COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1964/159

McARTHUR RIVER ELECTROMAGNETIC SURVEY,

NORTHERN TERRITORY 1963

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FOREWORD

In connexion with the Special Mineral Survey programme in the Northern Territory, a geophysical survey using electromagnetic methods was made over three areas near McArthur River during September and October 1963. The Survey was made under contract to the Bureau of Mineral Resources (BMR) by J.J. Masur & Co. Pty Ltd, local agents for Aktiebolaget Elektrisk Malmletning (ABEM), Stockholm, which provided the technical services.

The report on the survey by ABEM is attached hereto, with the following amendments and omissions :

(a) The section on "Field Operations" has been omitted.

(b) The section on "Geology" has been replaced by a section prepared by BMR. As originally written, this section would have been intelligible only to persons acquainted with the geology of the area or to those having access to the more comprehensive descriptions prepared by the Geological Branch of BMR or by the geological staff of Carpentaria Exploration Co. Pty Ltd.

(c) Of the 47 plates accompanying the report, only Plates 1, 2A, 2B, 2C, and 17 are reproduced. Plate 1 is a general locality plan. The other plates are included as examples of the plates accompanying the report. A list of all the 47 plates is given in Appendix B.

(d) The report has been edited to conform to BMR practices.

The full text of the report and all plans are held in the Geophysical Branch of the Bureau of Mineral Resources.

SUMMARY

At the request of the Bureau of Mineral Resources, Geology & Geophysics, Actiebolaget Elektrisk Malmletning made a geophysical survey between 17th August and 30th October 1963 in the McArthur River area, Northern Territory, about 50 miles south-west of the Gulf of Carpentaria. Three separate areas, totalling 6.7 sq. miles, were investigated.

The problem was the location of a stratum containing pyrite and sulphides of copper, zinc, and lead. The Turam method of geophysical exploration was used as a complement to previous geochemical surveys.

Owing to a conductive overburden, a large number of anomalies were obtained. However, a list is made of anomalies from deeper-seated conductors, which may indicate the probable courses of pyritic shales. A number of drill holes are recommended to investigate these anomalies.

1. INTRODUCTION

Lead-zinc-copper mineralisation in the area of the McArthur River Homestead was first discovered in 1887, and by 1891 the area had been well prospected for silver, but without success. Interest in the area revived in 1909, when Cook's deposit was drilled, and again in 1953, when Bald Hills prospect was drilled by Consolidated Zinc Pty Ltd. Little systematic work was done in the field until Mount Isa Mines began a programme of mapping and prospecting in 1955. Two promising prospects, the Reward and H.Y.C., were discovered. Subsequently the Reward was abandoned, but drilling was still being done at H.Y.C. in 1963 by Carpentaria Exploration Co. Pty Ltd (CEC), a subsidiary company of Mount Isa Mines Ltd.

In 1958 the Bureau of Mineral Resources (BMR) carried out a geophysical survey of the Reward lease (Horvath, 1959). The following year the BMR made a reconnaissance gravity survey from Normanton, Queensland, to Daly Waters, Northern Territory (Neumann, 1964), crossing the Bauhinia Downs 1:250,000 map area, which includes the McArthur River area. Detailed mapping of an Authority to Prospect of 600 square miles around McArthur River Homestead was begun by geologists of CEC in the same year. Since 1961, a geochemical survey has been carried out in the McArthur River Homestead area by BMR and CEC. Some parts of the area have also been geophysically surveyed by CEC.

In connexion with a Turam and Turam Transformer survey at Pine Creek, ABEM was requested by BMR to carry out a Turam survey of three sections of the McArthur River area during the dry season in 1963.

The geophysical survey was made by two ABEM geophysicists in collaboration with J.J. Masur & Co. Pty Ltd, Melbourne, who was the main contractor, and who also did the land surveying.

2. GEOLOGY

The McArthur River mineralised area is part of the Bauhinia Downs 1:250,000 map area, the geology of which has been described by Smith (1962) and is summarised below.

The dominant structure is the McArthur Basin, which extends for a considerable distance north and south of the area. Over a small area, cutcrops of a volcanic sequence, the Scrutton Volcanics, occur. These have been tentatively referred to the Lower Proterozoic. Apart from these, the oldest rocks are the Tawallah Group, a sequence generally about 10,000 feet thick, composed mainly of sandstone, with minor dolomite and volcanics. This is followed in age by the McArthur Group, also about 10,000 feet thick, composed mainly of dolomite. The groups are conformable in the Bauhinia Downs map area, but an unconformable relation exists elsewhere. The McArthur Group forms the main outcrop over a north-south strip, occupying the central one-third of the area. East and west of these outcrops, the McArthur Group is overlain with slight unconformity by the Roper Group, also about 10,000 feet thick and composed predominantly of sandstone.

Each of these three groups is assigned to the Upper Proterozoic. In the eastern and western portions of the area they are overlain mostly by minor thicknesses of flat-lying rocks of ages varying from Cambrian to Recent.

