INVESTIGATION OF RAILWAY BALLAST SITES, MINING RESERVE NO. 344, JAMES RANGES, N.T.

by

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SUMMARY

Mining Reserve No. 344, south of Alice Springs, was surveyed for railway ballast in February-March, 1972. Four outcrops (two of silicified Palaeozoic sandstone and two of Proterozoic limestone) were selected for testing by exploratory diamond drilling. Two of these outcrops lie outside the original reserve, and the reserved area is being extended to include them.

INTRODUCTION

Mining Reserve No. 344 is located approximately 50 miles south of Alice Springs, as shown on Plate 1, and lies in the Rodinga 1:250,000 geological series sheet SG53-2 area. It is covered by the following air photographs at 1:46,500 scale, flown by the Royal Australian Air Force in 1950 - Rodinga Run 6/5083-5085, Run 7/5150-5154, and Run 8/5158-5162.

The original reserve extends from 24°20'S to 24°28'S, and from 133°42'E to 133°48'E, and is approximately 60 square miles in area. However, as a result of the investigations described in this report, a new reserve is being created with its eastern boundary at 133°51'E, thereby increasing the reserved area to approximately 85 square miles.

Access roads to the area are shown on Plate 1. The Hugh River Stockroute/Stuart Highway junction is located approximately 150 yards south of a grid, 64 miles from Alice Springs. Within the Reserve, all outcrops except some in the James Ranges can be reached by vehicle. There are several bores in the Reserve, and the best drinking water is that at the Walkabout bore.

This report describes the results of a survey of Mining Reserve No. 344 carried out in February-March, 1972. The Reserve was created following a preliminary examination of the Central Australian Standard Gauge Railway route by Fruzzetti (1971). The purpose of the current survey was to find rock outcrops which might be quarried for railway ballast.

In this survey, outcrops located on air photographs were examined on the ground. An alidade, plane table and staff, and enlarged air photographs were used to measure the dimensions and to map the geology of favourable outcrops. A solution of sodium alizarinsulphonate in hydrochloric acid was used to determine whether carbonate rocks were predominantly calcitic or dolomitic.

BALLAST REQUIREMENTS

The following information was obtained from Mr. D. Smith, Commonwealth Railways, during informal discussions in Alice Springs.

Crushed stone for railway ballast should be relatively strong and abrasion resistant. The percentage of wear measured in the Los Angeles test should be less than 40, and ideally would be less than 20. Limestone, acidic and basic igneous rocks, and quartzite are commonly used.

.../2

For the construction of this railway 3,600 cubic yards of ballast per mile are required. As a 50 mile spacing of quarries is desirable, each quarry should produce approximately 200,000 cubic yards of ballast. If only poor quality ballast material is available at any particular locality, a lesser amount can be used as foundation material in the railbed, with higher quality ballast being transported along the railway from more distant quarries. Quarries should if possible be less than 8 miles from the proposed railway route.

It was emphasised that all rock from each reserve should be quarried from one pit only. Quarries would normally be worked with 25 foot face heights, but faces as low as 10 feet high are workable. Hence relatively thin, flat lying beds such as silcrete and conglomerate can be considered as possible raw material for ballast. Gravel and scree may also be used, but deposits must be large or must contain a high proportion of coarse material, because only pebbles coarser than 3 inches diameter are acceptable for crushing.

REGIONAL GEOLOGY

Cook (1969) and Wells et al. (1970) have described the geology of this region. The following table summary is from Cook (1969).

.../3

TABLE 1

Age	Formation (map symbol)	Maximum Thickness (feet)	Lithology	Topographic Expression	Remarks
Quaternary	(Qa)	100?	Alluvial gravel, sand, silt.	Streams, alluvial flats, scree slopes.	-
	(Qs)	50?	Aeolian sand.	Dunes, sand plains.	-
	(Qc)	10	Conglomerate, scree.	Gibber plains, scree slopes.	-
Tertiary	(Tc)	50	Coarse conglomerate.	Low rubbly outcrops.	Clasts of Silcrete.
	(Tb)	10	Silcrete.	Mesa cappings.	-
	(Ts)	c.200	Siltstone, sandstone, conglomerate, clay, lignite.	Mesa cappings and low outcrops.	Mainly known in waterbores.
Devonian to Carboniferous	Hermannsburg Sandstone (Pzr)	1500	Red-brown silty sandstone with pebbles; minor siltstone.	Prominent ridges and ranges.	-
? Silurian to Devonian	Mereenie Sandstone (Pzm)	1700 est.	White well sorted sandstone with large cross-beds.	Prominent ridges and ranges.	-
Ordovician	Stokes Siltstone (Ot)	500	Green siltstone and shale; limestone.	Strike valleys.	Very poorly exposed.
	Stairway Sandstone (Os)	600	Sandstone, siltstone, sandstone units; some red-beds.	Strike ridges.	-
	Horn Valley Siltstone (Ol)	150	Siltstone, shale, limestone.	Valleys.	Poorly exposed.

