisture content and rising water-table will ensure ponding and runoff of most of the water during the rest of the wet season. The sandy soils of the upper Magela flood plain are capable of admitting large amounts of precipitation until the water-table rises to near the surface. Runoff from the upper flood plain in the early wet season should only occur from storms of intense rainfall.

SURVEYING AND LEVELLING OF BOREHOLES

Surveying and levelling of proposed boreholes was undertaken by the field party to establish grid references according to the Australian Geodetic Grid 1966, and heights above mean sea level were tied to the Australian Height Datum. Magela Creek was

TABLE 5

SATURATED HYDRAULIC CONDUCTIVITIES
DETERMINED FROM INFILTRATION TESTS

Site No.	Test No.	NT Land Conserv. Soil Gp	Description of soil	Depth (m)	Type of test	$k_{SAT.}$ (mm/hr)
MAGELA CREEK CATCHMENT						
M101	1	7A3	Black peaty clay	0-0.15	Ring infiltro-meter	3.7
M101	1A	7A3	Black loam	0.3-0.45	Ring infiltro-meter	30.3
M103	3	5E	Siliceous sands	0-0.3	Ring infiltro-meter	31.5
M104	4	-	Lateritised weathered schist	0.93-1.52	Auger hole	12.1
M104	4A	-	Lateritised weathered schist	0.70-1.09	Auger hole	5.8
M106	6	5E	Siliceous sands	0.52-1.02	Auger hole	14.6
M106	6A	5E	Siliceous sands	0.6-1.1	Auger hole	13.5
M107	7	7A3	Black cracking clay	0-0.3	Ring infiltro-meter	0.9
M108	8	9A	Grey-green cracking clay	0-0.3	Ring infiltro-meter	0.2
M109	9	3C2	Massive red gravelly earth	0-0.3	Ring infiltro-meter	18.6

TABLE 5 (cont.)

Site No.	Test No.	NT Land Conserv. Soil Gp	Description of soil	Depth (m)	Type of test	k_{SAT} (mm/hr)
MAGELA CREEK CATCHMENT (cont.)						
M110	10	6B2	Massive gleyed clay	0-0.3	Ring infiltro-meter	14.6
M111	11	4E	Yellow earth	0-0.3	Ring infiltro-meter	56.0
M112	12	-	Mottled gravelly clay	1.28-1.78	Auger hole	1.7
M113	13	-	Medium yellow-brown sand	1.1-1.5	Auger hole	31.7
M114	14	5E	Siliceous sands	0-0.15	Ring infiltro-meter	30.3
M115	15	5E	Black loamy sand	0-0.15	Ring infiltro-meter	60.7
NABARLEK CATCHMENT						
N104	4	-	Grey earth	0.10-0.42	Auger hole	1.6
N104	4A	-	Mottled silty sand	0.6-0.9	Auger hole	11.4
N104	4B	-	Mottled sandy clay, dense	1.65-2.2	Auger hole	0.4
N105	5	-	Pale grey fine slopewash	0.3-0.96	Auger hole	4.9
N108	8	-	Mottled yellow gravelly sand	0.52-0.95	Auger hole	22.9

TABLE 5 (cont.)

Site No.	Test No.	NT Land Conserv. Soil Gp	Description of soil	Depth (m)	Type of test	k_{SAT} (mm/hr)
NABARLEK CATCHMENT (CONT.)						
N108	8A	-	Mottled grey & red clayey sand	0.78-1.05	Auger hole	34.7
N108	8B	-	Massive sandy clay	1.1-1.5	Auger hole	0.3
N109	9	-	Reddish brown friable silty clay	0.25-0.58	Auger hole	3.5
N109	9A	-	Red clayey sand	0.20-0.65	Auger hole	12.0
N109	9B	-	Yellow brown silty clay	0.20-0.69	Auger hole	1.2
N111	11	-	Red brown clay	0.18-0.73	Auger hole	0.9
N111	11A	-	Mottled yellow-grey massive sandy clay with carbonate nodules	1.30-1.52	Auger hole	0.08

plane-tabled for a distance of 100 m upstream and downstream of its intersection with traverse 1. No surveying or levelling was done at Nabarlek.

Instruments used were a Wild "T2" theodolite for horizontal angle determinations and tacheometry, and a Hilger & Watts "Auto Set" dumpy level for height measurements. A Wild self-reducing alidade was used for plane-tabling.

Borehole traverses were tied to stations surveyed by mining companies or to aerial survey markers, and initial bearings for a reference line were taken by compass. Time did not permit ties for loop closure. Tie points are shown in Appendix 4.

Twenty boreholes were surveyed in four traverses and five sites were fixed individually. Coordinates of holes are shown in Appendix 4. Boreholes which were surveyed but not drilled during 1979 have been marked in the field by yellow star pickets with BMR numbers.

A block of 100 Water Division registered numbers has been reserved for BMR boreholes.

Surveying and levelling of all bores not done in 1979 will be undertaken during the 1980 field season. If time permits, the holes proposed for drilling during 1980 will be surveyed during the season.

CONCLUSIONS

The upper Magela Creek is entrenched in Quaternary alluvium which has been deposited on the downthrown side of the Magela Fault. The alluvium constitutes the major surficial aquifer in the area and attains thicknesses of up to 70 m upstream from Mudginberri. Steady-state yields greater than 6.5 L/s were obtained in the flood-plain sands, and much higher rates are expected in gravels of palaeochannel deposits.

Red and yellow earths which cover the higher lateritised interfluves of the upper Magela catchment are highly permeable. Measured constant-head infiltration rates ranged from 10 mm/hr in the lower catenary position to above 50 mm/hr in well drained sandy soils, indicating that significant interflow will occur on top of the laterite during the wet season. Consequently, surface pollutants from the mining areas are likely to be mobilised and transported towards Magela Creek only during the wet season, which is also the time of maximum dilution.

Hydraulic continuity within the vugh network of the lateritised surface has been demonstrated by steady infiltration rates up to 10 mm/hr.

Initial infiltration rates in the cracking clays around the Magela billabong system are very high when the antecedent moisture content is low, but decrease to less than 1 mm/hr after 1 to 2 hours of wetting. The first rainstorms of the wet season will produce very little runoff on these clays, but runoff and ponding will take place in later storms because of higher initial soil moisture content and a rising water-table. Runoff from the sandy soils of the upper Magela flood plain will not occur until much later in the wet season.

At Nabarlek steady-state yields up to 4.5 L/s were obtained in the alluvium and lowest terraces of Tin Camp Creek and Cooper Creek. Clay soils developed on reworked laterite on the interfluves are characterised by very low seepage rates through their sub-sola.

Stagnation points of very slow groundwater flow are likely in the sands of the basin of upper Tin Camp Creek in prolonged dry seasons. This area required careful management because it lies below the Nabarlek sewerage pond, from which seepage into the sands would be maximised during the dry season. Pollutants would build up in the alluvium of the basin during the dry season and dilution would occur during the following wet season.

Groundwater flow rates during the dry season in Cooper Creek alluvium are considered to be very low because drainage is thought to be very low. The maximum subsurface discharge was estimated at 20 m^3/day during September-October 1979. Careful monitoring of groundwater quality in Cooper Creek is necessary during dry seasons because the only source of recharge to the surficial aquifers is from the fractured rock aquifers below.

PROGRAM FOR 1980

Drilling

It is proposed to install 72 monitoring bores in the Magela catchment as shown in Plates 1 and 2. This figure includes 28 bores which were planned for 1979, but which the contractor failed to drill, and a further 44 holes originally planned for the

1980 field season. Eighteen shallow piezometers for stream underflow studies are planned in the Magela streambed at traverses 1, 2, and 3.

Six bores are planned for Nabarlek and these are located in stream alluvium (Fig. 2).

It is anticipated that the Nabarlek bores and the initial 28 Magela bores would be put down before 30 June 1980 and the remainder should be completed by 30 September 1980. In addition BMR drilling section has programmed four stratigraphic holes to be put down during September-October to the south of Cannon Hill at no charge to the OSS. These holes will provide a link with the stratigraphy obtained from a number of holes previously drilled by BMR to the northwest of the Magela Creek catchment.

Aquifer testing

Pump testing of bores to determine aquifer parameters is programmed to start in June and will carry through until October. Dye tracing experiments are planned to be conducted concurrently with the pump testing. Dye injection is to be carried out at Nabarlek bores N11, N12, N5 to N7, N2, and N3, and in the shallow piezometers on Magela traverses 1, 2, and 3. Some dye tracing is also planned for bores near the billabongs to test groundwater/surface-water connection.

Joint analysis, Kombolgie Formation

Fractures in the Kombolgie Formation are to be analysed as time permits throughout the field season. Structural domains on the western side of the Brockman Massif and on the Jabiluka Outlier have been selected for analysis, and approval has been obtained to enter these areas.

Surveying and levelling

Surveying and levelling of bores will contine throughout the field season.

Duration of field season

In order to carry out the program it is essential that the party depart from Canberra in early May and that drilling start in the fourth week of May. Fieldwork should finish by the end of October and the party should arrive back in Canberra by mid November.

ACKNOWLEDGEMENTS

The party is indebted to Dr Tjeard Talsma, CSIRO, for his advice on infiltration testing.

Scientist from the Office of the Supervising Scientist, the NT Water Division, the NT Geological Survey, and the NT Land Conservation Unit were most helpful to the party both in the field and in Darwin.

Chris Haynes of the Australian National Parks and Wildlife Service, and David Rourke of the Northern Land Council assisted the party greatly by negotiating on our behalf with the traditional landowners of the area and by obtaining permission for drilling.

The mining companies cooperated fully with the party; in particular, the courtesy and assistance of Safar Sarmed (Ranger) and Les Hunter (QML) are gratefully acknowledged.

Clive Prichard of BMR provided the party with solid backing from Darwin and offered wise counsel, which was much appreciated, on a wide range of matters.

The Division of National Mapping's loan of surveying equipment to the party is gratefully acknowledged.

The contributions of the OSS in providing accommodation at Jabiru, and of QML in providing accommodation at Nabarlek, are gratefully acknowledged.

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Appendix 1

Description of BMR Contribution to Alligator Rivers Hydrogeological Study: Approved by the Hydrogeological Committee, 9 April 1979

DESCRIPTION OF BMR CONTRIBUTION TO ALLIGATOR RIVERS HYDROGEOLOGICAL STUDY 1979

AIMS

(i) To investigate the hydrogeology, including hydrochemistry, of the surficial (generally unsaturated) cover in the Magela Creek and Coopers Creek catchments.

(ii) To determine the diffusivity and dispersion tensors of the surficial material as an imput to the mass transport model to be developed by Water Division NT Department of Transport and Works.

(iii) To determine infiltration capacities, zones of surface recharge and subsurface piping by buried alluvial aquifers, as an input to the source terms for the groundwater hydraulics model to be developed by Water Division.

(iv) To participate in the Hydrogeological Committee. By this means and by general consultation to contribute to the overall Alligator Rivers Hydrogeological project study and ensure uniformity of data input.

PROJECT 1 Hydrology of Alluvial Aquifers.

(a) Distribution and morphology of aquifers, based on Survey of available data and airphoto interpretation, plus Field mapping (see below). To be confirmed by drilling. Any geophysical input will be by others.

(b) Drilling and equipping of Piezometers. Estimated requirements is 100 piezometers for Magela Catchment and 25 for Cooper Creek Catchment (some variations will be necessary in the light of field experience). Thin ($\frac{1}{2}$") pvc tubes and tensiometers will be used for aquifers of low K; pumping bores cased with 3" - 4" pvc tubing will be used for aquifers of high K.

(c) Determination of (T & S (confined)) by pump testing
(K & μ (unconfined)

PROJECT cont.

(d) Regular chemical sampling throughout the field season arrangements are to be made with Water Division (or Geological Survey in Project Areas?) for sampling to be done during the Wet Season. Samples are to be despatched initially to AMDL in Adelaide, for determination but may subsequently be determined in Jabiru Laboratory by Water Division Staff. Uniform sampling procedures and analytical techniques are to be agreed on by WD, GS and BMR.

(e) Production of potientiometric contour map for surficial sediments for Magela and Cooper catchments. Limited additional work will be done as required in areas of surface recharge into streams, piping etc.

(f) Tracer studies to determine travel times (dyes only).

(f) Statistical analysis of geochemical trends.

2. Surficial Geology and Infiltration Capacities.

(a) Map and determine the characteristics of the surficial (post - Proterozoic) sediments and sites of the Magela and Cooper catchments below the escarpment.

(b) Produce map(s), at 1:25 000 scale, showing the distribution and thickness of the units referred to in 2(a).

(c) Infiltration testing of all the mapping units identified by 2(a). In view of the limited field season it will be possible to determine kSAT only. It is proposed to use

(i) Flooding - type constant head
(ii) Downhole injection

(d) Mineralogical investigation of clays, using: X-Ray diffraction (representative samples to be determined by BMR, routine samples by AMDL).

VEHICLES

2 x 3 ton International trucks (one only if based at Jabiru)
- 1 from Canberra, 1 from Brisbane
2 x L.W.B. Landrovers - 1 from Canberra, 1 from Darwin
1 x S.W.B. Landrover - from Canberra
1 Laboratory caravan from Canberra
1 Water tanker - from Darwin
1 Pump trailer unit - from Canberra if available

(Note: These vehicles and equipment can be provided by BMR but reimbursement of hire charges, repairs and maintenance and fuel will be sought from Office of the Supervising Scientist)

EQUIPMENT (other than vehicle and accommodation equipment)

* Indicates that item so marked has to be acquired by purchase or by loan from other organisations
+ Indicates that item so marked will need to be purchased and constructed by BMR before field season

*
* 2 Low capacity pumps
* 1 High capacity pump
* Pressure transducer(s) to record instantaneous variation in water level
* Tensiometers (80) to determine progress of wetting front through surficial cover
* 3" to 4" pvc pipe (to be installed by driller, perforated by BMR). Screens
+ Chemical grouts, ceramic pots, galvanized pipe, ½" pvc pipe, glues and cement (to be installed by BMR or by driller under BMR supervision)
* Electronic recorders (2) for water level measurements in thin piezometers
* Salinity meter
+ Infiltrometers and downhole injectors (to be constructed by BMR)
* Dyes and recorder(s)

Portable laboratory, standard field and laboratory equipment. Consumables to be paid for by OSS.

PROJECT cont.

(d) Scanning electron microscopy (BMR)
Cation exchange capacity (CSIRO or AMDL)

(e) Determination of diffusivity and dispersion tensors by slug injection.

(f) Sediment samples - collection, preparation and testing by BMR.

3. Joint Analysis in Kombolgie Sandstone - field and office studies

STAFF

J.R. Kellett, Party Leader.
Office studies, equipment preparation May - June. Field work June - September Office Studies, laboratory studies, Petrography and report writing November - December (continuing 1980)

W.R. Evans.
Office studies, equipment preparation May - June. Field work June - October. Office studies part-time November - December (continuing 1980)

Technical Officer, Grade 1.
Equipment preparation May - June. Field work July - October. Sample preparation and testing November - December.

Technical Assistant, Grade 2.
As for TO 1 May - December

Field Hand(s).
- 1 if party based at Jabiru (some further assistant may be required at times) June - October.
- 2 if party has its own field camp.

(Services of mechanic may be required from time to time to service equipment and vehicles).

EQUIPMENT cont.

* Automatic bore recorders (6)

Note Bore completion, security and identification facilities to be supplied and installed by drilling contractor.

AIR PHOTOGRAPHY AND BASE MAPS

One set of colour photographs (to be supplied by OSS) Base maps, preferably at 1:25 000 scale over entire area; larger scale maps as available in areas adjacent to areas of special interest. Infra-red photography.