The mineralisation occurs in the McArthur Group. The sequence of deposition was complex, but the first major episode appears to have been the deposition of the Mallapunyah Formation (up to 2700 feet thick), transitional between the arenaceous Tawallah Group and the predominantly carbonate McArthur Group. This was followed by the deposition of widespread carbonate mud, accompanied by the growth of large algal biostromes and by much slumping. This resulted in the Amelia Dolomite, which is up to 6000 feet thick. Several later tectonic episodes were followed by the deposition of thinner layers of local dolomite and sandstone. The Amelia Dolomite contains a sub-formation, the Barney Creek Member, to which the mineralisation is restricted, and which, incidentally, contains the only volcanics of the McArthur Group.

The structure within the McArthur Group is complex. Folding is generally gentle, with dips of the order of 20°, but the rocks are much broken by minor faults. As the area is mainly covered with soil, the mineralised formation is difficult to trace. The ore minerals are confined to pyritic shale containing disseminated galena and sphalerite at depth. At the surface, complete removal and oxidation of the sulphide minerals has taken place. The areas for survey were selected on the basis of geological mapping, which suggested the presence of folded structures in which the mineralised formation might be present at depth.

3. THE PROBLEMS AND THE GEOPHYSICAL METHODS USED

The problem was the location of the H.Y.C. pyritic shale layer in the different areas. Because of the pyrite and the other sulphide ingredients, the layer is an electrical conductor, which makes possible the use of electrical prospecting methods. The Bureau of Mineral Resources chose the Turam electromagnetic method for the survey. Occasionally an EM Gun was used for reconnaissance.

Turam survey

In the Turam method, a primary alternating electromagnetic field is set up by an alternating current flowing in a long straight cable laid out on the ground, and grounded at both ends. A portable motor/generator set feeds the alternating current into the cable, which forms a circuit with the conducting paths in the ground. Instead of a grounded cable an insulated rectangular or circular loop may be used. In both instances the strength of the field can be computed at any point.

If there is a conductive body within the primary field, a secondary current will be induced in the body. This secondary current produces a secondary field, which together with the primary field produces a resultant field of different amplitude and phase from the primary field. At a given point the resultant field has a definite direction and a magnitude proportional to the strength of the current in the cable. Usually only the vertical component of the field vector is measured. In practice, the field strengths at two consecutive observation stations on a traverse at right angles to the cable are compared by means of a receiver coil at each station and a compensator-amplifier unit. After adjustments have been made for minimum signal, by use of a stethoscope as a null indicator, the ratio of the two field strengths can be read directly from one dial of the compensator and the phase difference between the alternating electromagnetic fields at the two observation stations can be read directly from a second dial.

The observed amplitude ratio is corrected for distance from the primary cable by dividing it by the calculated normal amplitude ratio of the primary field at that distance. The reduced ratio will be unity if no conductor is present and greater or less than unity above a conductor, depending on which of the two receiver coils is nearer the conductor.

The phase difference reaches a negative maximum above a conductor and turns positive away from the conductor. The relation between the reduced ratio and the phase difference varies with the conductivity; very good conductors cause strong ratio anomalies and weaker phase difference anomalies, whereas for poorer conductors the phase differences will be more pronounced.

For the creation of the primary electromagnetic field, a grounded cable was used. The advantage of a grounded cable is that the conductors within the area to be surveyed act as paths for the galvanic current between the grounded ends of the cable. The galvanic current adds to the induced current, and the anomalies are intensified. To improve the grounding and to amplify the return currents through the ground in Area No. 2, which was difficult to survey, completed drill holes, drilled by CEC, were used for the grounding of the cable in the cable layouts at 23E, 32E, 43E, 54E, and 76E.

The survey was started in Area No. 1S using a coil separation of 100 ft, but on the first traverse the distance had to be changed to 50 ft because of high readings that were beyond the capacity of the Turam compensator. A new attempt to use a coil separation of 100 ft was made in Area No. 2 with the primary cable at 23E. This was satisfactory on Traverses 0S, 4S, 8S, and 12S, but on Traverse 16S the distance had to be decreased again to 50 ft.

The frequency of 660 c/s was used as a standard, since it gave sharper readings than the lower frequency of 220 c/s. For comparison, a few traverses were surveyed with both frequencies. Elsewhere, some observation points with high readings were surveyed with both frequencies. The complete list of stations surveyed with both 660 c/s and 220 c/s is as follows:

Area No. 1S. Traverse 0W: 1.5N-21.5N with 100-ft coil separation and 0.75N-9.75N with 50-ft coil separation.

Traverses 4W, 8W, 12W, and 16W: 0.75N-21.75N.

Traverse 28W: 2.75S.

Traverse 52W: 13.75N.

Traverse 72W: 4.75S-5.75S.

Traverse 76W: 4.25N and 11.25N.

Traverse 4E: 0.75N-7.75N.

Area No. 1 NW. Traverse 44NE: 8.75SE-10.25SE.