TABLE 1 (Continued)

Age	Formation (map symbol)	Maximum Thickness (feet)	Lithology	Topographic Expression	Remarks
Cambrian to Ordovician	Pacoota Sandstone (C-Op)	1500	Sandstone, silty sandstone; cross bedded in places; some pebble bands; rare phosphorite, glauconite.	Prominent ridges.	-
Cambrian	Jay Creek Limestone (Cj)	1400	Interbedded brown and green shale and yellow or grey limestone, dolomite.	Strike valleys, low limestone ridges.	-
	Chandler Limestone (Cl)	600	Limestone and dolomite, with chert laminae and evaporites.	Low ridges and mounds.	Highly contorted and incompetently folded. Evaporites not seen in outcrop.
	Arumbera Sandstone (Ca)	2500 est.	Sandstone, conglomeratic sandstone, siltstone; glauconitic in places.	Very prominent strike ridges.	-
Precambrian	Pertatataka Formation (Pup)	6040	Siltstone, shale; minor dolomite, limestone, sandstone conglomerate.	Strike ridges and valleys.	-

RESULTS OF INVESTIGATION

Pertatataka Formation (Pup)

Outcrops of limestone in the Pertatataka Formation occur as strike hills and ridges. The limestone appears brown massive or laminated (½" - 1" laminations) on weathered surfaces. It fractures independently of laminae, and fresh surfaces are grey brown or brown, and finely crystalline. The rock is mostly calcitic, though parts may be dolomitic or sideritic. This rock would probably be suitable for ballast, if it is sufficiently abrasion resistant.

The best outcrop of possible ballast material examined during this survey, is that at Site 1 (see Plate 4.). If drilling shows that the finely crystalline dolomitic limestone, which caps the ridge, extends to ground level, reserves of this material above ground level should exceed 500,000 cubic yards.

A second large hill of Pertatataka Formation rocks, shown on Plate 7, has an estimated volume exceeding 3,000,000 cubic yards. The hill is mantled with brown finely crystalline calcitic limestone. Close examination of this hill showed that the brown limestone is folded, and because the surface of the hill parallels the folded stratum, little of the stratigraphic section is exposed. As nearby hills to the south-east have exposures of red brown shale and friable limestone, these rocks could also occur beneath the limestone mantle. Drilling at this site would therefore be necessary to test the unexposed section.

Jay Creek Limestone (Cj)

Most of the Jay Creek Limestone outcrops are found in low rises, between 15 and 50 feet above the surrounding plains. In the southern part of the Reserve some outcrops occur at a higher level in the sides of mesas. The amount of outcrop on each rise is usually about 10%, comprising 2 - 3 foot thick beds of carbonate rock, separated by bands with no outcrop. Rabbits burrowing in these bands have excavated fragments of red to green shale, and calcareous sandstone. The carbonate beds range in dip from 5° to 60°.

The carbonate rock has a brown or grey-brown weathered surface, either massive or with laminae ½" - 2" thick. There is no tendency for the rock to split along these laminae. Fresh surfaces are light brown or light grey. The rock could be classified as a finely crystalline calcitic limestone, and would probably be suitable for ballast, if it is sufficiently resistant to abrasion.

However, occurrences of Jay Creek Limestone are considered unsuitable as raw material for ballast, because most of the section apparently consists of shale and friable sandstone.

Chandler Limestone (Cl)

Several outcrops of Chandler Limestone were examined. They range in height from 15 feet to 100 feet and have 25-50% outcrop of cherty carbonate rock. Medium-scale folding is usually present. In hand specimen, the carbonate rock has a grey to red-brown, massive or

.../6

laminated weathered surface, and fractures independently of laminae. Fresh surfaces are light brown or grey. The rock contains up to 5% black chert lenses, 1/4" - 1" thick. It could be classified as a very finely to finely crystalline, cherty calcitic limestone.

Outcrops of Chandler Limestone may be suitable for ballast, provided that the chert lenses do not cause the rock to crush to a flaky aggregate, and provided the aggregate is sufficiently abrasion resistant.

Arumbera Sandstone (Ca)

Outcrops of the Arumbera Sandstone form a prominent strike ridge south of the James Ranges and just outside the eastern boundary of the Reserve. This sandstone is not silicified except for an outcrop of pebble conglomerate, which is only partly silicified and would be unsuitable for ballast material.

Palaeozoic Sandstones

The Palaeozoic sandstones consisting of the Hermannsburg Sandstone, Mereenie Sandstone, Stairway Sandstone and Pacoota Sandstone, form the James Ranges, which occupy the centre of the area. These sandstones have an east-west strike and dip to the north at angles varying from 10° to 40°.

In places, outcrops of these sandstones are silicified and may be suitable as ballast material.