ACCOMMODATION

Require facilities for 6 + 3 (visitors) Messing at Jabiru and Nabarlek (if available), as appropriate to field program, preferred with facilities for field camping or job (bedroll, cooking facilities only). Alternative is base camp. Equipment for base camps and fly camps to be provided by BMR.

CONTRACT SERVICES

Drilling (125 holes, average depth 10 m) Undisturbed sampling. Airlifting may be required in high transmissivity alluvial aquifers. Large diameter perforated pvc casing (and/or screens) to be installed by contractor. Wells to be completed and secured by contractor.

Water sample testing: determinations by AMDEL, subsequently by Water Division.

Petrography: thin sections prepared by AMDEL or BMR period contractors, descriptions by BMR.

X-Ray Diffraction determination of routine samples by AMDL.

Cation exchange capacity of soils. Determination of samples collected by BMR by CSIRO or AMDL.

Note All external services to be charged to Office of the Supervising Scientist. Sediment samples to be prepared and tested by BMR.

Appendix 2

Borelogs of Holes Completed in 1979

~~Northern Territory Geological Survey~~ BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. M1

LOCATION OF BORE: MAGELA CK
MAP NAME: CAHILL 1:100000 5472
GRID REFERENCE: 786595

A.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING
GAMMA RAY LOGGING BY NTGS.

DRILLING METHOD:
Dry plug - 0.0 to 8.25
Rotary - 8.25 to 11

HOLE COMMENCED: 10/9/79
HOLE COMPLETED: 14/9/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~FROM~~ CORE RECOVERY	TO	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Fine to medium silty sand. quartzose. Dark grey organic to light grey bleached.		
	.9		Dark grey silty fine to medium qtz sand. Laminated		
	1.4		Light grey to red as above		
	1.6		to clayey silty fine to medium qtz sand Fe segregation at top.		Lateritic gravel
	2			▼ 2.22	
	2.4		Grey, red, yellow mottles at base	3/10	Large angular rock frags qtz, fspars.
	3		clayey medium sand with large angular fragments. predominantly yellow & white mottles with some minor red.		
	4		intense red mottles gravel layer		Angular qtz 2x1x1
	5		intense yellow-brown and white mottles gravel layer		Angular qtz 6x4x3
	6		Yellow-brown clayey medium to coarse sand and fine gravel		No mottles
	6.4		Large schist boulder. Completely weathered to green clay.		
	7				
	8		Sandy clay with fine gravel. red-brown mottles		minimal ang. qtz
	8.7		Extremely weathered green schist white & brown staining		
	9				
	10		large qtz pebbles (vein). slightly lateritised		
	11	EOH	Record 1979/88		

~~UNITED~~

~~Commonwealth of Australia~~ ~~Department of Territories and Northern Development~~ ~~Northern Australia Geological Survey~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. M2

LOCATION OF BORE: MAGELA CK | R.N.:

MAP NAME: CAHILL 1:100 000 5472 | I.N.:

GRID REFERENCE: 766595 | PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS

DRILLING METHOD: Dry plug - 0.00 to 5.30; Rotary - 5.30 to 10.07

HOLE COMMENCED: 10/10/79

HOLE COMPLETED: 11/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
			Light brown to grey silt to silty-sand.		
	0.7		Mottled yellow-brown		
	1		White to light grey sand		
	2		Purple-grey medium sand		
	3		Grey sand		
	3.2		Mottled yellow grey sand		
	3.8			▼3.72 8/10/79	
	4		Mottled yellow-red sand		Angular quartz ?laterite
			Grey sand - no gravel Some brown and yellow mottles		
	4.8		Yellow mottling intensifies		
	5		Yellow sand		
	5.6	Core loss			
	5.9				
	6		minor small angular gravel		
	6.5		Yellow-grey silty sand with angular quartz pebbles. Some red mottles.	Minor seepage from basal gravels	
	7				
	8				
	9				
	9.56		E.M. Bedrock Brown schist		
	10.07	EOH			

PRELIMINARY, UNEDITED

Record 1979 [illegible]

~~Department of Territory and Works~~
~~Mines Division~~
~~Hydrological Section~~

GEOLOGICAL LOG OF BORE. BMR M3 ALLIGATOR RIVERS.

LOCATION OF BORE: MAGELA CK. R.N.:
MAP NAME: CAHILL 1:100 000 I.N.:
GRID REFERENCE: 5472 769596 PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS.

DRILLING METHOD: Dry plug 0.00 to 3.20; Rotary 3.20 to 7.60

HOLE COMMENCED: 12/10/79
HOLE COMPLETED: 13/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	.3		Grey brown silty sand - organic		
	.6		Light grey silty sand		
	1		Yellow-brown mottled silty sand. Sand slightly more coarse than above		
	2				
	2.3			▼ 2.25 31/10	
		core loss			
	3			Aquifer	
	3.2		White to light grey coarse sand - some fines	Yield 3l/sec	slightly indurated
	3.8				
	4	core loss			
	4.1		Grades to yellow and grey mottled sand.		Indurated
	5		Minor angular qtz pebbles		
			Yellow mottles dominate	Aquifer	
	6		Intense red and yellow mottles.		
	6.25	core loss			
			large gravel at base		
	7		E.W. Bedrock Schist. Same weathering pattern as above		
	7.60				
		EOH			

PRELIMINARY, UNEDITED

Record 1979/88

~~Department of Technology and Mines~~
~~Mines Division~~
~~Mineralogical Section~~
BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. M4

LOCATION OF BORE: MAGELA CK.
MAP NAME: CAHILL 1:100 000
5472
GRID REFERENCE: 773966

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING
GAMMA RAY LOGGING
BY NTGS

DRILLING METHOD:
Dry plug 0 to 5.75
Rotary 5.75 to 16.50

HOLE COMMENCED: 26/10/79
HOLE COMPLETED: 26/10/79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	.5		Grey silty sand		
	1		Grey to yellow grey silty sand		
	2				
	3		Some Yellow brown mottles		
	3.5			YIELD >6 S.L/S. ▼3.50 SWL	
	4		Red-Brown mottled sand		
	5			Aquifer	
	5.5		Unconsolidated clean sand. Brown to grey	to Bedrock	
	6				
	7	Core loss			
	8				
	9				
	10				

PRELIMINARY, UNEDITED

Record 1979/88

~~Water Resources Division~~
~~Mines Division~~
~~Geological Survey~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE: M4 (cont.)

LOCATION OF BORE: MAGELA CK. | R.N.:
MAP NAME: CAHILL 1:100 000 | I.N.:
GRID REFERENCE: | PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS. | DRILLING METHOD: | HOLE COMMENCED: | HOLE COMPLETED: | JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	TO	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)				
	11				
	12	Core loss			
	13				
	14		Coarse loose clean sand Yellow grey		
			Clayey sand. Yellow grey		
	15		loose dark brown sand		
			M.ml. Bedrock		
	16		Schist		
	16.50				
		ECH			

PRELIMINARY, UNEDITED

Record 1979/88

~~Commonwealth of Australia Department of Home Affairs Australian Geological Survey~~ BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. M5

LOCATION OF BORE: MAGELA CK | R.N.:
MAP NAME: CAHILL 1:100000 5472 | I.N.:
GRID REFERENCE: 779596 | PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS.

DRILLING METHOD: Dry plug 0.00 to 2.70; Rotary 2.70 to 12.10

HOLE COMMENCED: 25/10/79
HOLE COMPLETED: 25/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~CORE~~ CORE RECOVERY	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	0.10 (m)		Dark Brown silty sand.		Yellow brown mottles
			Loose white to yellow sand		
	1				
	1.20		loose dark grey fine sand. Saturated		
	2			▼ 2.04 31/10	
	2.43				
	3			Seepage only.	
Core loss					
	4		Fine sand in cuttings	Continuous Aquifer to Bedrock	
	5				
	6				
	7				
	7.70		organic pebbly silty sand.		Dark grey to black
	8		Dense olive grey clays. Pedal. Fe stained cutans		
	8.70		Gravel at base		
Core loss	9		Gravel layer hit during reaming		
	10				

PRELIMINARY, UNEDITED

Record 1979/88

~~[illegible]~~

~~[illegible]~~

~~[illegible]~~

GEOLOGICAL LOG OF BORE. BMR ALLIGATOR RIVERS. M5 (cont.)

LOCATION OF BORE:

MAP NAME:

GRID REFERENCE:

R.N.:

I.N.:

PROJECT:

DOWNHOLE LOGGING
GAMMA RAY LOGGING
BY NT GS

DRILLING METHOD:

HOLE COMMENCED:

HOLE COMPLETED:

JOB NUMBER:

DEPTH (m) LIFT AND ~~CORE~~ CORE RECOVERY.		GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	To (m)				
		Core loss			
	11		Large cobbles, coarse sand		
			Bedrock,		
			Schist		
	12·10 12	EOH			

PRELIMINARY, UNEDITED

Record 1979/88

~~Commonwealth of Australia~~
~~Department of Territories and Housing~~
~~Water Conservation Section~~
BMR ALLIGATOR RIVERS
Geological Log of Bore. M6

Location of Bore: MAGELA CK. R.N.:
Map Name: CAHILL 5472 I.N.:
Grid Reference: 779969 Project:

Downhole Logging: GAMMA RAY LOGGING BY NTGS.

Drilling Method: Dry plug 0 to 2-30; Rotary 2-30 to 7-75

Hole Commenced: 24/10/79
Hole Completed: 24/10/79

Job Number:

Depth (m) Lift and Core Recovery	To	Graphic Log	Lithology	Aquifers Yield SWL	Additional Information
	(m)	CORE LOSS			
	.5		Grey to light brown silt.		
	1		Some yellow-brown mottles	▼ 1-26 31/10	
	1.5		Light grey to purple silt		
	2			Seepage only	
	2.30				
		CORE LOSS		Aquifer to Bedrock	Reaming intersected two gravel beds in the interval
	3		Fine cuttings		
	4				
	4.30		Large Komsolgie gravels and qtz cobbles set in Red-brown clay		
			E.W. Bedrock		
	5		Interbedded brown schist with completely weathered schist. Weathered to clay		
	6				
	7				
	7-75				
		EOH			

PRELIMINARY, UNEDITED

Driller: F.A. KELLY Drill Type: GEMCO
Record 1979/88

~~Geological Survey of Australia~~ ~~Mines Administration~~ ~~Department of Minerals and Energy~~ BMR ALLIGATOR RIVERS.

GEOLOGICAL LOG OF BORE. M20

LOCATION OF BORE: MAGELA CK. R.N.:
MAP NAME: CAHILL 1:00,000 5472 I.N.:
GRID REFERENCE: 705593 PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS

DRILLING METHOD: Dry plug to 3.20 Rotary 3.20 to 9.97

HOLE COMMENCED: 16/10/79
HOLE COMPLETED: 17/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~ERROR~~ CORE RECOVERY	TO	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)				
	.4		Grey hard silt		
	1		Yellow to light grey medium sand		
				▼ 1.44 31/10	
	2			2 l/sec	
			Some layering evident Beds 3 to 5cm thick Distinguished by Fe content	Aquifer continues to Bedrock	
	3				
	3.40	core loss		Main section at base	
	4		Dark brown gravelly sand Gravel is reworked laterite		
	4.95				
			Bedrock Sequence of highly weathered gneiss and schist		
	6				
	7				
	8				
	9				
	9.97	EOH			

PRELIMINARY, UNEDITED

DRILLER: F.A. KELLY DRILL TYPE: GEMCO

Record 1979/88

~~Water Resources Division~~
~~Mines Section~~
~~Groundwater Section~~

BMR ALLIGATOR RIVERS M21

GEOLOGICAL LOG OF BORE.

LOCATION OF BORE: MAGEZA CK
MAP NAME: CAHILL 1:50,000 5472
GRID REFERENCE: 705593

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS

DRILLING METHOD: DM plug 0.00 to 4.22

HOLE COMMENCED: 17/10/79
HOLE COMPLETED: 18/10/79

JOB NUMBER:

DEPTH (m) FROM (IFT AND CORE RECOVERY)	TO	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Yellow brown clean sand grading to grey clean sand		
	1				
	2			▼ 2.01	
				5/10 Seepage only	
	3		Yellow brown clayey gravel and medium sand		
	3.8		Gravel reworked laterite		
	4 4.22		H.St. Bedrock - gniess		
		ECH			

PRELIMINARY UNEDIT

DRILLER: F.A. KELLY
DRILL TYPE: GEMCO

Record 1979/88

~~Department of Transport and Works~~
~~Water Resources~~
~~Hydrological Survey~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. M22

LOCATION OF BORE: MAGELA CK
MAP NAME: CAHILL 100,000 Map Sheet
GRID REFERENCE: 703 593

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING
GAMMA RAY LOGGING BY NT GS.

DRILLING METHOD:
Dry plug to 2.60
Rotary 2.60 to 7.24

HOLE COMMENCED: 18/10/79
HOLE COMPLETED: 19/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1		Brown silt		
	2		White silt	▼2.34 31/10	
	3			Aquifer to bedrock	
	3.8	core loss			
	4		clean brown to black silty sand	Yield 0.5 l/s	
	4.6				
	5	core loss			
	5.9				
	6		Mod Bedrock schist		
	7				
	7.24	EOH			

PRELIMINARY, UNEDITED

DRILLER: F.A. KELLY
Printed 1979/88

DRILL TYPE: GEMCO

~~Mines Department~~ ~~Mines Division~~ ~~Geological Survey~~

BMR ALLIGATOR RIVERS.

GEOLOGICAL LOG OF BORE. M23

LOCATION OF BORE: MAGELA CK | R.N.:

MAP NAME: CAHILL 100000 MAP 5472 | I.N.:

GRID REFERENCE: 701593 | PROJECT:

DOWNHOLE LOGGING: GAMMA RAY LOGGING BY NTGS.

DRILLING METHOD: Dry plug to 4.25 Rotary 4.25 to 8.22

HOLE COMMENCED: 19/10/79

HOLE COMPLETED: 20/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~CORE~~ CORE RECOVERY	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Grey fine sand to silt		
	1				
			Yellow-brown clean medium sand		
	2			▼2.14 31/10	
	2.8				
	3		Light grey medium sand	Seepage only	
	3.5		Dark grey/grading to light grey clayey sand		
	4				
	4.61				
	5	CORE LOSS			
	5.97				
	6		white to light grey clean fine sand		
	6.2	CORE LOSS			
	6.5		FINE schist		
	7	CORE LOSS			
	8				
	8.22	EOH			
	9				

UNEDITED

PRELIMINARY

DRILLER: F.A. KELLY DRILL TYPE: GEMCO

Record 1979/88

~~Water Resources Division~~
~~Hydrogeological Section~~
GEOLOGICAL LOG OF BORE. BMR M24 ALLIGATOR RIVERS

LOCATION OF BORE: MAGELA CK
MAP NAME: CAHILL 100,000 5472
GRID REFERENCE: 670593

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING
GAMMA RAY LOGGING BY NTGS.

DRILLING METHOD:
Dry plug 0.00 to 5.00

HOLE COMMENCED: 21/10/79
HOLE COMPLETED: 21/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~CORE~~ CORE RECOVERY		GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		organic at top 10cm (A1)		
			Fine silty sand		
	1		bleached (A2)		
	1.5			▼ 1.62 31/10	
			Grey to yellow coarse clean sand		
	2		Some angular qtz pebbles	seeping only	
	3		large qtz cobbles		
	3.3		E.W. gneiss - Yellow to white clay with qtz grains		
	4				
	5		schist at base		
		EOH			

PRELIMINARY, UNEDITED

DRILLER: F.A. KELLY DRILL TYPE: GEMCO

Record, 1979/88

~~Department of Transport and Works~~
~~Water Resources~~
~~Hydrogeological Section~~
BMR ALLIGATOR RIVERS
GEOLOGICAL LOG OF BORE. M25

LOCATION OF BORE: MAGELA CK.
MAP NAME: CAHILL 100,000 5472
GRID REFERENCE: 698594

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug 0.00 to 3.60

HOLE COMMENCED: 23/10/79
HOLE COMPLETED: 23/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	.5		clayey sand and reworked laterite gravel. Grey to red-brown		
	1		Clayey coarse sand and gravel. Red-Brown		laterite profile
	2			Hole Dry	
	2.10		E.W. Bedrock		
	3		White clay with qtz grains ? gniess / amphibolite		
	3.60				
		EOH	Hole backfilled and abandoned.		