Area No. 1 N. Traverse 28E: 1.25S-14.75S.

Traverse 60E: 5.25S-12.75S.

Area No. 2. (Primary cable at 23E).
Traverse OS: 13.25S, 13.75S, 14.75S, and 15S-20S (15S-20S surveyed with 100-ft coil separation).

EM Gun survey

The Electromagnetic Gun is, like Turam, an equipment for ore prospecting by the electromagnetic inductive method. It is portable and can be operated by two men. The transmitter unit, for setting up the primary field, consists of a transistorised oscillator and a transmitter coil wound on a ferrite core. The measurements are made with a receiver unit consisting of a receiver coil and a compensator-amplifier unit. A pair of headphones connected to the amplifier serve as a null instrument when measuring. The transmitter unit is connected to the compensator-amplifier unit by a cable, which serves to deliver to the compensator a reference voltage proportional to the primary field. The cable may also be used as a measure of the distance between observation points. The voltage induced at the receiver coil is compared with the reference voltage by means of the bridge system of the compensator. The bridge consists of potentiometers and variometers, and when these have been adjusted for balance by means of the null instrument, the in-phase (real) and out-of-phase (imaginary) components of the induced voltage at the receiver coil can be read from two dials. As the dials are calibrated in percentage of the reference voltage, the readings also express the real and imaginary components of the "secondary" (secondary + primary) field as percentages of the primary field.

The scale readings show directly where conductors occur, as these cause deviations from 100% and 0% in the real and imaginary components respectively. Deviations in the real component may also be caused by altitude or separation differences between the two coils. Changes in the imaginary component are therefore more indicative of a conductor. Anomalies caused by vertical and steeply dipping, sheet-like conductors are characterised by negative imaginary values and real values of less than 100%. When applying a vertical field to horizontal conductors and measuring the vertical field vector, real values smaller or larger than 100%, and positive or negative imaginary values will be obtained, depending on the depth to, and the conductivity of, the conductor. On ordinary surface-conductors (conductive overburden), real values larger than 100% and positive imaginary values will be obtained; the deviations from 100% and 0% are, however, small and amount only to a few percent.

The EM Gun equipment used at McArthur River was tuned for frequencies of 1760 c/s and 440 c/s. Traverse 28S in Area No. 2 was surveyed with both frequencies and all other traverses with 1760 c/s only. The coil separation was 200 ft and the corresponding depth range was 140 ft for vertical or steeply dipping conductors and 300 ft for horizontal or gently dipping conductors.

Large elevation differences occurred on Traverse C and on part of Traverse B in Area No. 1SW. Terrain corrections have been applied to the real readings.

4. DISCUSSION OF RESULTS

Plate 1 is a plan of the whole of the McArthur River area (scale 1 in = 1000 ft), showing the survey grids, the principal topographic and geologic features, and the positions of the axes of electrical conductors located by the Turam and EM Gun survey.

Plates 2-16 (scale 1 in = 200 ft), show divisions of the geophysical grids, Plates 2-4 for Area No. 1S, Plates 5 and 6 for Area No. 1NW, Plates 7-9 for Area No. 1N, Plates 10-15 for Area No. 2, and Plate 16 for Area No. 3. For each division, the profiles of Turam normalised ratio and phase difference have been plotted on a plate denoted by the letter "A", the contours of Turam ratio on a separate plate marked "B", and the contours of phase difference on a third plate marked "C".

The profiles of real and imaginary components obtained by the EM Gun survey are shown in Plate 17.

Turam survey

A large number of Turam anomalies were obtained, particularly in Areas Nos. 2 and 3. Most of the anomalies are probably due to conductive overburden. An old wire fence in Area No. 1S and newly erected fences in Area No. 2 also caused anomalies, but these anomalies can easily be recognised. Traverse 12S in Area No. 2 was surveyed with the fence wires cut and then resurveyed after the fence had been mended; the results showed that the influence from the fence was considerably reduced by cutting the wires. Consequently the fence wires in Area No. 2 were generally cut where they crossed a traverse.

Black soils and rusty soils occur in different places in the surveyed areas. It is believed, however, that these soils, like sand and gravel, are almost non-conductive in the surface layer above the ground water level, which was reported to be at a depth of 20-30 ft. On the other hand, all overburden and fissured rock below ground water level are soaked with more or less conductive solutions. The ground constitutes a conductor of varying thickness and conductivity, depending on the height of the ground water level, the configuration of the bedrock surface, the amount of fissures in it, and the varying strength of the solution.

However, when consideration is taken of the geological assumptions, some of the anomalies may be interpreted as corresponding to conductive pyritic shale. Suspected indication courses are listed in Appendix A. The axes of the conductors (current concentrations) are denoted by Roman figures. The Z co-ordinate is the computed depth to the current concentration, R is the normalised ratio, and ϕ the phase difference per 50 ft distance. Q denotes the quality of the conductor (i.e. the thickness of the conductor multiplied by the conductivity) divided into three grades - low (L), medium (M), and high (H). In the grading, both the normalised ratio and the depth to the current concentration have been taken into account.