In the northern part of the Reserve, outcrops of Hermannsburg Sandstone occur as mesa type hills. These mesas are usually composed of friable sandstone with a silicified sandstone or ironstone capping, which may range in thickness from 5 to 15 feet. None of the outcrops examined is considered to warrant detailed investigation, either because of their inadequate size or because they are only partly silicified.

Several outcrops of the underlying Mereenie Sandstone are silicified and one of these warrants drilling to test the vertical extent of the silicified capping. This outcrop has an estimated volume above ground level exceeding two million cubic yards. The southern side of the occurrence shows a capping of quartzite at least 20 - 25 feet thick, the rest of the slope being covered with quartzite scree. However, the northern side of the occurrence is composed of unsilicified sandstone with a capping of quartzite only 15 feet thick.

As the area of the occurrence is approximately 220,000 square yards, the silicified capping need only be 20 feet thick to give approximately one and a half million cubic yards of ballast. A vertical diamond drill hole sited approximately in the centre of this outcrop would give an indication of the average thickness of the quartzite capping and would allow a better estimate of the available ballast material to be made. Plate 6 shows a plan of the outcrop.

.../7

The Stairway Sandstone also contains some outcrops which are partly silicified, and one of these is regarded as the most promising outcrop of quartzite for use as ballast material within this area.

This outcrop, which is situated approximately four miles north-west of No. 2 bore, appears to be completely silicified, apart from a small section of sandstone on the north-eastern side. The outcrop has a volume above ground level of approximately 700,000 cubic yards.

A vertical drill hole sited on the top of this hill would confirm whether the outcrop is silicified to ground level. Plate 5 shows a plan of the outcrop.

The Pacoota Sandstone, which forms the southern border of the James Ranges, was also found to be partly silicified in places, but, like the Hermannsburg Sandstone, outcrops were too small, or only partly silicified, and do not warrant further investigation.

Tertiary Sediments (Ts and Tc)

Tertiary sandstone (Ts) outcrops in low rises and in mesas. It ranges in type from brown or white friable sandstone and grit conglomerate to white silcrete or 'billy' (completely silicified sandstone and conglomerate). Tertiary sandstone is considered unsuitable as ballast material because the zone of silicification is only about 5 feet thick and because silicification is usually incomplete.

Tertiary conglomerate (Tc) contains pebbles of silcrete which might be suitable for ballast material, but because of the presence of a sandy matrix, it would be less suitable than the scree and gravels described below.

Quaternary scree and gravel (Qc and Qa)

Large areas of the Reserve are covered by scree composed largely of silcrete fragments (Qc). Silcrete fragments also occur as alluvial gravel (Qa) in the bed of the Hugh River. Neither of these types of deposit were investigated, but if outcrops of limestone and silicified sandstone prove unsatisfactory, sufficiently large gravel or scree deposits might be found to supply the ballast requirements.

CONCLUSIONS AND RECOMMENDATIONS

Raw material for ballast might be obtained from outcrops of silicified Palaeozoic sandstone or from outcrops of massive Proterozoic limestone. Two outcrops of sandstone and two of limestone have been selected for testing by exploratory diamond drilling. As each of these outcrops are considered to be the best of their type, unsatisfactory test results would reduce the prospects of locating adequate supplies from other outcrops of these rock units.

Because two of these outcrops are situated just outside the original Mining Reserve No. 344, the area under Reservation is being extended so as to cover from 24°20'S to 24°28'S, and from 133°42'E to 133°51'E.

.../8

The four outcrops mentioned above should be tested by diamond drilling as follows:

D.D.H. Number	Location	Direction	Depression	Length	Aim
1	Site 1 (see Plate 4)	015°MN	45°	250'	To test depth extent of massive limestone.
2	Site 2 (see Plate 5)	-	Vertical	75'	To test depth of silicification.
3	Site 3 (see Plate 6)	-	Vertical	75'	Ditto.
4	Site 4 (see Plate 7)	-	Vertical	200'	To test unexposed stratigraphic section.

Special care should be taken in all holes to obtain the maximum possible core recovery.

Subject to satisfactory drilling results the ballast raw material at each site should be sampled and representative samples sent to Commonwealth Railways for Los Angeles abrasion tests.

If these tests are also satisfactory, the reserves of ballast material at the most promising site should be determined accurately by detailed mapping and pattern drilling.