PRELIMINARY, UNEDITED

DRILLER: F.A. KELLY
DRILL TYPE: GEMCO

Record 1979/88

~~Commonwealth of Australia Water~~
~~Water Resources~~
~~Administrative Services~~
BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N1

LOCATION OF BORE: COOPER CK MAGEL
MAP NAME: OENPELLI 1:100 000
GRID REFERENCE: 5573 175121

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0 to 3.00
Rotary 3.00 to 8.50

HOLE COMMENCED: 5/10/79
HOLE COMPLETED: 6/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~FROM~~ CORE RECOVERY	TO	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Light grey to grey coarse sand highly porous.		
	1				
	2				
	3				
	4	CORE LOSS			
	5				
	5.30				
	5.50				
	5.80		RW Bedrock Schist		
	6	CORE LOSS			
	7				
	8				
	8.50	EOH			

PRELIMINARY, UNEDITED

Record 1979/88
DRILLER:
DRILL TYPE:

KMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N2

MAP NAME: ORNPELLI 1:100 000 5573

GRID REFERENCE: 172415

IN.:

PROJECT

DOWNHOLE LOGGING: N.A.

DRILLING METHOD: Rotary

HOLE COMMENCED: 26.9.79

HOLE COMPLETED: 26.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1		Grey to light grey fine sandy silt some organic material		
	2.15	Core loss			
	3				
	4				
	5				
	5.20		schist cobble		
	5.50	Core loss			
	6				
	7				
	7.50		light brown to grey schist		

Record 1979/88

~~Department of Transport and Works~~
~~Water Division~~
~~Hydrogeological Section~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N3

LOCATION OF BORE: COOPER CK

MAP NAME: OENPELLI [illegible] 5573

GRID REFERENCE: 171417

R.N.:

I.N.:

PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug 2.84, Rotary 2.84 to 9.27

HOLE COMMENCED: 27/9/79

HOLE COMPLETED: 5/10/79

JOB NUMBER:

DEPTH (m) LIFT AND ~~[illegible]~~ CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	0–2.84		Light grey to white silty sand. Highly porous. Unconsolidated		
			silt content decreases		
	2.84				
	2.84–4.50	CORE LOSS			
	4.50		Contains pieces of M.W. Kombolgie sandstone - white to pink.		
	5.65				
	5.65–6.42	CORE LOSS			
	6.42				
			Kombolgie fragments slightly larger		
	9.27	EOH			

PRELIMINARY, UNEDITED

Record 1979/88

DRILLER:

DRILL TYPE:

~~Department of Territory and Water~~
~~Mines Section~~
~~Hydrogeological Section~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N4

LOCATION OF BORE: COOPER CK
MAP NAME: OENPELLI 5573
GRID REFERENCE: 166396

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 500m
Rotary 5.00 to 6.00

HOLE COMMENCED: 28/9/79
HOLE COMPLETED: 4/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Light grey silty sand		
	.80		Light grey and yellow mottled clayey - silty sand, with fine gravel - usually Komboigie pieces		
	1				
	2		mottling increases		
	2.60		Get small areas of intense Fe concentration - laterite		
	3		Yellow clayey sand - minor grey mottles. Minor reworked laterite gravel		
	4		Large qtz pebbles		
			Gravel content increases towards base of bed		Grey mottles at or near base consist of clay
	4.80		E.W. Bedrock		
	5		Komboigie Sandstone shows some weathering as above but grain size different		
	6				
		ECH			

PRELIMINARY, UNEDITED

Record 1979/88

DRILLER:

DRILL TYPE:

~~Department of Transport and Works~~
~~Water Resources~~
~~Hydrogeology Section~~
BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N5

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000 5573
GRID REFERENCE: 197413

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug

HOLE COMMENCED: 25.9.79
HOLE COMPLETED: 25.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
			light grey silty fine sand		
	1.9				Yellow earth (?Qa)
			reddish-yellow fine sand		
	1.5				
			grey fine sand		Sub-Solum
	2 2.20				
		EOH	Reamed to 2.5 m		

PRELIMINARY, UNEDITED

Record 1979/88

~~Water Resources Division~~ BMR ALLIGATOR RIVERS
~~Hydrogeology Section~~
GEOLOGICAL LOG OF BORE. N6

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000 5573
GRID REFERENCE: 198413

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug

HOLE COMMENCED: 24.9.79
HOLE COMPLETED: 24.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1		Grey silty sand		
	2		colour changes to yellow-grey		Alluvium
	3		colour changes to Reddish-grey contains pieces of crumbly Kombolgie		
	3.25				
	3.67	EOH	Kombolgie Sandstone		
	4				

PRELIMINARY, UNEDITED

Record 1979/88

~~BMR~~ ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N7

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100000 5573
GRID REFERENCE: 199413

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0 - 1.4
Rotary 1.4 - 3.58

HOLE COMMENCED: 24.9.79
HOLE COMPLETED: 24.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1		Grey silty sand Minor yellow mottling		Yellow earth Profile to 2.94 m slopewash - alluvium off Kombolgie s'st.
	2		Yellow grey sand - well sorted		
	2.33	core loss			
	2.94		Slightly weathered Kombolgie Sandstone		
	3.58	EOH			

PRELIMINARY, UNEDITED

Record 1979/88

~~Water Resources~~ BMR ALLIGATOR RIVERS
~~Hydrogeological Section~~
GEOLOGICAL LOG OF BORE. N8

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000 5573
GRID REFERENCE: 194388

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0-4.2m
Rotary 4.20 to 7.00

HOLE COMMENCED: 20/9/79
HOLE COMPLETED: 23/9/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	0.4		Light grey to yellow fine to medium sand		
	1		Mottled light grey to red brown clayey sand - some gravel		
	1.6		Mottled light grey to red brown silty clay.		
	2		Mottled light grey to yellow gravelly sand		
	2.5		Yellow brown to brown sandy gravel.		
	3		E.W. Bedrock. Light green to white mottled clay. Dolerite		
	4				
	5				
	6				
	7		M.W. Dolerite		
	8	ECH			
	9				
	10				

Record 1979/88

~~Water Supply~~ ~~Water Section~~ ~~Hydrogeology Section~~ BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N9

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000 5573
GRID REFERENCE: 200395

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0-2.2
Rotary 2.2-10.0

HOLE COMMENCED: 20.9.79
HOLE COMPLETED: 22.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m) .25		Yellow-Grey silty fine sand.		Slightly organic
	.9 1		Yellow-Brown to Red-Brown mottled silty clay. Contains reworked lateritic gravel		Slightly lateritised at base
			Dense grey clay - some lateritic gravel in top 1dem.		
	2		Gravel replaced by ?secondary feldspar		
	3		Extremely weathered Dolerite		
	4				
	5				
	6				
	7				
	8				
	9				
	10	EOH.			

PRELIMINARY, UNEDITED

Record 1979/88

~~Commonwealth Department of Mines~~ BMR ALLIGATOR RIVERS
~~Mines Branch~~
~~Geophysical Section~~
GEOLOGICAL LOG OF BORE. N10

LOCATION OF BORE: COOPER CK | R.N.:
MAP NAME: OENPELLI 1:100 000 5573 | I.N.:
GRID REFERENCE: 166394 | PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug 3.30; Rotary 3.30 to 6.00

HOLE COMMENCED: 5/10/79
HOLE COMPLETED: 5/10/79

JOB NUMBER:

DEPTH (m) JET AND ~~CORE~~ CORE RECOVERY		GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Light grey silty sand		
	1				
	1.80		Red-brown clayey silty sand with minor gravel. gravel – qtz pebbles		
	2				
	3		minor layering of grey sands		
	3.20		Yellow grey mottled clayey sand - minor gravel - reworked laterite pebbles		
	3.60				
	4		Extremely weathered laterite		
		CORE LOSS			
	4.90				
	5		M.W. to H.W. Bedrock. Koolpinyah sandstone		
	6	ECH			

PRELIMINARY, UNEDITED

Record 1979/88

~~Northern Territory Geological Survey~~ BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N11

LOCATION OF BORE: NABARLEK

MAP NAME: OENPELLI 1:100 000

GRID REFERENCE: 5573 171369

A.N.:

I.N.:

PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug 0-4.0 Rotary 4.0-7.8

HOLE COMMENCED: 26.9.79

HOLE COMPLETED: 26.9.79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	.1 (m)		Light grey silty sand - fine gravel		
	.6		Yellow-brown to light grey silty sand, minor fine gravel		Angular gravel increases towards base, mostly qtz.
	1		Red-Brown clay - fine gravel.		Massive
	1.5		Yellow-Brown clay - fine gravel Yellow-Brown medium sand, poorly sorted to better sorted at base.		gradational contact porous at base
	2		Yellow Brown medium sand.		No gravel
	2.55				Mottles at 2.10 m Medium Gravels at 2.30
	3		Red-Brown clayey sand - medium gravel - some gravel reworked laterite		small areas of Fe concent'n (Lateritisation)
	4		Gravel size increases to coarse and angular		gravel 9×7×3
			clay content increases with depth.		gravel 7×6×4
	5		large Kombolgie s'st cobble		
	6				
	7		Extremely Weathered ?Dolerite		
	7.8	EOH			
	8				

PRELIMINARY, UNEDITED

Record 1979/88

~~Australian Bureau of Mineral Resources and Geology~~
~~Water Resources Division~~
~~Hydrogeochemical Section~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N12

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000 5573
GRID REFERENCE: 179375

I.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0 - 1.8 m
Rotary 1.8 - 4.0 m

HOLE COMMENCED: 25.9.79
HOLE COMPLETED: 25.9.79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY.	To	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	(m)		Yellow-grey silty sand-fine gravel		
	.25				
	1.5		clayey silt-sand . yellow. brown		
	1				
	1.20				
			Carbonate nodules		
	1.50		red clayey lateritic gravel		
	1.80		medium grey clay		
	2				
	2.20				
	2.95		red-grey mottled clay + lateritic gravel		
	2.70		medium grey clay		
	3		Grey clay + qtz gravel		
	4	EOH	Grey green clay - qtz pebbles		

PRELIMINARY, UNEDITED

Record 1979/88

~~Water Division~~
~~Hydrogeology Section~~

BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N13

LOCATION OF BORE: NABARLEK
MAP NAME: OENPELLI 1:100 000
GRID REFERENCE: 5573 201386

R.N.:
I.N.: 1
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug 0 - 2 m
Rotary 2 - 6.9 m

HOLE COMMENCED: 23.9.79
HOLE COMPLETED: 23.9.79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
			Dark grey silty sand		
	.8		Light grey silty sand - porous		
	1		Some iron banding		
	1.75		yellow grey at base		
	2		Grey coarse sand. fine gravel Angular qtz, some Kombolgie cobbles		
	2.9				
	3	core loss			
	3.4		Large to medium quartzose gravel Angular		
	4				
	4.2	core loss			
	4.9		clean sand - gravel		highly porous
	5				
	5.15		Extremely weathered olive-green chlorite schist.		
	6				
		core loss			
	7	EOH 6.87 m			

PRELIMINARY, UNEDITED

Record 1979/88

~~Water Supply~~
~~Groundwater Section~~

GEOLOGICAL LOG OF BORE. BMR N14 ALLIGATOR RIVERS

LOCATION OF BORE: LOOKER CK
MAP: OENPELLI 1:100 000 SHEET 5573
GRID REFERENCE: 193394

K.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD: Dry plug 0.0 to 2.40

HOLE COMMENCED: 23/9/79
HOLE COMPLETED: 23/9/79

JOB NUMBER

DEPTH (m) LIFT AND CORE RECOVERY	To (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1	No core recovery	Clean medium sand.		
	2				
	2.40	EOH	Kombolgie Sandstone		

PRELIMINARY, UNEDITED

Record 1979/88

LOGGED BY:

DRILLER:

DRILL TYPE:

~~Water Resources~~
~~Hydrogeology Section~~
BMR ALLIGATOR RIVERS

GEOLOGICAL LOG OF BORE. N15

LOCATION OF BORE: COOPER CK
MAP: OENPELLI 1:100 000 SHEET 5573
GRID REFERENCE: 193451

R.N.:
I.N.:
PROJECT:

DOWNHOLE LOGGING

DRILLING METHOD:
Dry plug to 2.25
Rotary 2.25 to 4.08

HOLE COMMENCED: 6/10/79
HOLE COMPLETED: 6/10/79

JOB NUMBER:

DEPTH (m) LIFT AND CORE RECOVERY	TO (m)	GRAPHIC LOG	LITHOLOGY	AQUIFERS YIELD SWL	ADDITIONAL INFORMATION
	1		Light grey to dark grey silty sand		
	2		colour changes to white with depth occasional small qtz xl in clay		
	2.4		Bedrock		
	3		Coarse grained meta morphic no schistose structure (meta-sandstone)		
	4.08	EOH			

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Record 1979/88

LOGGED BY: R.E.
DRILLER: E.A. KELLY
DRILL TYPE: GEMCO

Appendix 3

Casing Schedules of Bores Drilled in 1979

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION
CASING SCHEDULE

BORE No: M1

PROJECT : MAGELA

R.N. :

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472
COORDS 766595

I.N. :

PREPARED BY: F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC
SCREENS stainless steel

RL COLLAR:

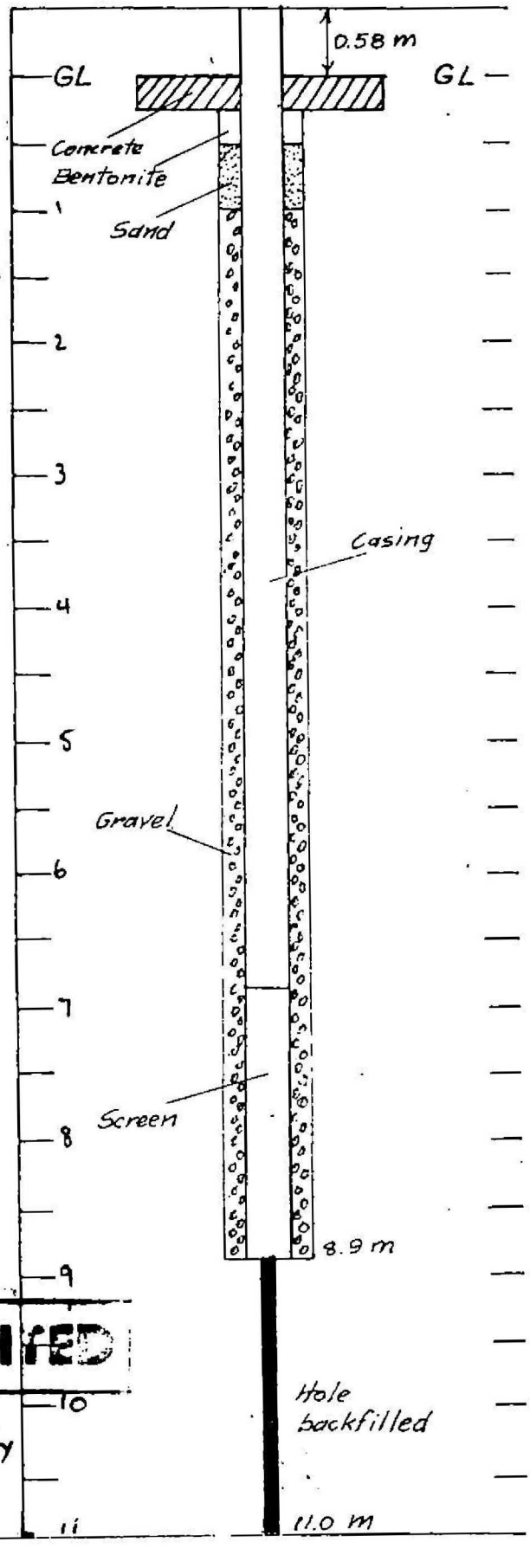
CASING TOP m above ground
c. 58m above collar

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 - 6.90	uPVC 140 mm diam
6.90 - 8.90	Screens: Stainless steel 1 x 2 m x 1.5 mm aperture 100 mm diam.