All the listed anomalies correspond to deeper-seated conductors, with depths ranging from 50 to 250 ft. Shallower conductors are more likely to consist of conductive overburden.

EM Gun survey

In Area No. 1S no prominent EM Gun anomalies were obtained, either on traverse 16W or on traverse 36W. In Area No. 1SW the EM Gun survey was a substitution for Turam survey. On Traverse A, anomalies at 9.5SW (R = 106%, I = +14%) and at 21.5SW (R = 103%, I = +13%) were obtained. The values indicate a horizontal position of the conductor. On Traverse B, anomalies occur at 10.8SW (R = 101%, I = +6%), 13.2SW (R = 98%, I = -5%), and at 20.2SW (R = 101%, I = +11%). The first and third anomalies originate from horizontal conductors and the second from a dipping conductor. On Traverse C, anomalies were obtained at 12.0SW (R = 93%, I = -9%) and at 27.0 SW (R = 96%, I = -6%), both from dipping conductors.

In Area No. 2, Traverse 28S, anomalies were obtained at 2.5W (R = 86%, I = -3%), 17.8E (R = 97%, I = -13%), 30.5E (R = 104%, I = +13%); and 59.6E (R = 92%, I = -11%). The third anomaly originates from a horizontal conductor, the others from dipping conductors. All of them coincide with Turam anomalies. Traverses 96S and 100S were surveyed because of a strong Turam anomaly on Traverse 92S, but the EM Gun anomalies obtained evidently originated from the wire fence.

5. CONCLUSIONS AND RECOMMENDATIONS FOR TESTING.

Owing to conductive solutions below the ground water level, a large number of anomalies were obtained. Anomalies from deeper-seated conductors have been listed in Appendix A. They indicate the probable courses of pyritic shales. Several alternative courses have been included. In Area No. 2 numerous short anomaly-courses appear.

In the eastern end of Area No. 1S, the geophysical results show that the pyritic layer is to be found more to the south than anticipated. In Areas Nos. 1NW and 1N, the positions of the geophysical anomalies, taken as a whole, correspond to the anticipated position of the pyritic layer and to the Bald Hills fault.

In Area No. 2, anomalies were obtained almost everywhere on account of the conductive overburden. Here it is therefore difficult to recognize the folded pyritic layer as pictured by the geologists.

Area No. 3 is wholly disturbed. In addition, some of the indications are relatively strong. It is assumed that most of the anomalies obtained in this area originate from conductive overburden.

For testing, a number of diamond-drill holes are recommended. Anomalies to be tested are denoted by a DDH No. in the right-hand column of Appendix A. Co-ordinates, length, direction, and depression of the proposed drill holes are listed below:

List of proposed diamond-drill holes

DDH No.	Area No.	Plate	Co-ordinates X	Co-ordinates Y	Length in ft	Direction	Depression
1	1S	2	4W	3.35N	160	S	60°
2			20W	0.2 N	300	S	60°
3		3	60W	1.75N	250	S	60°
4			64W	1.5 N	260	S	60°
5		4	108W	6.05S	180	S	60°
6			100W	14.3 N	150	S	60°
7	1NW	5	12NE	8.15SE	200	NW	60°
8			12NE	10.05SE	180	NW	60°
9		6	44NE	10.6 SE	200	NW	60°
10			60NE	13.35SE	150	NW	60°
11	1N	7	20E	5.4 S	150	N	60°
12			16E	13.15S	200	N	60°
13		8	60E	9.05S	240	N	60°
14			44E	12.15S	240	N	60°
15		9	80E	10.5 S	180	N	60°
16	2	10	0	15.75E	320	W	60°
17			36S	4.3 W	220	W	60°
18		11	68S	2.25E	200	-	90°
19			76S	11.2 E	220	E	60°
20		12	8S	29.9 E	350	W	60°
21			4S	36.85E	240	W	60°
22		13	76S	23.1 E	160	-	90°
23		14	4S	58.5 E	200	-	90°
24		15	92S	76.2 E	200	W	60°
25	3	16	12E	18.1 N	200	S	60°
26			0	11.6 N	220	S	60°
27			20W	11.3 N	240	S	60°

Further diamond drilling will depend on the results obtained from the 27 test holes. If any one of these holes enters the pyritic shale, it is recommended that further holes be drilled along the indication courses shown in Plate 1.

7. ACKNOWLEDGEMENTS

It is desired to express appreciation to the staff of the Bureau of Mineral Resources for providing the maps and reports used as the basis for the present report, to Mr. G. Marlow, geologist in charge of the McArthur River Camp, who provided geological information, to Mr. J.J. Masur, Managing Director of J.J. Masur & Co. Pty Ltd, and to the surveyor, Mr. J. Jackson, for their willing collaboration and attention to the needs of the party.

Stockholm, 20th May 1964.