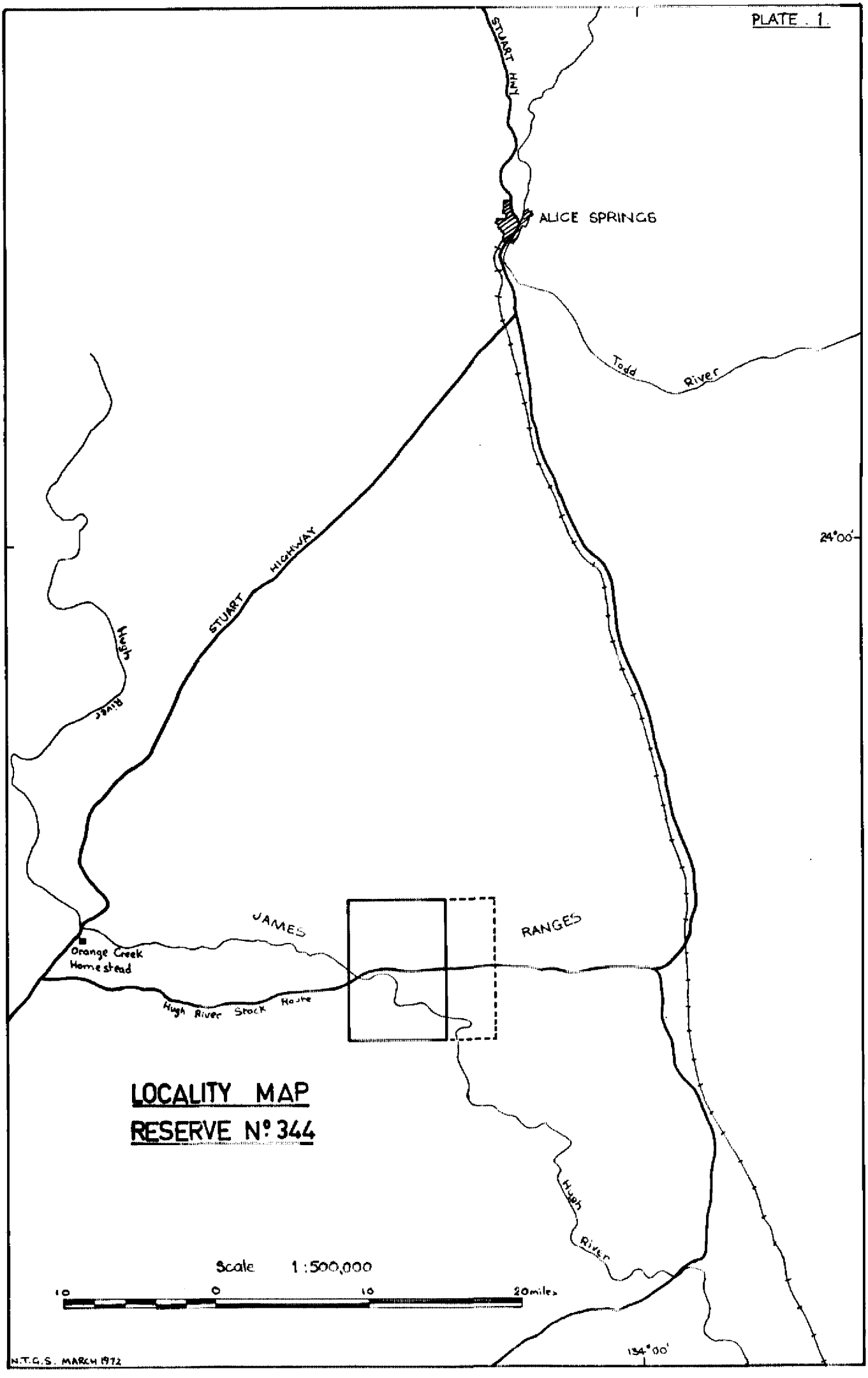
REFERENCES

COOK, P.J. 1969 Rodinga, N.T. - 1:250,000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SG/53-2.

FRUZZETTI, O. 1971 Preliminary report on a reconnaissance survey of ballast resources, Tarcoola - Alice Springs standard gauge railway, Kulgera - Alice Springs section. N.T. Geol. Surv. unpub. rep. GS279.

WELLS, A.T., FORMAN, D.J., RANFORD, L.C. and COOK, P.J. 1970 Geology of the Amadeus Basin, Central Australia. Bur. Miner. Resour. Aust. Bull. 100.

PLATE . 1.