* Below ground level

GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
1.00 - 8.90	3/8" Gravel - crushed.



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Record 1979/89

Hole developed and capped. Not ready for sampling

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT : MAGELA CASING SCHEDULE

BORE No: M2

R.N. :

I.N. :

LOCATION (map + grid) : CAHILL 1:100,000 SHEET 5472 COORDS 766595

PREPARED BY: KELLY / BMR

MATERIAL TYPE : BLANK uPVC

SCREENS St. Steel

R.L. COLLAR

CASING TOP 0.64 m above ground
0.64 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0 – 1.36	uPVC 140 m.m diam
1.36 – 9.36	Screens: 100 mm diam
	3 x 2m x 1.15 mm aperture
	1 x 0.6m x 0.75mm "
	2 x 0.6m x 0.50 mm "

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.30 – 9.36	3/8" crushed aggregate

Status 1.11.79 : Pumped intermittently since completion. Takes 24 hrs to recover – needs more pumping.

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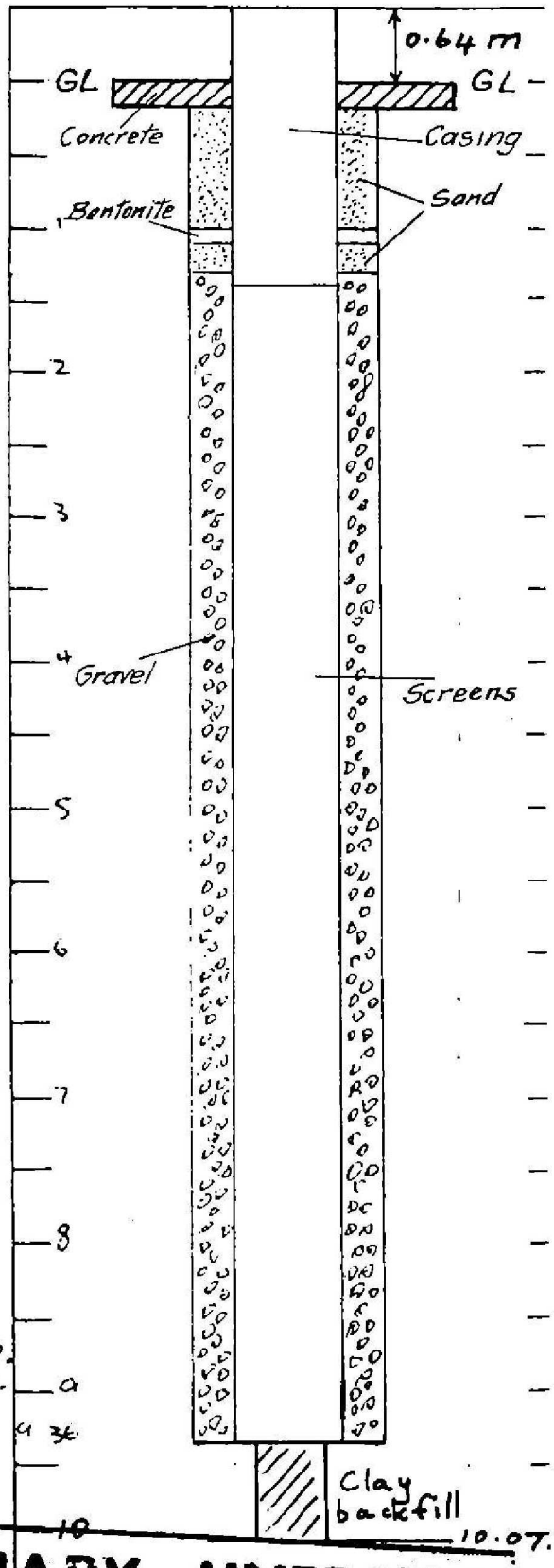


PRELIMINARY, UNEDITED

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT : MAGELA CASING SCHEDULE

BORE No: M3

R.N. :

I.N. :

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472 GOORDS 769596

PREPARED BY : KELLY / BMR.

MATERIAL TYPE : BLANK uPVC

SCREENS St. Steel

R.L. COLLAR:

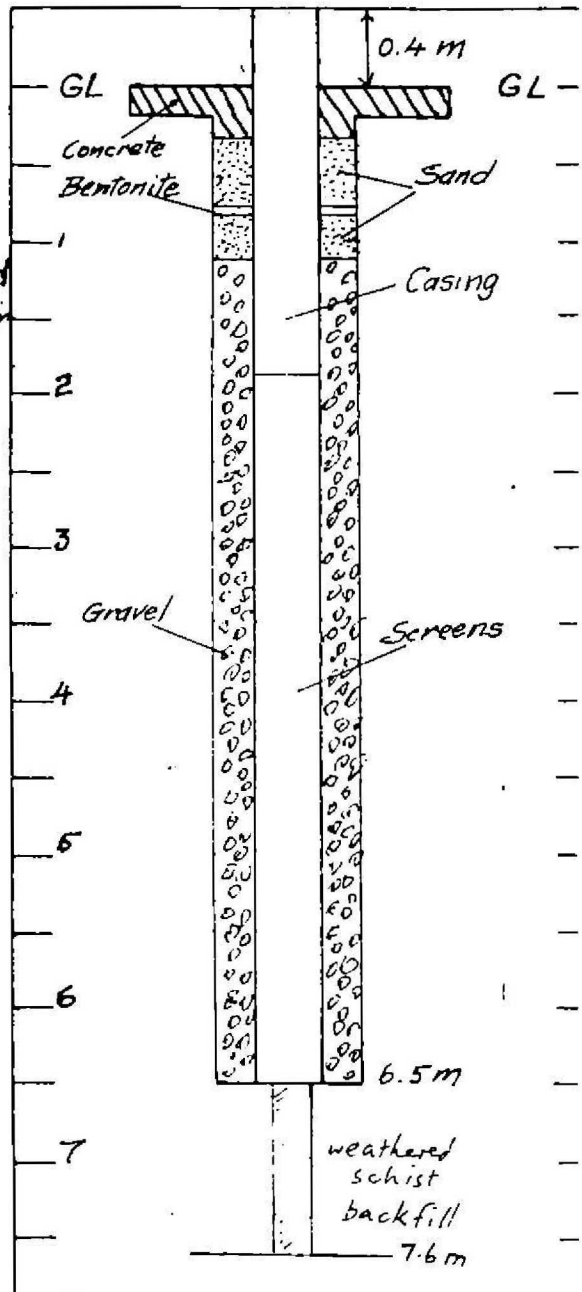
CASING TOP: 0.4 m above ground
0.40 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0 — 1.90 m	UPVC 100.0 mm diam
	Screens: 100 mm diam.
1.90 — 6.50	2 × 2m × 1.15 mm aperture
	1 × 0.6m × 1.15 mm aperture

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.10 — 6.50	3/8" Crushed aggregate



Status: 13/10/79 pumped for 2 hrs 40 min - water clean.
15/10/79 " " 40 min - " "
16-18/10/79 pumped intermittently, ready for sampling.

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M14

PROJECT : BMR / MAGELA DRILLING

R.N.:

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472 COORDS TT3966

I.N.:

PREPARED BY: F.A KELLY / BMR

MATERIAL TYPE : BLANK uPVC

SCREENS Stainless Steel

RL COLLAR:

CASING TOP : 0.50 m above ground
0.50 m above collar

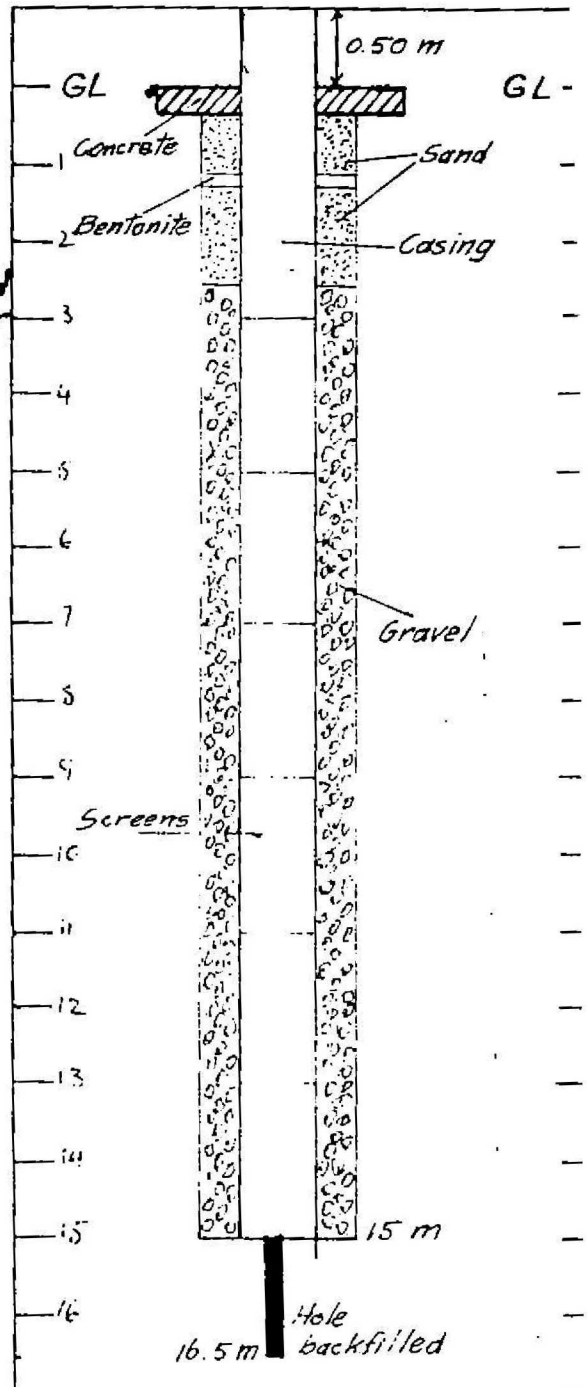
DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 3.00	uPVC 140mm diam
3.0 to 15.0	Screens 100mm diam 6 x 2m x 1.15mm aperture

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
2.60 to 15.00	3/8" crushed aggregate

Status: 20.10.79 pumped for 3 hrs - water clean, ready for sampling.



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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M5

PROJECT : BMR | MAGELA DRILLING

R.N.:

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472 COORDS 779596

I.N.:

PREPARED BY : F.A. KELLY | BMR

MATERIAL TYPE : BLANK uPVC

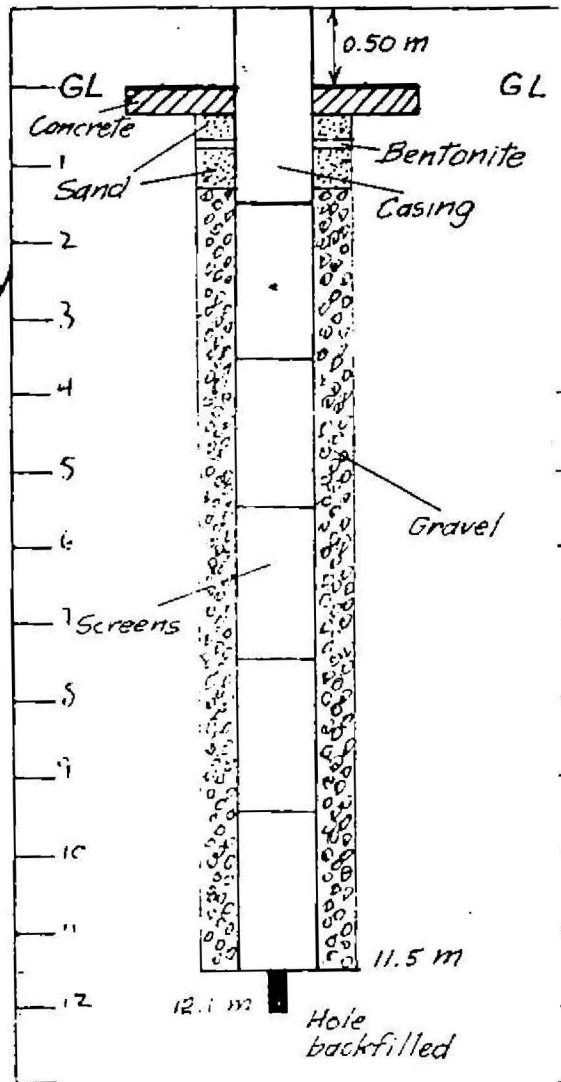
SCREENS Stainless Steel.

RL COLLAR :

CASING TOP : m above ground
0.50 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 1.50	uPVC 140 mm dia.
1.50 to 11.50	Screens 100 mm dia.
	5 x 2 m x 1.15 mm aperture

* Below ground level



GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.80 to 11.50	3/8" crushed aggregate

Status : Pumped 19/10/79 20/10/79 - requires more pumping. seepage only entering hole.

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M6

PROJECT : BMR / MAGELA DRILLING

R.N. :

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472 CODRDS 779969

I.N. :

PREPARED BY : F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

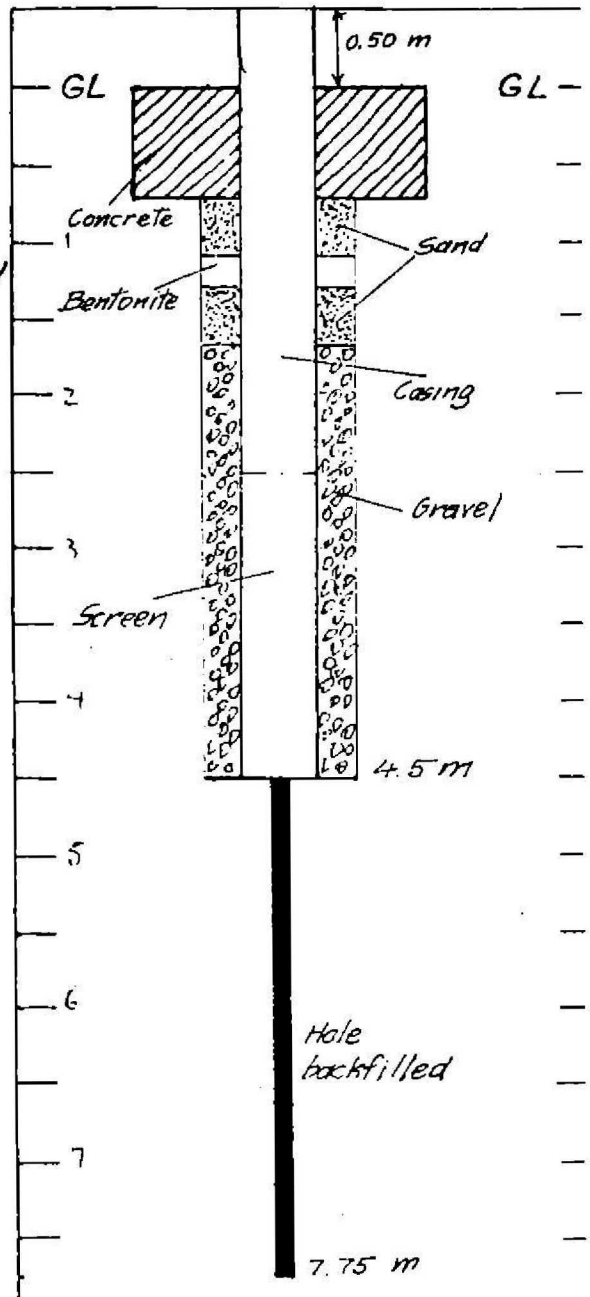
SCREENS ~~Stainless Steel~~

RL COLLAR : 0.50 m above ground

CASING TOP : 0.50 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 2.50	uPVC 140 mm dia.
2.50 to 4.50	Stainless Steel 100 mm dia. 1.5 mm aperture 1 x 2 in length

* below ground level



GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.70 to 4.50	3/8" crushed aggregate

Status: 19-20/10/79 pumped. Not ready for sampling Seepage only at this stage.