ABEM - AB Elektrisk Malmletning

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APPENDIX A

A list of noticeable Turam anomalies

Area	Plate	Axis	Co-ordinates X	Y	Z	R	ø	Q	DDH
1 S	2	I	4 E	3.5 N	100	1.07	-7	M	
			0	3.5 N	130	1.10	-2	M	
			4 W	2.75 N	80	1.59	-28	H	No. 1
			8 W	1.25 N	120	1.10	-8	M	
			12 W	1.0 N	120	1.14	-10	H	
			16 W	1.2 S	90	1.07	-8	M	
			20 W	1.2 S	210	1.06	-8	M	No. 2
			24 W	1.75 S	80	1.04	-4	L	
			28 W	1.6 S	100	1.07	-5	M	
			32 W	2.75 S	100	1.03	-4	L	
			36 W	3.4 S	100	1.07	-5	M	
	3	I	40 W	2.75 S	140	1.08	-6	M	
			44 W	2.6 S	160	1.08	-6	M	
			48 W	1.75 S	90	1.07	-5	M	
			52 W	1.75 S	90	1.07	-5	M	
			56 W	2.0 S	90	1.08	-5	M	
		II	48 W	0.6 S	90	1.10	-8	M	
			52 W	0.5 S	110	1.04	-3	L	
			56 W	0.25 S	60	1.06	-4	L	
			60 W	0.75 N	150	1.11	-7	H	No. 3
			64 W	0.3 N	190	1.12	-6	H	No. 4
		III	64 W	5.75 S	60	1.08	-5	L	
			68 W	6.25 S	90	1.16	-9	M	
		IV	68 W	5.25 S	50	1.20	-5	M	
			72 W	5.25 S	60	1.14	-15	M	
			76 W	6.75 S	120	1.07	-7	M	
			80 W	6.5 S	150	1.04	-4	M	
			84 W	7.0 S	110	1.04	-5	L	
		V	76 W	4.25 N	60	1.05	-8	L	
			80 W	4.25 N	70	1.04	-5	L	
			84 W	3.2 N	110	1.07	-8	M	
		VI	76 W	11.25N	70	1.10	-10	M	
			80 W	11.25 N	90	1.12	-8	M	
			84 W	12.7 N	100	1.07	-6	M	
		VII	80 W	13.1 N	110	1.09	-6	M	
			84 W	14.75 N	90	1.10	-9	M	
	4	I	88 W	7.0 S	100	1.03	-4	L	
			92 W	6.9 S	120	1.04	-5	L	
			96 W	6.6 S	90	1.03	-3	L	
			100 W	6.25 S	90	1.09	-6	M	
			104 W	6.75 S	100	1.03	-4	L	
			108 W	6.75 S	100	1.06	-6	M	No. 5
		II	88 W	14.0 N	120	1.05	-3	M	
			92 W	16.0 N	160	1.06	-4	M	
			96 W	17.25 N	80	1.09	-5	M	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	ø	Q	DDH
		III	96 W	12.5 N	140	1.05	-3	M	
			100 W	13.7 N	90	1.08	-7	M	No. 6
			104 W	14.75 N	100	1.05	-4	L	
			108 W	16.75 N	110	1.08	-6	M	
			112 W	17.25 N	100	1.05	-5	L	
			116 W	18.4 N	130	1.09	-8		
		IV	112 W	15.25 N	130	1.05	-5	M	
			116 W	16.6 N	120	1.11	-7	M	
			120 W	17.6 N	130	1.08	-5	M	
			124 W	18.0 N	130	1.05	-4	M	
			128 W	18.75 N	100	1.04	-3	L	
I NW	5	I	4 NE	8.0 SE	110	1.04	-5	L	
			8 NE	7.6 SE	140	1.08	-6	M	
			12 NE	7.25 SE	125	1.10	-6	M	No. 7
			16 NE	7.25 SE	115	1.07	-4	M	
			20 NE	5.75 SE	65	1.07	-7	L	
			24 NE	4.3 SE	80	1.03	-5	L	
		II	8 NE	9.25 SE	120	1.10	-9	M	
			12 NE	9.25 SE	110	1.11	-10	M	No. 8
			16 NE	9.25 SE	90	1.10	-7	M	
			20 NE	9.25 SE	100	1.08	-7	M	
			24 NE	9.75 SE	90	1.04	-5	L	
			28 NE	10.8 SE	90	1.05	-3	L	
			32 NE	10.5 SE	110	1.12	-6	M	
		III	16 NE	11.25 SE	90	1.09	-9	M	
			20 NE	11.25 SE	100	1.05	-6	L	
			24 NE	11.75 SE	70	1.07	-6	L	
			28 NE	12.25 SE	50	1.15	-10	M	
			32 NE	12.25 SE	80	1.04	-2	L	
		IV	24 NE	12.75 SE	90	1.07	-9	M	
			28 NE	14.25 SE	70	1.12	-10	M	
			32 NE	14.25 SE	60	1.04	-1	L	
	6	I	36 NE	10.25 SE	90	1.12	5	M	
			40 NE	10.25 SE	90	1.12	6	M	
			44 NE	9.8 SE	120	1.31	13	H	No. 9
		II	36 NE	11.25 SE	160	1.09	-5	M	
			40 NE	11.25 SE	140	1.16	-8	H	
		III	48 NE	6.25 SE	90	1.14	-7	M	
			52 NE	8.75 SE	80	1.06	-5	L	
			56 NE	10.75 SE	100	1.09	-8	M	
			60 NE	12.75 SE	90	1.31	-20	H	No. 10
			64 NE	15.5 SE	130	1.17	-15	H	
			68 NE	18.4 SE	160	1.12	-9	H	
I N	7	I	0	2.25 S	90	1.10	-6	M	
			4 E	2.25 S	200	1.09	-5	H	
			8 E	2.6 S	120	1.08	-5	M	
			12 E	3.1 S	170	1.07	-5	M	
			16 E	3.75 S	120	1.07	-4	M	
			20 E	3.75 S	100	1.07	-3	M	
			24 E	4.6 S	140	1.07	-4	M	