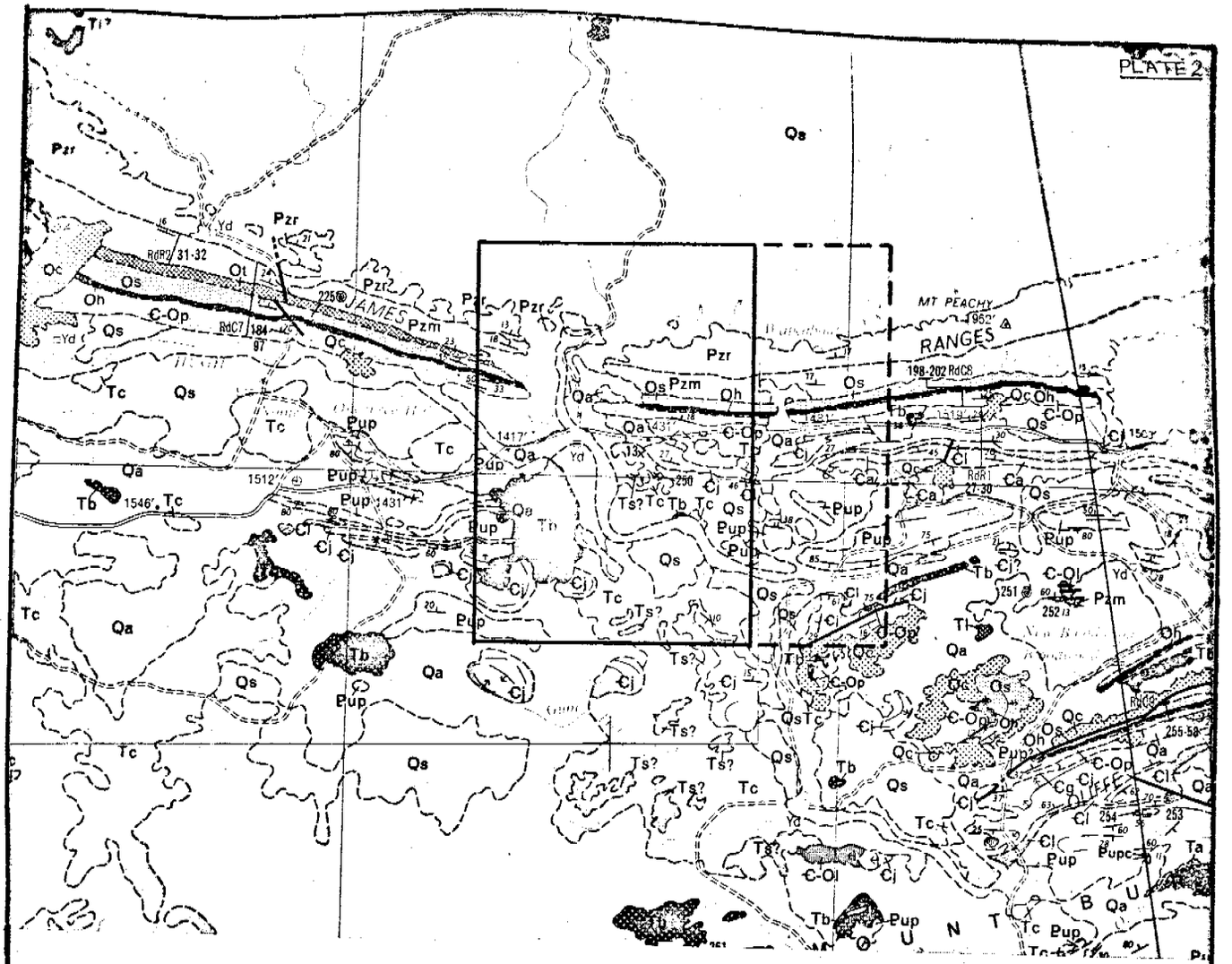


LOCALITY MAP
RESERVE Nº 344

Scale 1:500,000

10 0 10 20miles

N.T.G.S. MARCH 1972



REGIONAL GEOLOGY — RESERVE N° 344.

(from Cook 1969)

Scale 1 : 250,000

5 0 5 10

Reference (units within reserve area)

Cainozoic	Quaternary	Qa Qs Qc	- for lithology, see Table 1
	Tertiary	Tc Tb Ts	
Palaeozoic	Devonian to Carboniferous	P3r	Pertnjara Group, Hermannsburg Sandstone
	Silurian to Devonian	P3m	Mereenie Sandstone
	Cambrian to Ordovician	Ot	Larapinta Group, Stokes Siltstone
		Os	Stairway Sandstone
		Oh	Horn Valley Siltstone
		€-Op	Pacoota Sandstone
	Cambrian	€j	Pertaoorrta Group, Jay Creek Limestone
		€	Chandler Limestone
			Arumbera Sandstone
Precambrian	Proterozoic	Pup	Pertatataka Formation

PLATE 2.

RUN 6

RUN 7

RUN 8

5083

5084

5085

5154

5153

5152

5151

5150

5158

5159

5160

5161

5162

JAMES

RANGES

HUGH

RIVER

Hugh River Stockroute

Stuart Highway

approximate boundary of reserve

approximate position of reserve boundary

D.D.H. 1.

D.D.H. 2.

D.D.H. 3.

D.D.H. 4.

Per

Pzr

Pzm

Qs

ϵ-Op

ϵj

ϵl

Pup

Qc

Tc

Ts

?Tc

?Ts

?ϵ-Op

MAP OF RESERVE Nº 344

Scale 1:46,500

1000 0 1000 5,000 10,000 Feet

LEGEND

Quaternary		Qc	conglomerate
Tertiary		Tc	conglomerate
		Ts	sandstone
Devonian – Carboniferous	Hermannsburg Sandstone	Pzr	
?Silurian – Devonian	Mereenie Sandstone	Pzm	
Ordovician	Stairway Sandstone	Os	
Cambrian – Ordovician	Pacoota Sandstone	ϵ-Op	
Cambrian	Jay Creek Limestone	ϵj	
	Chandler Limestone	ϵl	
Proterozoic	Perhatatnka Formation	Pup	