PRELIMINARY, UNEDITED

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CHECKED BY :

Record 1979/88

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M2C

PROJECT : BMR / MAGELA DRILLING

RN :

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472 COORDS 705593

IN :

PREPARED BY : F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

SCREENS Stainless Steel

RL COLLAR:

CASING TOP: m above ground
0.60 m above collar

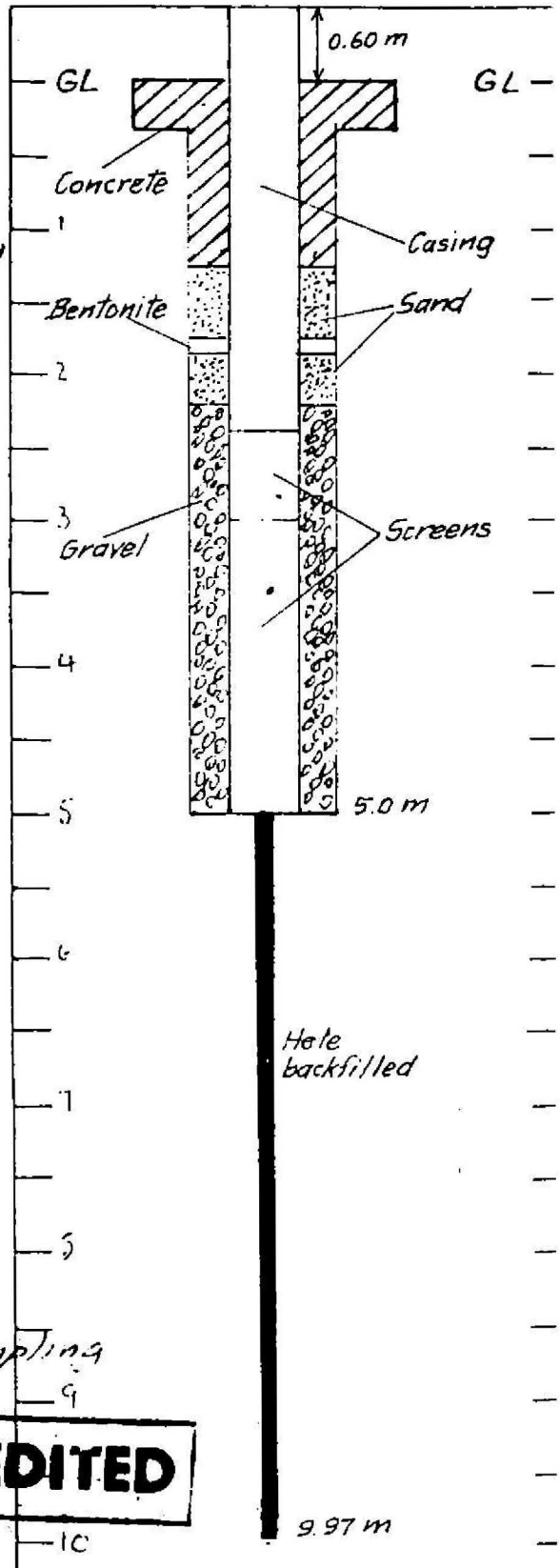
DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 2.40	uPVC 140 mm dia.
2.40 to 5.00	Screens: 1 x 2 m 1.15 mm aperture
	1 x 0.6 m 1.15 mm aperture
	100 mm dia.

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
2.24 to 5.00	3/8" crushed aggregate

Status: 22/10/79 pumped ready for sampling



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DATE RECEIVED:

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Record 1979/88

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M21

PROJECT : BMR | MAGELA DRILLING

R.N. :

LOCATION (map + grid) : CAHILL i 100 000 SHEET 5472
COORDS 705593

I.N. :

PREPARED BY : F.A KELLY | BMR

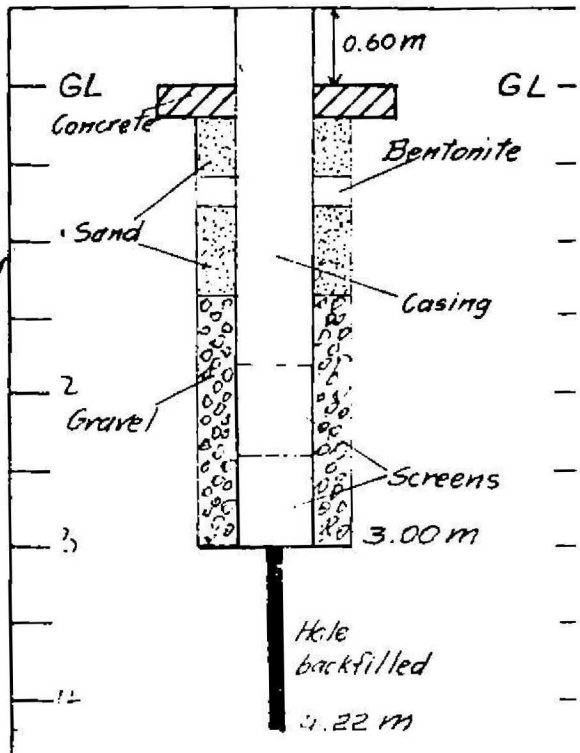
MATERIAL TYPE : BLANK uPVC
SCREENS Stainless Steel

RL COLLAR :

CASING TOP: 0.60 m above collar
m above ground

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 1.80	uPVC 140 mm dia.
1.80 to 3.00	Screens Stainless Steel 1.5 mm aperture 100 mm dia 2 x 0.6 m lengths

* below ground level



GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.40 to 3.00	3/8" crushed aggregate

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Record 1979/88

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M22

PROJECT : BMR/MAGELA DRILLING

R.N :

LOCATION (map + grid) : CAMILL 1:100,000 SHEET 5472 COORDS 703593

I.N :

PREPARED BY : F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

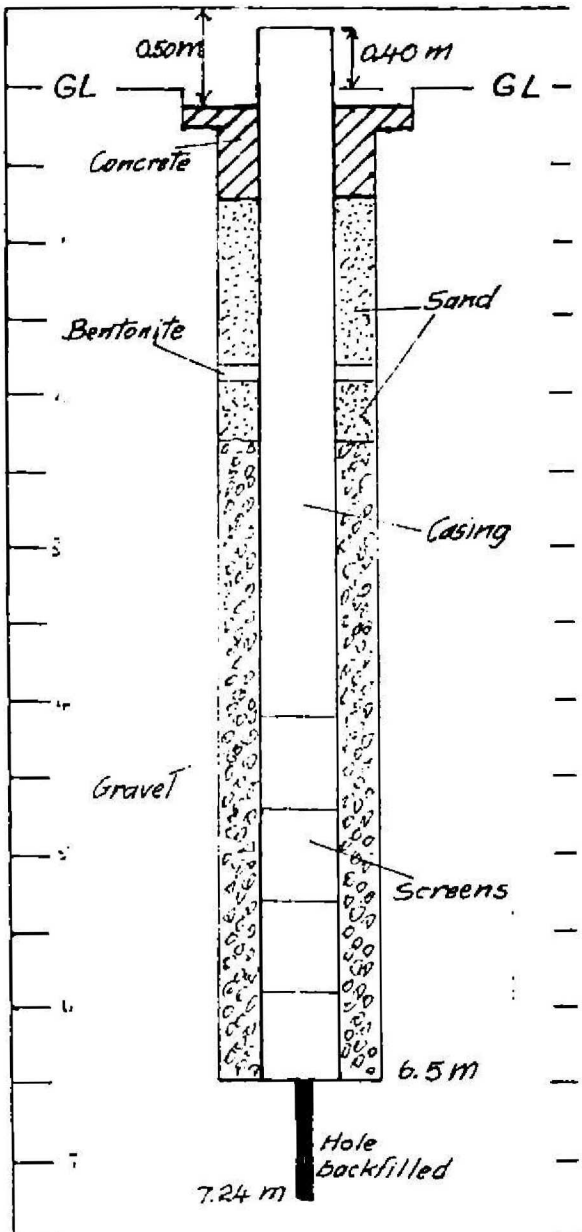
SCREENS Stainless steel

RL COLLAR:

CASING TOP: 0.40 m above ground
0.50 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 4.80	uPVC 140 mm dia
4.80 to 6.50	Screens 4 x 0.6m x 1.15mm aperture 100 mm dia

* Below ground level



GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
2.30 - 6.50	3/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: M 23

PROJECT : BMR | MAGELLA DRILLING

R.N. :

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472
COORDS 701593

I.N. :

PREPARED BY : F.A. KELLY | BMR

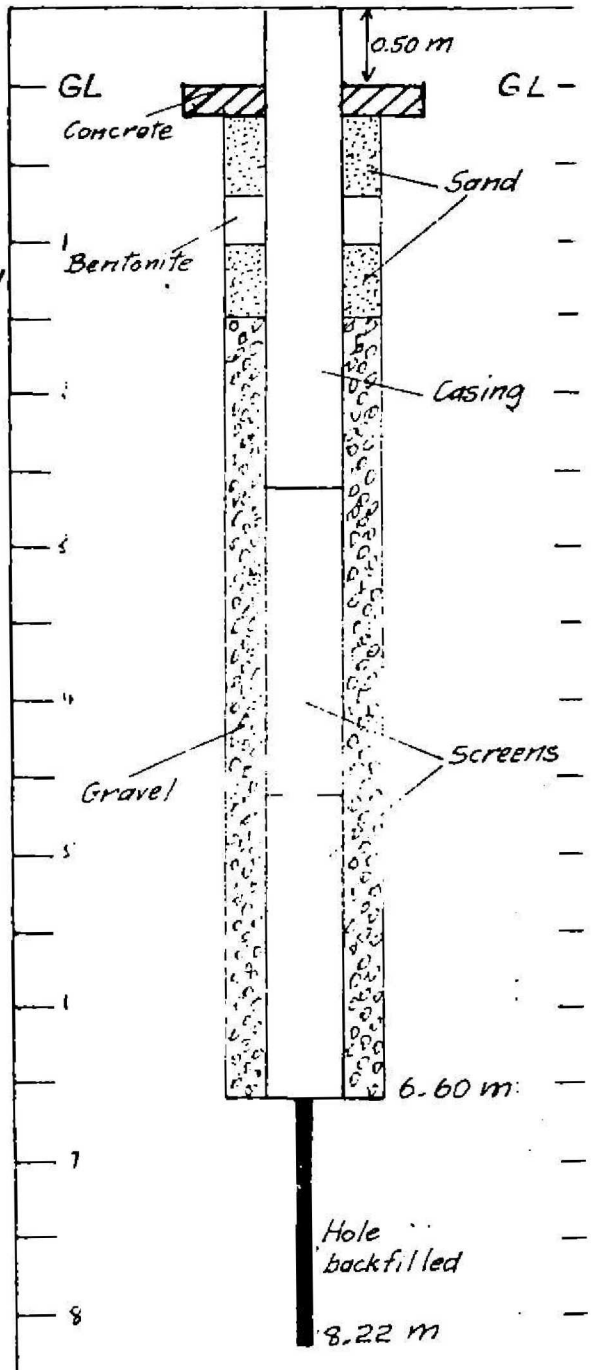
MATERIAL TYPE : BLANK uPVC
SCREENS Stainless Steel

RL COLLAR:

CASING TOP: m above ground
0.50 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0.00 to 2.60	uPVC 140 mm dia
2.60 to 6.60	Screens: 2 x 2m x 1.15mm aperture 100 mm diam

* Below ground level



GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.50 - 6.60	3/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE NO: M24

PROJECT : BMR / MAGELLA DRILLING

R.N.:

LOCATION (map + grid) : CAHILL 1:100 000 SHEET 5472
COORDS 670593

I.N.:

PREPARED BY: F.A. KELLY / BMR

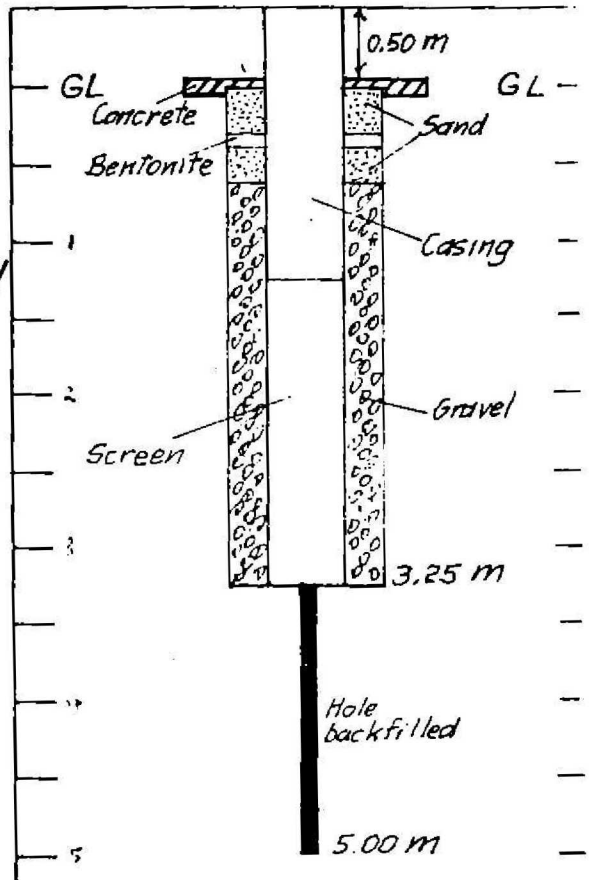
MATERIAL TYPE : BLANK uPVC
SCREENS Stainless Steel

RL COLLAR:

CASING TOP: m above ground
c. 30 cm above collar

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 to 1.25	uPVC 140 mm dia
1.25 to 3.25	Screens. 1 x 2m x 1.15 mm aperture 100 mm dia

* below ground level



GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
0.63 - 3.25	3/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N1

PROJECT : COOPER

R.N. :

LOCATION (map + grid) : DENDELI 1:100000 SHEET 5573 coords 175421

I.N. :