			28 E	5.25 S	100	1.08	-6	M	
			32 E	7.25 S	150	1.07	-4	M	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	∅	Q	DDH
		II	0	3.25 S	130	1.15	-8	H	
			4 E	3.9 S	100	1.09	-7	M	
			8 E	3.25 S	130	1.08	-7	M	
			12 E	4.75 S	80	1.07	-6	M	
			16 E	4.75 S	70	1.10	-9	M	
			20 E	4.75 S	90	1.18	-13	H	No. 11
			24 E	6.75 S	80	1.13	-13	M	
			28 E	7.0 S	110	1.06	-6	M	
			32 E	8.25 S	70	1.07	-5	L	
		III	0	11.25 S	130	1.11	-8	M	
			4 E	12.25 S	100	1.06	-6	M	
			8 E	12.25 S	90	1.08	-7	M	
			12 E	12.75 S	60	1.14	-14	M	
			16 E	12.3 S	130	1.14	-11	H	No. 12
			20 E	12.25 S	70	1.20	-14	M	
			24 E	12.0 S	80	1.22	-18	H	
			28 E	11.25 S	90	1.16	-15	M	
			32 E	10.75 S	100	1.12	-8	M	
	8	I	36 E	7.4 S	110	1.07	-4	M	
			40 E	7.75 S	110	1.12	-8	M	
			44 E	7.25 S	110	1.05	-4	L	
			48 E	7.75 S	60	1.06	-5	L	
		II	36 E	8.75 S	90	1.06	-4	L	
			40 E	8.75 S	100	1.09	-7	M	
			44 E	8.25 S	80	1.09	-7	M	
			48 E	8.75 S	110	1.12	-8	M	
			52 E	8.25 S	80	1.34	-14	H	
			56 E	8.25 S	80	1.24	-11	H	
			60 E	8.25 S	130	1.20	-11	H	No. 13
			64 E	8.25 S	130	1.18	-11	H	
			68 E	8.1 S	150	1.20	-11	H	
		III	36 E	10.75 S	100	1.20	-12	H	
			40 E	11.1 S	200	1.17	-10	H	
			44 E	11.1 S	160	1.20	-9	H	No. 14
			48 E	10.75 S	100	1.29	-11	H	
			52 E	10.25 S	100	1.20	-22	H	
			56 E	10.25 S	80	1.08	-11	M	
			60 E	9.3 S	130	1.16	-18	H	
			64 E	9.7 S	90	1.09	-13	M	
			68 E	9.25 S	70	1.06	-3	L	
		IV	64 E	6.75 S	130	1.14	-8	H	
			68 E	6.75 S	130	1.08	-3	M	
	9	I	72 E	8.9 S	140	1.15	-9	H	
			76 E	9.75 S	80	1.14	-8	M	
			80 E	9.75 S	120	1.08	-5	M	No. 15
			84 E	9.75 S	100	1.04	-4	L	
			88 E	9.75 S	100	1.06	-4	M	
2	10	I	0	14.25 E	250	1.47	-20	H	No. 16
			4 S	13.1 E	140	1.12	-5	H	
		II	0	10.9 E	110	1.09	-7	M	
			4 S	10.6 E	130	1.15	-7	H	
			8 S	9.0 E	110	1.14	-6	M	
			12 S	8.4 E	100	1.20	-14	H	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	ϕ	Q	DDH
		III	32 S	5.0 W	110	1.04	-4	L	
			36 S	5.25 W	150	1.10	-10	M	No. 17
			40 S	5.2 W	85	1.16	-12	M	
	11	I	44 S	5.4 W	110	1.05	-6	L	
			48 S	5.25 W	90	1.06	-6	L	
		II	48 S	8.0 E	125	1.13	-7	H	
			52 S	9.4 E	125	1.11	-5	M	
			56 S	10.1 E	140	1.18	-10	H	
			60 S	8.1 E	140	1.17	-9	H	
			64 S	5.4 E	140	1.14	-7	H	
			68 S	2.25 E	140	1.17	-8	H	No. 18
			72 S	0.75 E	110	1.12	-4	M	
			76 S	0.1 W	130	1.13	-4	H	
			80 S	0.25 E	140	1.11	-5	M	
		III	48 S	13.75 E	80	1.08	-5	M	
			52 S	13.75 E	110	1.11	-6	M	
			56 S	15.75 E	120	1.09	-6	M	
			60 S	15.25 E	100	1.09	-9	M	
			64 S	15.75 E	100	1.11	-10	M	
		IV	68 S	11.1 E	95	1.08	-4	M	
			72 S	9.75 E	75	1.08	-3	M	
			76 S	7.5 E	115	1.10	-2	M	
			80 S	7.0 E	110	1.19	-5	H	
		V	76 S	12.2 E	150	1.11	-8	H	No. 19
			80 S	8.75 E	140	1.47	-12	H	
	12	I	0	32.25 E	130	1.19	-8	M	
			4 S	29.75 E	130	1.13	-11	H	
			8 S	28.4 E	250	1.10	-8	H	No. 20
		II	0	33.5 E	150	1.19	-8	H	
			4 S	33.25 E	150	1.20	-7	H	
			8 S	33.75 E	150	1.15	-7	H	
			12 S	31.25 E	170	1.26	-13	H	
			16 S	31.75 E	150	1.16	-10	H	
			20 S	31.75 E	110	1.18	-10	H	
			24 S	30.0 E	110	1.12	-8	M	
			28 S	32.75 E	150	1.12	-7	H	
			32 S	32.25 E	100	1.10	-7	M	
			36 S	33.25 E	120	1.09	-8	M	
			40 S	33.25 E	110	1.12	-9	M	
		III	0	36.25 E	150	1.09	-3	M	
			4 S	36.0 E	140	1.13	-7	H	No. 21
			8 S	35.25 E	130	1.10	-5	N	
		IV	16 S	47.0 E	175	1.10	-6	H	
			20 S	46.8 E	140	1.09	-6	M	
		V	16 S	49.25 E	110	1.13	-10	M	