Gravelled suitable for ballast, Subject to satisfactory drill results

Possible raw material for ballast

Unsuitable for ballast

Outline of James Ranges

Outcrop boundary

5154 Pharn - centre point, with number

Bore with windpump

Sand dunes

Road

Vehicle track

Fence

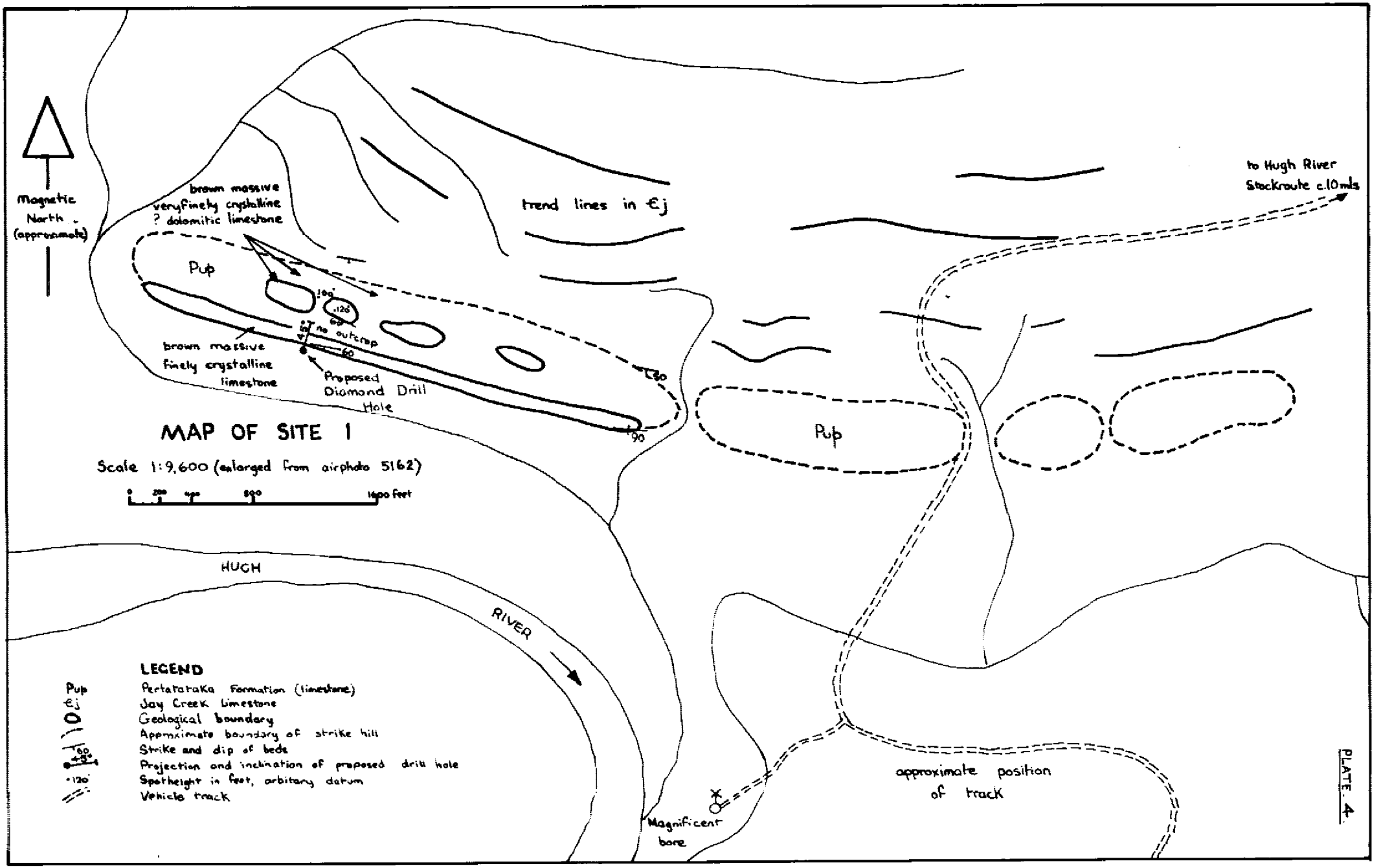
Indicates alternative railway routes

Vertical Diamond Drill Hole

Inclined " " "

True North 5° magnetic North

to Hugh River Stockroute C. 6 miles


Magnetic North (approximate)
brown massive very finely crystalline ? dolomitic limestone
Pup
trend lines in €j
to Hugh River Stockroute c.10mls
brown massive finely crystalline limestone
no outcrop
Proposed Diamond Drill Hole
MAP OF SITE 1
Scale 1:9,600 (enlarged from airphoto 5162)
0 200 400 800 1600 feet
Pup
HUGH
RIVER
LEGEND
Pup Pertatataka Formation (limestone)
€j Jay Creek limestone
Geological boundary
Approximate boundary of strike hill
Strike and dip of beds
Projection and inclination of proposed drill hole
Spotheight in feet, arbitary datum
Vehicle track
Magnificent bore
approximate position of track
PLATE 4.