PREPARED BY : F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

SCREENS Stainless Steel

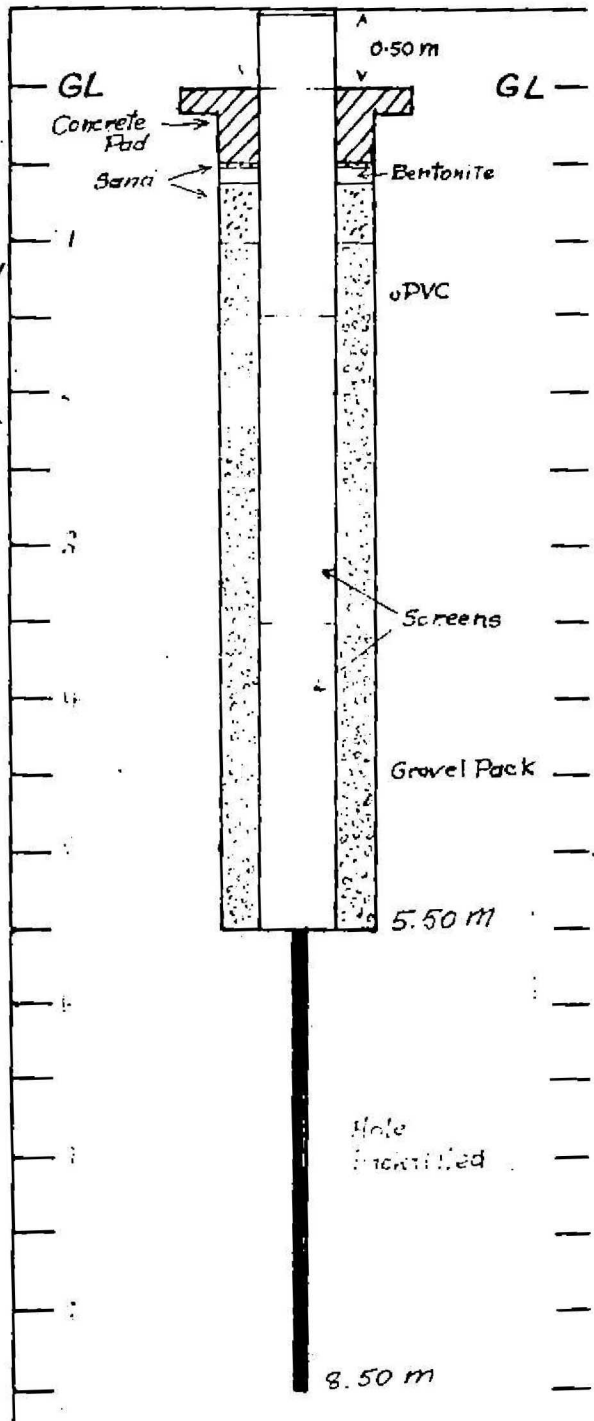
RL COLLAR:

CASING TOP: 0.50 m above collar / m above ground

DEPTH INTERVAL (m)	CASING DESCRIPTION
0.00 TO 1.50	uPVC 100 mm dia
1.50 TO 5.50	Screens 2 x 2m x 1.5 mm aperture 100 mm dia.

GRAVEL PACK

DEPTH INTERVAL (m)	DESCRIPTION
1.0 TO 5.5	3/8" washed gravel



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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N2.

R.N:

I.N:

PROJECT : Cooper

LOCATION (map + grid) : OETIPELLI 1:100000 SHEET 5573 Coords 172415

PREPARED BY: KELLY / B.M.R.

MATERIAL TYPE : BLANK upvc

SCREENS SC. Steel

RL COLLAR:

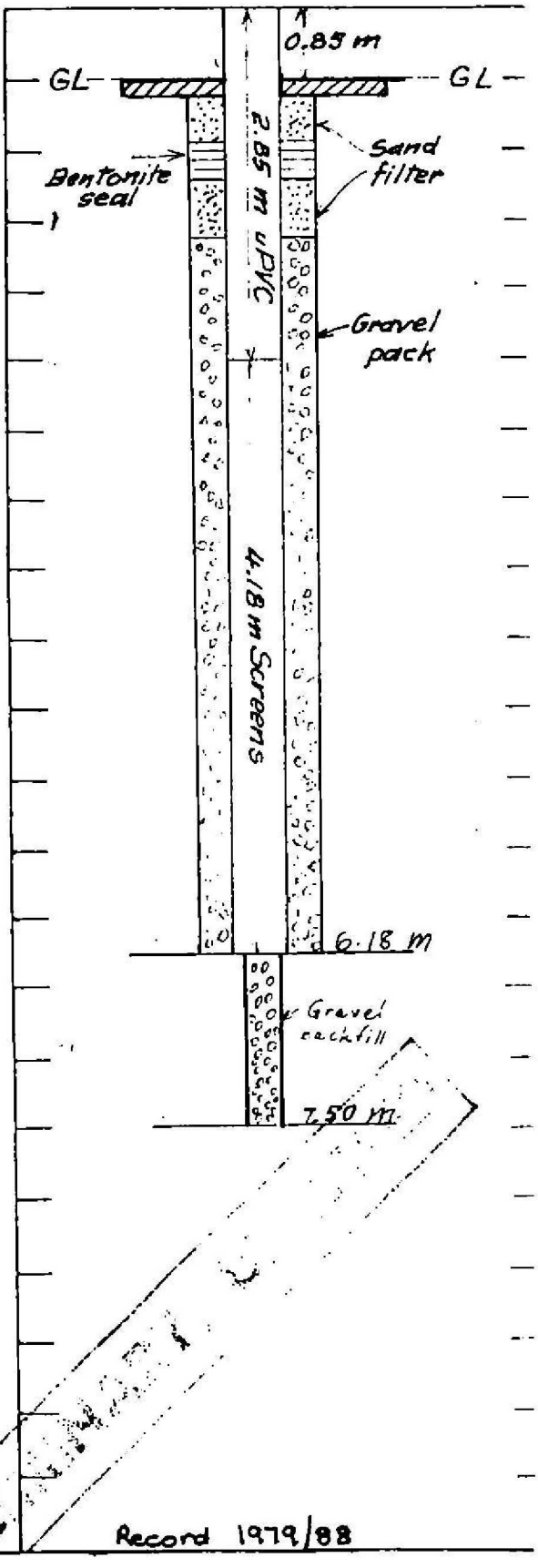
CASING TOP: 0.85 m above ground
0.85 m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0 - 2.00	upvc 140 mm diam.
2.00 - 6.18	Screens
	2 x 2.0 x 1.5mm aperture
	100mm diam.

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
1.12 - 6.18	3/8" Crushed aggregate.



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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N 3.

R.N.:

I.N.:

PROJECT : COOPER

LOCATION (map + grid) : CENPELLA 1:50,000 SHEET 6977 Coords 171417

PREPARED BY: F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

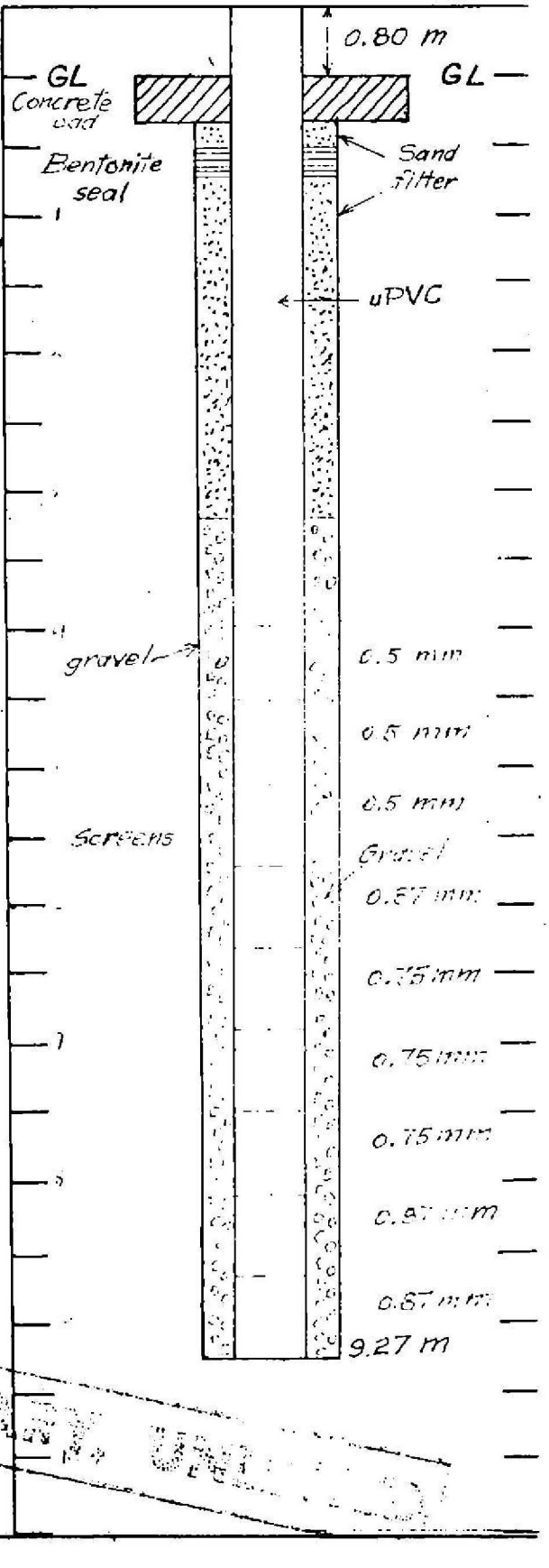
SCREENS Stainless Steel

RL COLLAR

CASING TOP: 0.80 m above ground
0.50 m above collar

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 to 3.90 m	uPVC 100mm class 9
3.90 to 9.27	Stainless Steel screen
	3 x 0.6mm x 0.53mm sp.
	3 x 0.6mm x 0.57mm sp.
	3 x 0.6mm x 0.75mm sp.
	(extra length due to corrosion)
	100mm class 9

* Below ground level



GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
3.20 to 9.27	3/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N4

R.N.:

I.N.:

PROJECT : COOPER

LOCATION (map + grid) : GENPELLI 1:100000 SHEET 6573 Coords 166396

PREPARED BY: F.A. KELLY/BMR

MATERIAL TYPE : BLANK uPVC

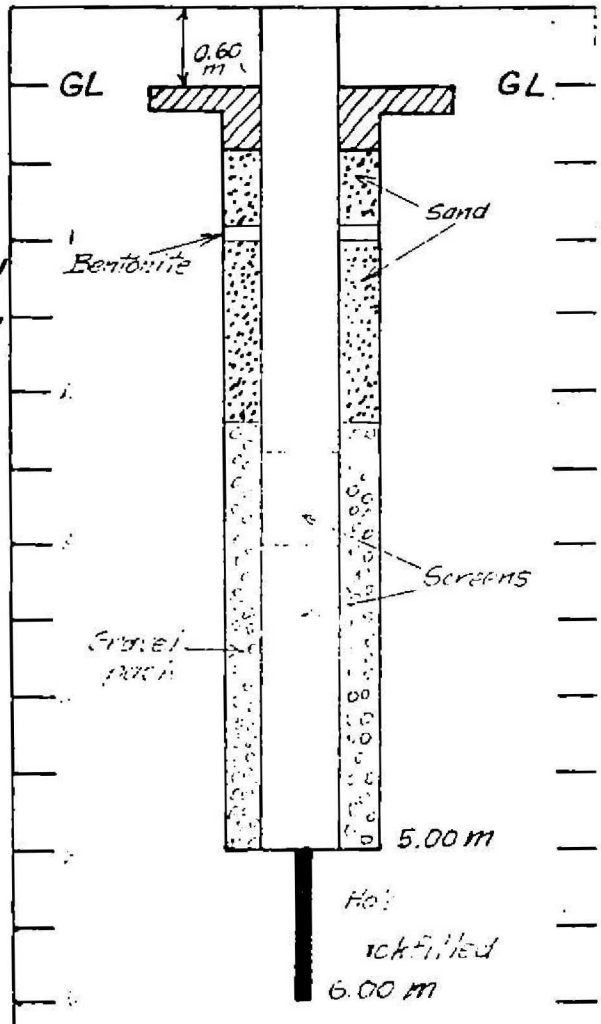
SCREENS Stainless steel

RL COLLAR:

CASING TOP: m above ground 0.60 m above collar

DEPTH INTERVAL (m) *	CASING DESCRIPTION
0.00 to 2.40	uPVC 140 mm dia
2.40 to 3.00	Screens 1 x 6mm x 0.75mm aperture
3.00 to 5.00	1 x 2mm x 1.15mm aperture
	100 mm dia

* Below ground level



GRAVEL PACK

DEPTH INTERVAL (m) *	DESCRIPTION
2.20 to 5.00	3/8" crushed aggregate

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DATE RECEIVED:

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Record 1979/88

DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT : Cooper CASING SCHEDULE

BORE No: N5

R.N. :

LOCATION (map + grid) : SENPELLI 1:100 000 SHEET 5573 COORDS 197413

IN :

PREPARED BY: KELLY / B.M.R.

MATERIAL TYPE : BLANK upvc

SCREENS st. steel

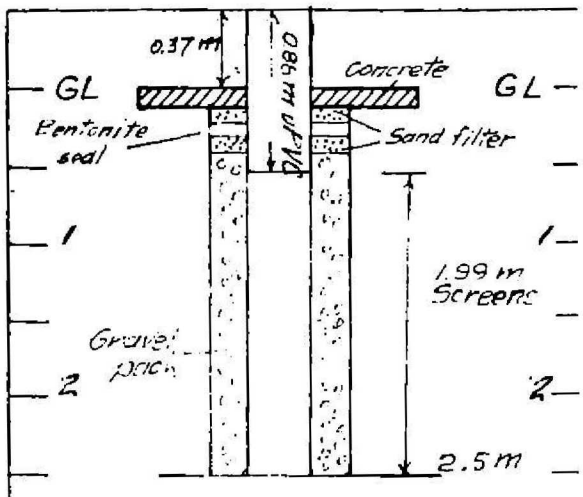
R.L. COLLAR

CASING TOP 0.37 m above collar / above ground

DEPTH INTERVAL (m)	CASING DESCRIPTION
0 - 0.51	140 mm upvc
0.51 - 2.50	1.2m x 5mm aperture 140 mm diam

GRAVEL PACK

DEPTH INTERVAL (m)	DESCRIPTION
0.47 - 2.50	3/8" crushed aggregate.



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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT COOPER CASING SCHEDULE

BORE No: N6

R.N.:

LOCATION (map + grid): OENPELLI 1:100 000 SHEET 5573 COORDS 198413

I.N.:

PREPARED BY: KELLY / BMR

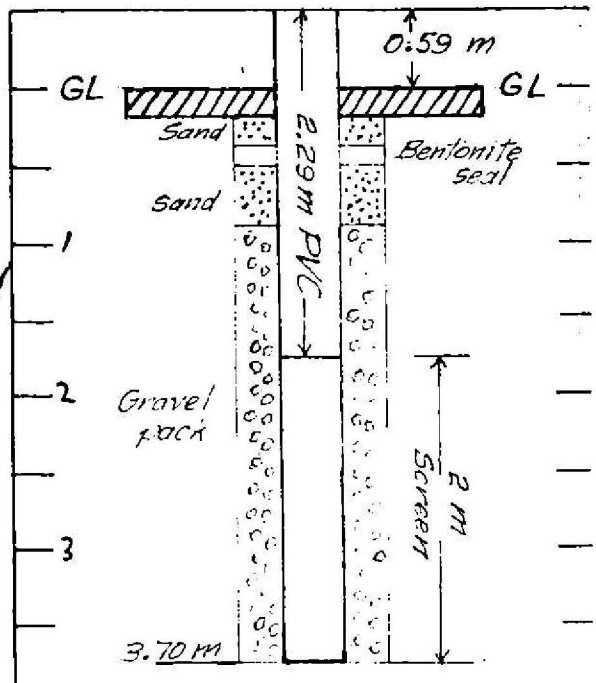
MATERIAL TYPE: BLANK uPVC

SCREENS st. steel

R.L. COLLAR:

CASING TOP: 0.59 m above ground
0.59 m above collar

DEPTH INTERVAL (m)	CASING DESCRIPTION
0 - 1.7	140 mm uPVC
1.7 - 3.7	Screens 1 x 2m x 1.5mm aperture 100 mm diam



GRAVEL PACK

DEPTH INTERVAL (m)	DESCRIPTION
0.9 - 3.7	3/8" crushed aggregate

Status 29.9.79 Water clear, ready for sampling
Concrete collar to be installed.