			20 S	49.5 E	140	1.10	-7	M	
			24 S	48.75 E	90	1.06	-6	L	
		VI	20 S	23.25 E	160	1.14	-8	H	
			24 S	22.75 E	170	1.10	-6	H	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	ϕ	Q	DDH
		VII	20 S	26.75 E	100	1.10	-8	M	
			24 S	27.2 E	100	1.10	-7	M	
			28 S	25.75 E	110	1.09	-6	M	
		VIII	20 S	45.25 E	100	1.30	-19	H	
			24 S	44.25 E	120	1.07	-5	M	
		IX	32 S	36.4 E	140	1.09	-8	M	
			36 S	36.8 E	130	1.08	-5	M	
			40 S	37.4 E	140	1.08	-6	M	
		X	36 S	25.75 E	160	1.10	-7	H	
			40 S	24.25 E	160	1.10	-7	H	
	13	I	44 S	38.25 E	80	1.09.	-7	M	
			48 S	38.4 E	150	1.06	-5	M	
			52 S	36.6 E	180	1.08	-7	M	
		II	44 S	48.25 E	70	1.06	-7	L	
			48 S	49.25 E	70	1.10	-10	M	
			52 S	49.75 E	75	1.09	-10	M	
		III	76 S	23.1 E	120	1.05	-4	M	No. 22
			80 S	24.1 E	160	1.04	-2	M	
	14	I	4 S	58.5 E	170	1.11	-6	H	No. 23
			8 S	60.9 E	150	1.07	-5	M	
			12 S	63.0 E	120	1.06	-3	M	
			16 S	64.2 E	130	1.09	-7	M	
			20 S	64.25 E	80	1.11	-7	M	
		II	12 S	77.25 E	60	1.05	-6	L	
			16 S	78.25 E	60	1.08	-8	L	
			20 S	79.75 E	60	1.05	-5	L	
		III	16 S	68.75 E	60	1.06	-7	L	
			20 S	70.75 E	50	1.04	-5	L	
		IV	20 S	60.75 E	80	1.10	-7	M	
			24 S	60.75 E	70	1.11	-10	M	
			28 S	59.75 E	80	1.14	-12	M	
		V	28 S	54.75 E	60	1.17	-13	M	
			32 S	54.25 E	50	1.08	-10	L	
			36 S	52.75 E	70	1.15	-12	M	
		VI	28 S	65.25 E	100	1.10	-7	M	
			32 S	65.75 E	90	1.08	-6	M	
			36 S	67.75 E	110	1.06	-5	M	
		VII	36 S	57.25 E	150	1.09	-7	M	
			40 S	55.75 E	100	1.08	-8	M	
		VIII	40 S	85.3 E	90	1.06	-5	L	
			44 S	86.3 E	90	1.01	-3	L	
	15	I	48 S	55.25 E	110	1.05	-4	L	
			52 S	55.75 E	90	1.08	-6	M	
			56 S	56.9 E	100	1.04	-6	L	
		II	52 S	59.25 E	80	1.06	-6	L	
			56 S	60.25 E	70	1.07	-6	L	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	ø	Q	DDH
		III	52 S	77.5 E	130	1.05	-4	M	
			56 S	77.75 E	100	1.06	-4	M	
		IV	56 S	64.25 E	110	1.07	-4	M	
			60 S	64.75 E	110	1.05	-3	L	
			64 S	65.6 E	120	1.07	-3	M	
		V	56 S	66.8 E	80	1.04	-4	L	
			60 S	67.2 E	90	1.08	-5	M	
			64 S	67.75 E	80	1.03	-2	L	
			68 S	69.75 E	85	1.08	-5	M	
			72 S	70.75 E	70	1.06	-5	L	
			76 S	73.0 E	100	1.04	-3	L	
		VI	60 S	70.4 E	100	1.05	-4	L	
			64 S	71.6 E	140	1.04	-2	M	
		VII	68 S	75.4 E	120	1.09	-5	M	
			72 S	78.75 E	100	1.04	-2	L	
		VIII	72 S	65.2 E	100	1.11	-5	M	
			76 S	64.75 E	100	1.10	-5	M	
		IX	72 S	73.75 E	70	1.08	-8	M	
			76 S	75.75 E	55	1.08	-4	L	
		X	80 S	75.75 E	110	1.08	-4	M	
			84 S	77.6 E	110	1.07	-5	M	
			88 S	80.0 E	150	1.08	-5	M	
			92 S	82.75 E	160	1.03	-3	L	
		XI	92 S	75.4 E	120	1.27	-13	H	No. 24
3	16	I	12 E	17.3 N	110	1.20	-10	H	No. 25
			8 E	17.75 N	110	1.23	-14	H	
			4 E	18.0 N	130	1.18	-9	H	
			0	18.75 N	90	1.09	-4	M	
			4 W	18.6 N	110	1.13	-8	M	
		II	12 E	7.25 N	110	1.25	-10	H	
			8 E	8.75 N	120	1.27	-11	H	
			4 E	9.25 N	130	1.20	-8	H	
			0	10.7 N	135	1.25	-16	H	No. 26
			4 W	11.25 N	90	1.21	-11	H	
			8 W	12.75 N	100	1.14	-9	M	
			12 W	12.75 N	130	1.13	-10	H	
			16 W	12.25 N	120	1.20	-14	H	
			20 W	12.6 N	120	1.08	-6	M	
			24 W	13.25 N	100	1.16	-11	H	
			28 W	12.25 N	160	1.14	-8	H	
			32 W	12.9 N	80	1.08	-6	M	
		III	12 E	6.3 N	100	1.17	-8	H	
			8 E	6.2 N	100	1.10	-6	M	
			4 E	6.75 N	80	1.09	-7	M	
			0	6.8 N	140	1.09	-6	M	
			4 W	7.75 N	70	1.12	-7	M	
			8 W	8.0 N	90	1.10	-5	M	
			12 W	9.0 N	150	1.15	-9	H	
			16 W	7.75 N	100	1.11	-7	M	