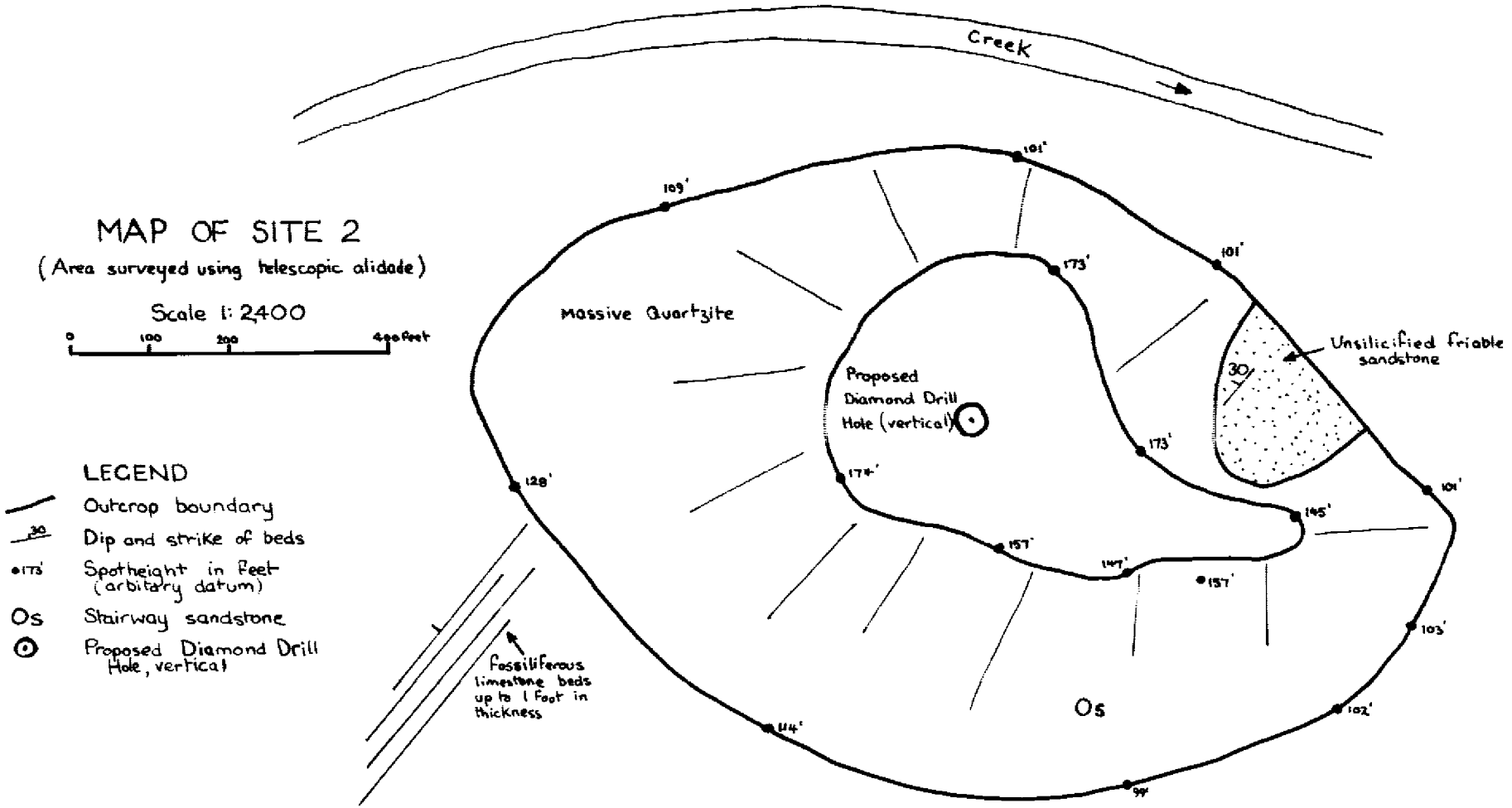
N.T.S. drawn by B.M.

MAP OF SITE 2

(Area surveyed using telescopic alidade)

Scale 1: 2400

0 100 200 400 Feet



LEGEND

- Outcrop boundary
- 30 Dip and strike of beds
- •173' Spotheight in Feet (arbitary datum)
- Os Stairway sandstone
- Proposed Diamond Drill Hole, vertical

PLATE 5.

MAP OF SITE 3

Scale 1:9,600 (enlarged from air photo 5151)

0 400 800 1600 feet

LEGEND

- Pzr — Hermannsburg Sandstone
- Pzm — Mereenie Sandstone
- Geological boundary
- -?—?- Geological boundary (inferred)
- 28 Strike and dip of beds
- ⊙ Proposed vertical drill hole
- -66' Spot height in feet (arbitary datum)
- —/—/—/ Fence line
- ======= Vehicle track

Magnetic North (approximate)

Pzr

Pzm

?—?—?—?—?