[redacted]

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT COOPER — CASING SCHEDULE

BORE No: N7

R.N.:

I.N.:

LOCATION (map + grid): CENPELLI 1:100 000 SHEET 5573
COORDS 199413

PREPARED BY: Kelly / BMR

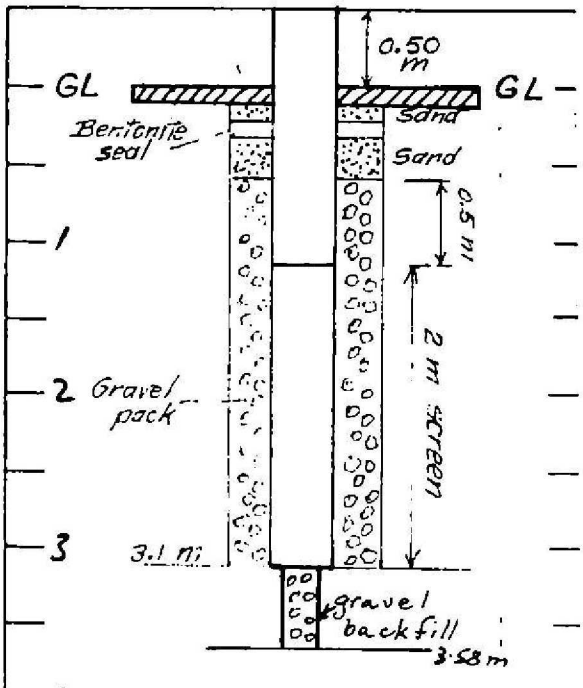
MATERIAL TYPE: BLANK uPVC

SCREENS St. steel

R.L. COLLAR:

CASING TOP: 0.50 m above ground / 0.50 m above collar

DEPTH INTERVAL (m)	CASING DESCRIPTION
0 - 1.1	uPVC (140 mm)
1.1 - 3.1	Screens 1 x 2m x 1.15 mm aperture 100 mm diam



Status 29.9.79. Water clear, ready for sampling. Concrete collar to be installed.

GRAVEL PACK

DEPTH INTERVAL (m)	DESCRIPTION
0.6 - 3.1	3/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT : Cooper CASING SCHEDULE

BORE No: N8

R.N. :

I.N. :

LOCATION (map + grid) : CEN PERTH 1:100 000 SHEET 5573 COORDS 194388

PREPARED BY: KELLY / B.M.R.

MATERIAL TYPE : BLANK uPVC .
SCREENS St. Steel.

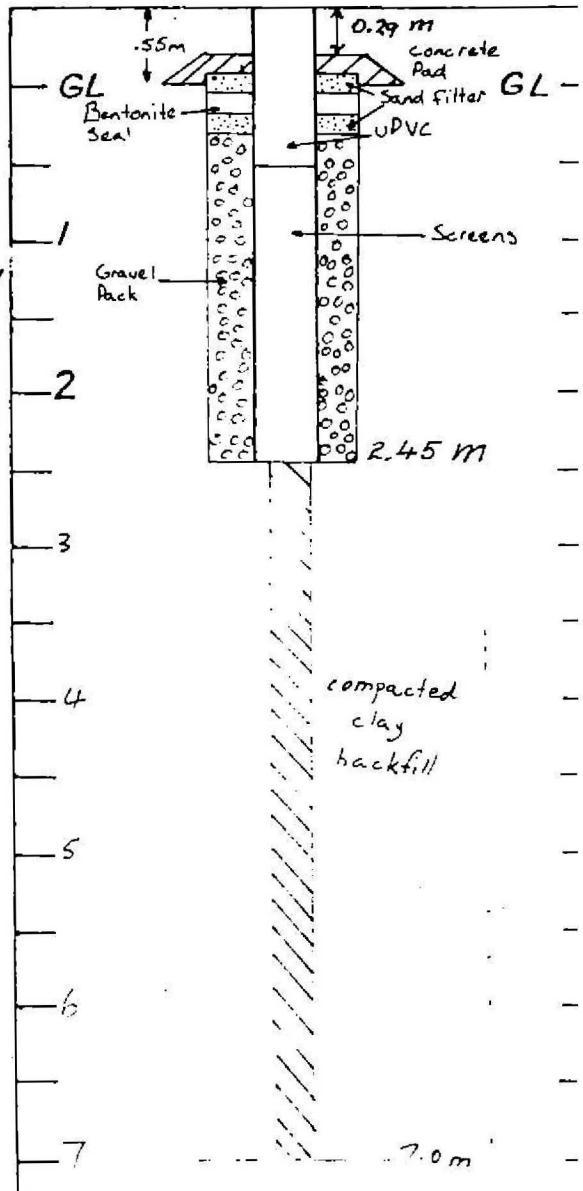
RL COLLAR:

CASING TOP: 0.55 m above ground
0.29 m above collar

DEPTH INTERVAL (m)	CASING DESCRIPTION
0 — 0.45 m	140mm uPVC
0.45 - 2.45	Screens
	1x3mm x 1.5mm aperture
	100mm diam.

GRAVEL PACK

DEPTH INTERVAL (m)	DESCRIPTION
0.20 - 2.45	3/8" crushed aggregate



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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N9

R.N.:

I.N.

PROJECT COOPER

LOCATION (map + grid): OENPELLI 1:100 000 SHEET 5573 COORDS 200385

PREPARED BY: F.A. Kelly P/L / BMR

MATERIAL TYPE: BLANK uPVC

SCREENS st. steel

RL COLLAR: 0.35 m above ground

CASING TOP: 0.35 m above collar

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0 - 5.75	140 mm m uPVC
5.75 - 9.75	Screens
	2 x 2m x 1.15mm aperture
	100 mm diam

* Below ground level

GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
1.6 - 9.75	3/8" crushed gravel

Status 28.9.79: Water clear, ready for sampling. Concrete collar to be installed.

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DATE RECEIVED:

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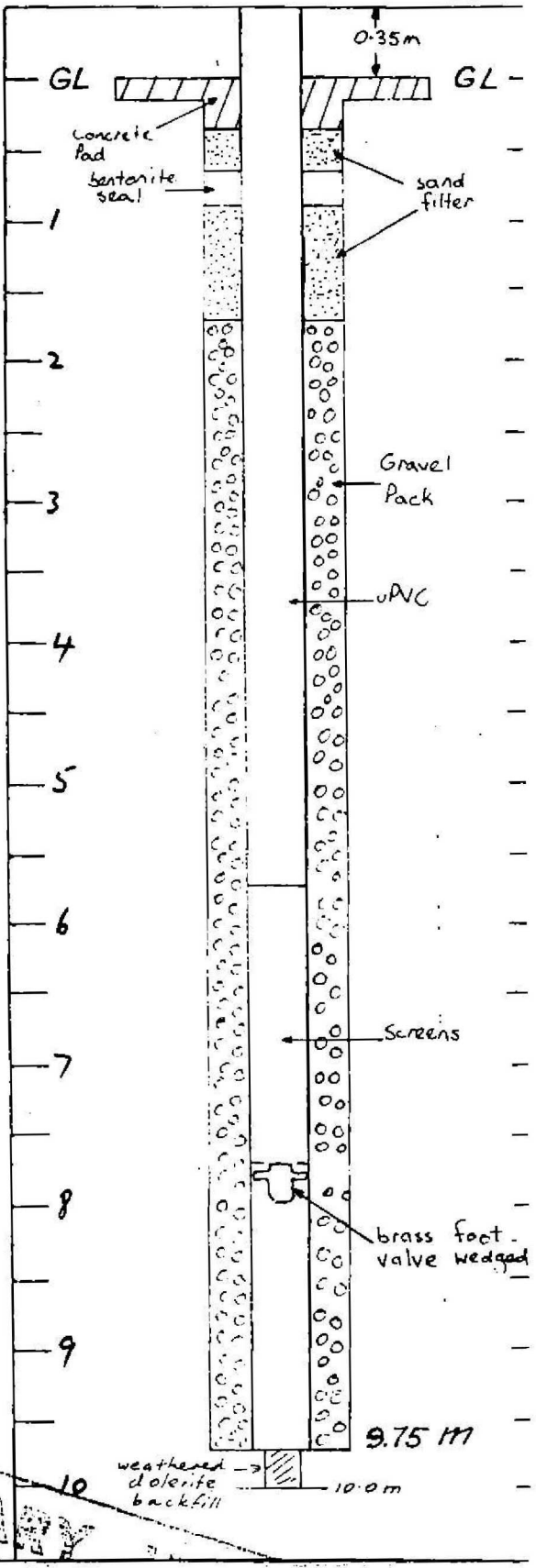
PRELIMINARY



DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE NO: N10

PROJECT : COOPER

R.N. :

LOCATION (map + grid) : CEMPELLI 1:100 000 SHEET 5573 COORDS 166394

I.N. :

PREPARED BY: F.A. KELLY / BMR

MATERIAL TYPE : BLANK uPVC

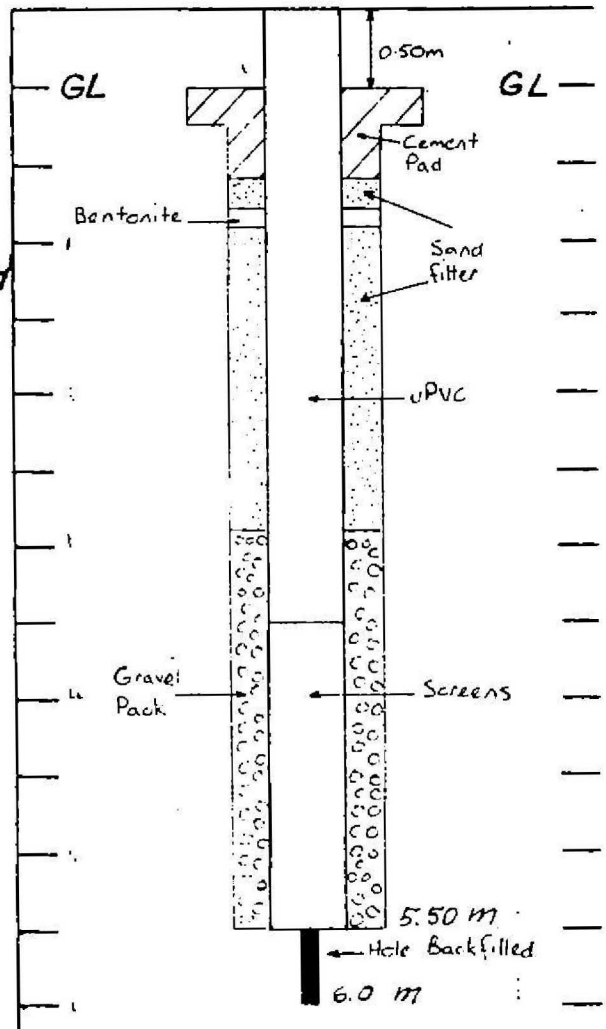
SCREENS Stainless Steel

RL COLLAR:

CASING TOP: 0.50 m above ground / 0.50 m above collar

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 to 3.50	uPVC 140 mm dia.
3.50 to 5.50	Screen - 1 x 2 m x 1.5 mm aperture 100 mm dia.

* Below ground level



GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
2.90 to 5.50	5/8" crushed aggregate

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N11

PROJECT COOPER

R.N.:

LOCATION (map + grid): GENPELLI 1:100 000 SHEET 5573 COORDS 171369

I.N.:

PREPARED BY: Kelly / BMR

MATERIAL TYPE: BLANK uPVC

SCREENS st. steel

RL COLLAR

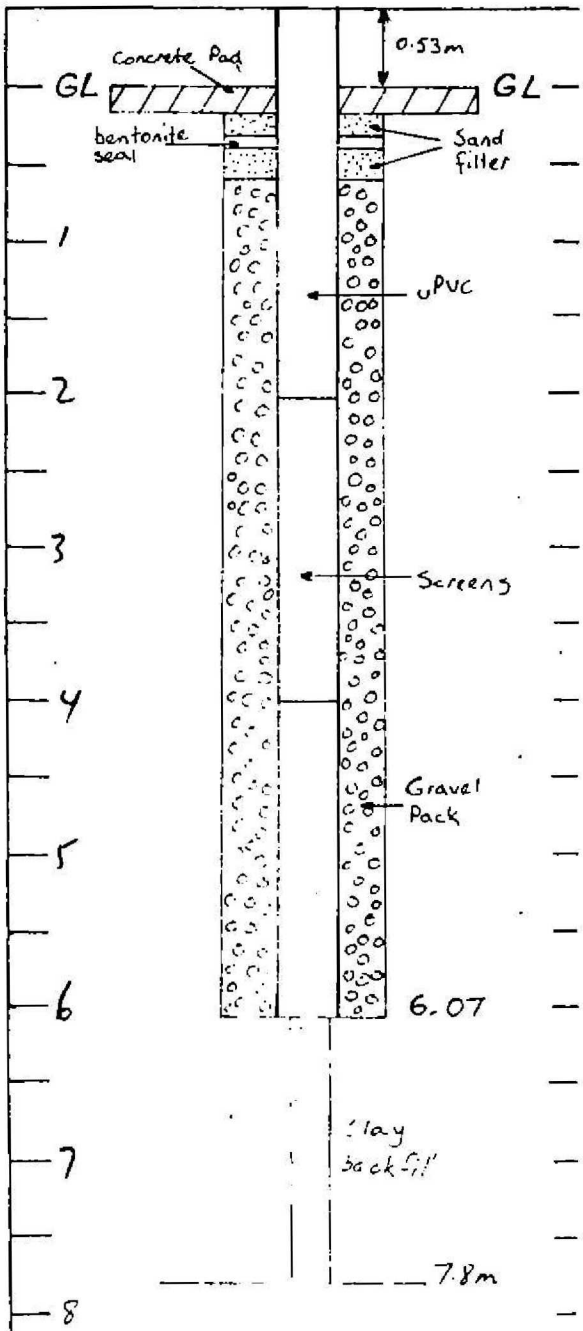
CASING TOP 0.53 m above ground
0.53m above collar

DEPTH INTERVAL* (m)	CASING DESCRIPTION
0-2.07	140 mm upvc
2.07-6.07	Screens: 2 x 2m x 1.5 mm aperture 100 mm diam

* Below ground level

GRAVEL PACK

DEPTH INTERVAL* (m)	DESCRIPTION
0.52 - 6.07	3/8" crushed aggregate



Status 30.9.79: Pumped 4hrs intermittently. Water improving but still not clear enough for sampling. Water has unpleasant odour. Concrete collar to be installed.

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N12

R.N.:

I.N.:

PROJECT COOPER

LOCATION (map + grid): OENPELLI 1:100 000 SHEET 5573 COORDS 179375

PREPARED BY: Kelly / BMR

MATERIAL TYPE: BLANK uPVC

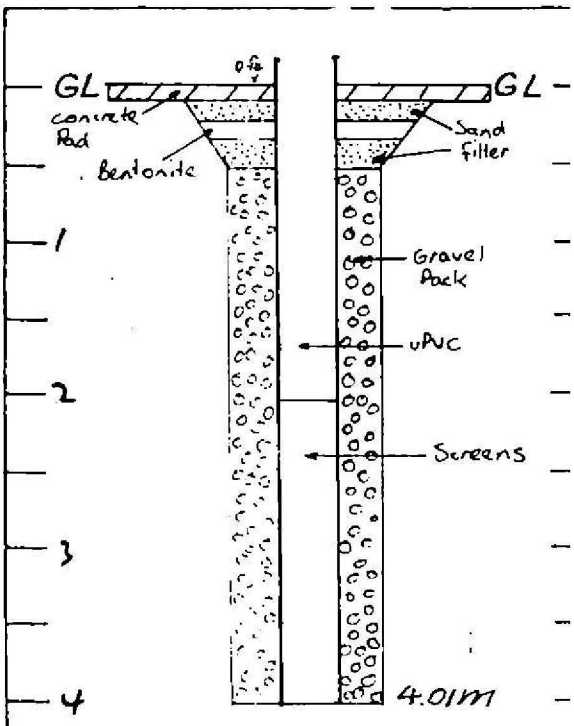
SCREENS st steel

RL COLLAR:

CASING TOP: 0.14 m above ground
0.14 m above collar

DEPTH INTERVAL (m) *	CASING DESCRIPTION
0 - 2.0	140 mm uPVC
2.0 - 4.01	Screens: 1.2m x 1.15mm aperture 100mm diam

* Below ground level



GRAVEL PACK

DEPTH INTERVAL (m) *	DESCRIPTION
0.5 - 4.0	3/8" crushed aggregate

Status 30.9.79: No cap. No concrete collar.
Requires more pumping before sampling

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

PROJECT COOPER CASING SCHEDULE

BORE No: N13

R.N :

I.N :

LOCATION (map + grid) : GENPELLI 1:100 000 SHEET 5573
COORDS 201396

PREPARED BY : F.A. Kelly / BMR

MATERIAL TYPE : BLANK uPVC
SCREENS stainless steel

RL COLLAR:

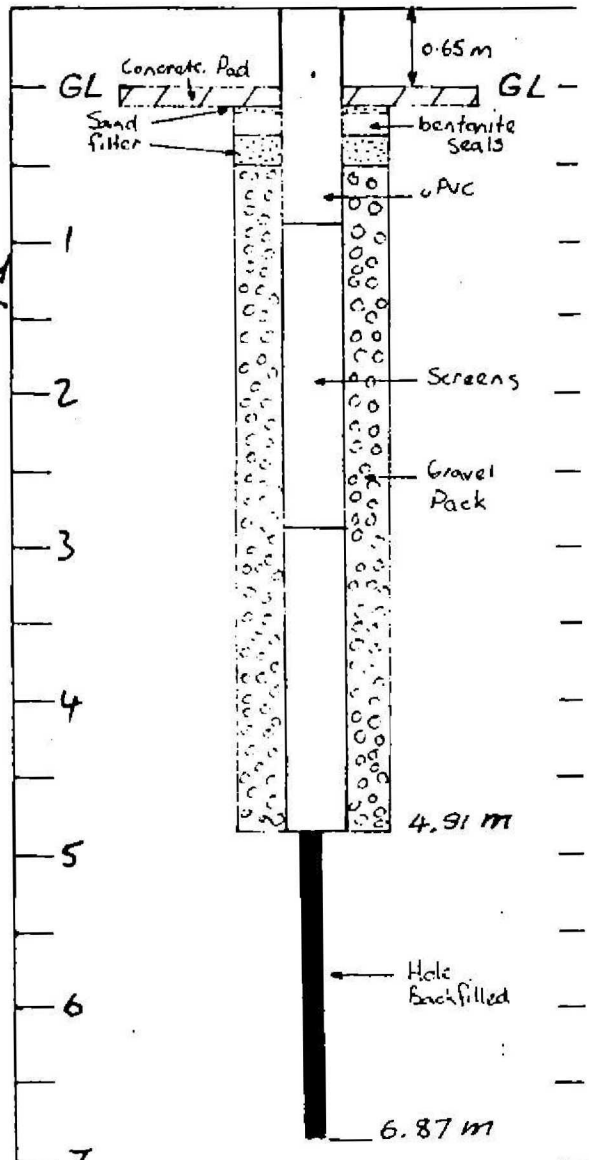
CASING TOP: 0.65 m above collar / m above ground

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0 - 0.91	140 mm uPVC
0.91 - 4.91	Screens: 2 x 2m x 1.15mm aperture 100 mm diam.

* Below ground level

GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
0.5 - 4.91	3/8" crushed aggregate (granite)



Status 28.9.79: Concrete collar to be installed. Requires bore cap. Water still turbid after approx 8 hrs intermittent pumping. Not ready for sampling.
29.9.79 3 hrs intermittent pumping, water still turbid yield increasing
30.9.79 1 hr intermittent pumping, yield increasing water quality improving but not ready for sampling

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DATE RECEIVED: Bore cap fitted
CHECKED BY :

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N14

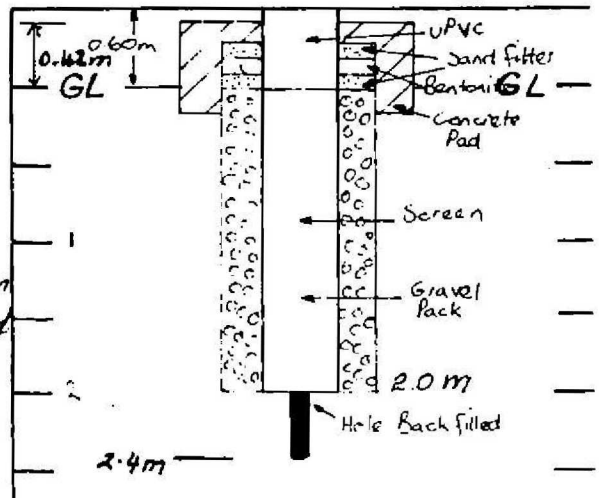
PROJECT : COOPER

R.N. :

LOCATION (map + grid) : OETIPELLI 1:100 000 SHEET 5073 COORDS 193394

I.N. :

PREPARED BY: F.A. KELLY



MATERIAL TYPE : BLANK uPVC

SCREENS stainless steel

FL COLLAR

CASING TOP 0.18 m above collar
0.60 m above ground

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 TO 2.00	100 mm dia.

* Below ground level

GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
0.00 TO 2.00	3/8 coated pigrade

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DEPARTMENT OF TRANSPORT AND WORKS
WATER DIVISION

CASING SCHEDULE

BORE No: N15

PROJECT : Cooper

R.N :

LOCATION (map + grid) : GENPELLI 1:100 000 SHEET 5573 COORDS 193457

I.N :

PREPARED BY : F.A. KELLY/BMR

MATERIAL TYPE : BLANK uPVC

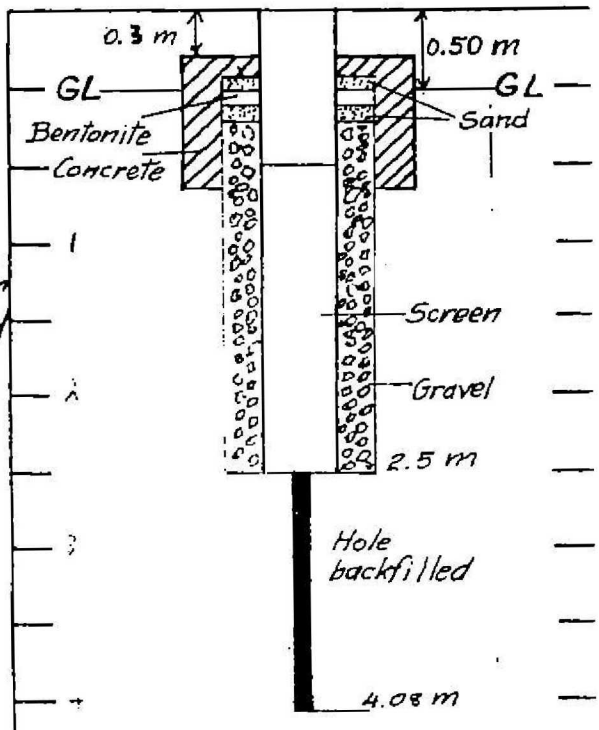
SCREENS Stainless Steel

RL COLLAR:

CASING TOP: 0.30 m above collar
0.50 m above ground

DEPTH INTERVAL (m)*	CASING DESCRIPTION
0.00 TO 0.50	uPVC 140 mm dia
0.50 TO 2.50	Stainless 1 x 2m x 1.5mm aperture 140mm dia

* Below ground level



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GRAVEL PACK

DEPTH INTERVAL (m)*	DESCRIPTION
0.27 TO 2.50	3/8" Crushed Aggregate

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DATE RECEIVED :

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Record 1370/88

Appendix 4

Tie Points, Coordinates and levels of Boreholes

Appendix 4

TIE POINTS FOR SURVEY OF BOREHOLES

TRAVERSE OR BOREHOLE NO	TIE POINT COORDINATES AND LEVELS
TRAVERSE 1	Special Mining Lease Boundary Marker No 27 for Ranger Uranium Mine Easting: 275839.10 Northing: 8595524.77 Level: 17.599 m ASL
TRAVERSE 2	Aerial Survey Target No 820 Easting: 269632.0 Northing: 8605882.0 Level: 7.05 m
TRAVERSE 3	As for Traverse 2
TRAVERSE 4	Special Mining Lease Boundary Marker No 52 for Ranger Uranium Mine Easting: 270675.00 Northing: 8593696.86 Level: 20.285 m
M26	Not Surveyed 1979
M27 and M28	Station No 3010 Surveyed by Pan Continental Easting: 271674.21 Northing: 8610570.84 No level given
M29	Station No 3139 Surveyed by Pan Continental Easting: 271201.54 Northing: 8610105.17 Level: 5.82 m ASL
M30 and M31	Station No 3146 Surveyed by Pan Continental Level: 14.97 m ASL
M32, M33 and M34	Station No 3061 Surveyed by Pan Continental Easting: 275665.53 Northing: 8607540.43 Level: 11.49 m ASL

COORDINATES AND LEVELS FOR BORE-HOLES
MAGELA CREEK CATCHMENT

BMR BORE-HOLE NUMBERS	WATER DIVISION* WELL NUMBERS	GRID REFERENCE EASTING	GRID REFERENCE NORTHING	HEIGHT (m) A.S.L.	REMARKS
TRAVERSE 1					
M1		276631.3	8595541.5	15.70	
M2		276719.8	8595622.3	16.16	
M3		276992.4	8596119.5	15.46	
M4		-	-	-	Not Surveyed 1979
M5		277862.5	8596870.3	18.05	
M6		-	-	-	Not Surveyed 1979
M7		-	-	-	Not Drilled or Surveyed 1979
M8		-	-	-	"
M9		-	-	-	"
TRAVERSE 2					
M10		270377.0	8603912.6	8.00	Not Drilled 1979
M11		270002.7	8603870.1	8.42	"
M12		269578.7	8603692.9	8.78	"
TRAVERSE 3					
M13		268879.6	8606020.8	13.38	Not Drilled 1979
M14		269299.4	8605961.2	6.01	"
M15		269562.0	8606042.9	6.79	"
M16		270065.6	8606056.6	7.38	"
M17		270720.9	8606174.4	7.02	"
M18		271270.2	8606226.2	13.46	"
TRAVERSE 4					
M19		270697.5	8593628.1	20.78	Not Drilled 1979
M20		270578.5	8593673.7	19.40	
M21		270467.9	8593716.2	19.49	
M22		270333.8	8593784.3	19.53	
M23		270158.3	8593868.8	19.90	
M24		269992.1	8593920.7	19.60	
M25		269825.9	8594004.3	22.38	
M26		-	-	-	Not Drilled or Surveyed 1979
M27		271720.2	8610665.2	-	Not Drilled, No R.L. found 1979
M28		271782.9	8610773.3	-	Not Drilled, No R.L. found 1979

*Water Division well numbers not available.

BMR BORE-HOLE NUMBER	WATER DIVISION* WELL NUMBERS	GRID REFERENCE EASTING	GRID REFERENCE NORTHING	HEIGHT (m) A.S.L.	REMARKS
M29		271184.0	8610095.8	5.14	Not Drilled 1979
M30		-	-	4.61	Not Drilled 1979 No Grid Ref. found
M31		-	-	5.16	Not Drilled 1979 No Grid Ref. found 1979
TRAVERSE 5					
M32		276006.0	8607531.5	11.76	Not Drilled 1979
M33		276032.3	8607675.2	13.63	"
M34		276074.1	8607967.5	12.02	"

*Water Division well numbers not available.

RIVER

reserve

EAST ALLIGATOR RIVER

+ARH1

+ARH2

+ARH3

+ARH4

M108

M107

M109

Drillhole - surveyed and drilled 1979, drillhole number

Drillhole - surveyed and undrilled

Drillhole - approximate

M5 Drillhole number, site 107

+ARH2 Proposed BMR stratigraphic drillhole

MAGELA PLAIN

NANKEEN BILLABONG

JABILUKA BILLABONG

LEICHARDT BILLABONG

TRAVERSE 9

TRAVERSE 8

JABILUKA PROJECT AREA

OENPELLI ROAD

CANNON HILL

AMENDMENTS					
No.	DESCRIPTION	AUTHOR	DATE	CHECKED	DATE
A1					
A2					
A3					
A4					
A5					
A6					

SCALE 0 250 500 750 1000 1250 m

BASE MAP/SURVEY

GEOLOGY BY

COMPILED AND CHECKED — PROJECT GEOLOGIST

CHECKED AND APPROVED — SENIOR GEOLOGIST

SUPERVISING GEOLOGIST

PLATE 1

COMMONWEALTH OF AUSTRALIA

BUREAU OF MINERAL RESOURCES

CANBERRA, A.C.T

TITLE LOCATION OF DRILLHOLES AND INFILTRATION SITES - NORTH MAGELA

PROJECT ALLIGATOR RIVER HYDROGEOLOGY PROGRESS REPORT 1979

TO ACCOMPANY RECORD 1979/88

DRAWN BY

DRAWING NUMBER D53/A1/84

260 50' 65 270 75


TRAVERSE 7
TRAVERSE 6
TRAVERSE 5
TRAVERSE 3
TRAVERSE 2
TRAVERSE 1
TRAVERSE 4
JAJA BILLABONG
JABILUKA OUTLIER
HIDDEN BILLABONG
(ISLAND BILLABONG)
Mayamarleprard Waterhole
HADES FLAT
Ford
BUFFALO BILLABONG
MUDGINBERRI BILLABONG
Mudginberri
J Creek
JABILUKA PROJECT AREA
RANGER PROJECT AREA
OENPELLI ROAD
Corndorl Waterhole
GULUNGUL WATERHOLE
MAGELA FAULT
GOANNA BILLABONG
Spring
Jabiru Airfield
COONJIMBA BILLABONG
waterholes
ARNHEM HIGHWAY
BARALIL CK
GULUNGUL CREEK
Numerous
Magela
Creek
GEORGETOWN BILLABONG
RANGER PROJECT BOUNDARY
BROCKMAN MASSIF
Falls
Boundary of aboriginal reserve
Drillhole - surveyed and drilled 1979, drillhole number
Drillhole - surveyed and undrilled
Drillhole - approximate
12°30′
133°00′
40′
50′
PLATE 2
AMENDMENTS
No. DESCRIPTION AUTHOR DATE CHECKED DATE
A1 A2 A3 A4 A5 A6
SCALE 0 250 500 750 1000 m
BASE MAP/SURVEY
GEOLOGY BY
COMPILED AND CHECKED
CHECKED AND APPROVED
PROJECT GEOLOGIST
SENIOR GEOLOGIST
SUPERVISING GEOLOGIST
COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.
TITLE LOCATION OF DRILLHOLES AND INFILTRATION SITES - SOUTH MAGELA
PROJECT ALLIGATOR RIVERS HYDROGEOLOGY PROGRESS REPORT 1979
TO ACCOMPANY RECORD 1979/88
DRAWN BY R.E.
DRAWING NUMBER D53/A1/85