28

66

⊙ Proposed Diamond Drill Hole vertical

only partly silicified sandstone

to Walkabout bore 1 mile

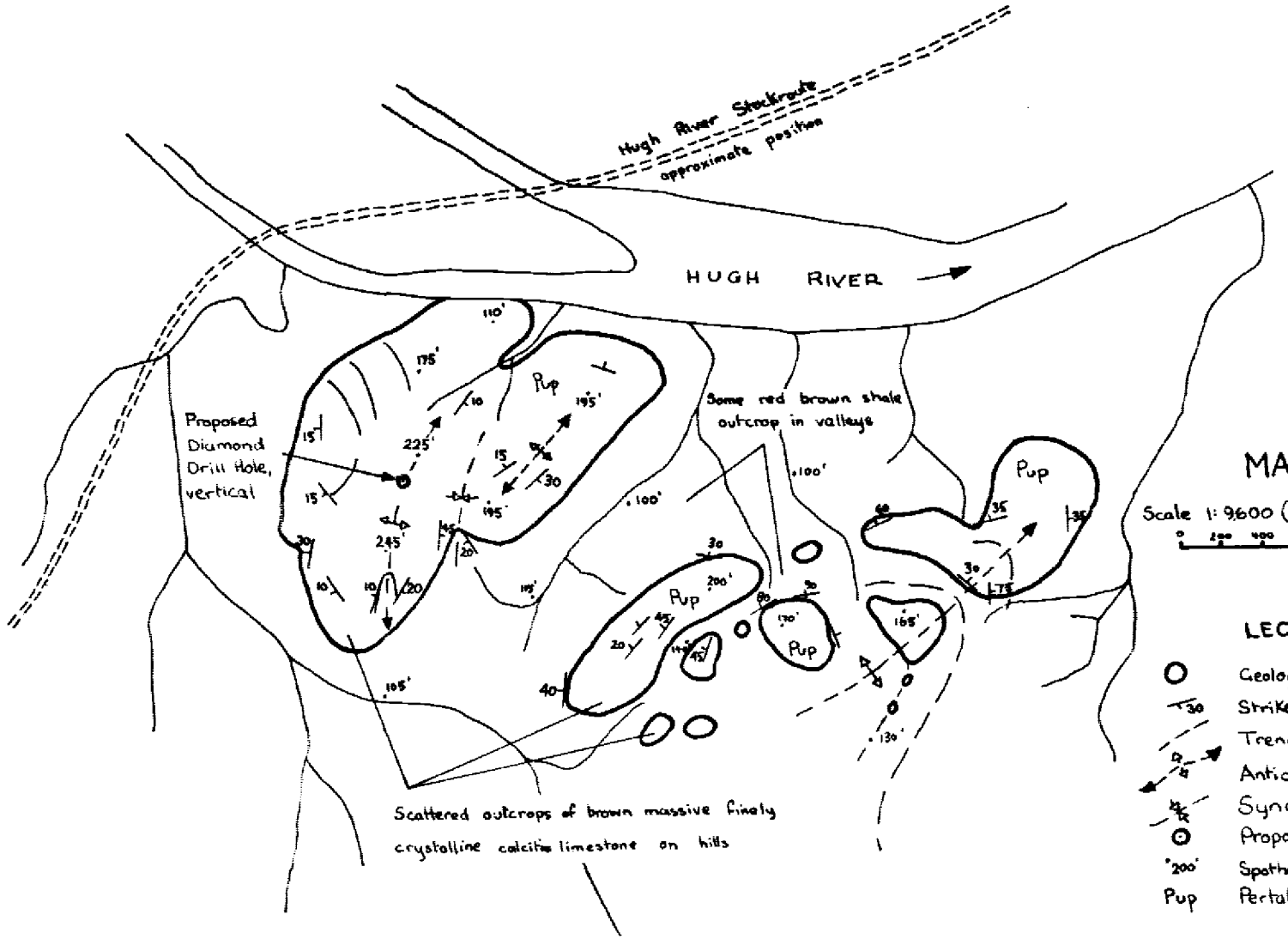
Outcrops of Mereenie Sandstone completely silicified on southern side but only partly silicified on northern side (top 15 feet)

Partly silicified Mereenie sandstone

to Hugh River stockroute 2 miles

DRAWN BY NTGS DH

NTGS drawn by DH



MAP OF SITE 4

Scale 1: 9600 (enlarged from air photo 5159)

0 200 400 800 1600 Feet

LEGEND

- Geological boundary
- 30 Strike and dip of beds
- Trend lines
- Anticline, with plunge
- Syncline
- Proposed vertical drill hole
- 200' Spotheight in Feet, arbitary datum
- Pup Pertatataka Formation

PLATE 7