Area	Plate	Axis	Co-ordinates X	Y	Z	R	∅	Q	DDH
		IV	0 W	8.75 N	100	1.10	-5	M	
			4 W	10.25 N	120	1.10	-4	M	
			8 W	10.25 N	100	1.17	-9	H	
			12 W	11.75 N	100	1.12	-6	M	
			16 W	11.25 N	100	1.18	-9	H	
			20 W	10.3 N	160	1.27	-14	H	No. 27
			24 W	10.25 N	90	1.08	-5	M	
			28 W	11.3 N	110	1.15	-7	H	
			32 W	11.25 N	110	1.18	-10	H	
		V	0	15.25 N	70	1.08	-7	M	
			4 W	15.1 N	90	1.13	-13	M	
			8 W	14.9 N	110	1.08	-5	M	
		VI	24 W	14.75 N	70	1.14	-13	M	
			28 W	14.3 N	80	1.10	-9	M	

APPENDIX B

A list of illustrations accompanying the ABEM report

Plate 8A.	Profiles of Turam ratio and phase difference Area No. 1 N. Traverses 36 E - 68 E		(E53/B7-37)
8B.	Contours of Turam ratio Area No. 1 N. Traverses 36 E - 68 E		(E53/B7-38)
8C.	Contours of Turam phase difference Area No. 1 N. Traverses 36 E - 68 E		(E53/B7-39)
9A.	Profiles of Turam ratio and phase difference Area No. 1 N. Traverses 72 E - 88 E		(E53/B7-40)
9B.	Contours of Turam ratio Area No. 1 N. Traverses 72 E - 88E		(E53/B7-41)
9C.	Contours of Turam phase difference Area No. 1 N. Traverses 72 E - 88E		(E53/B7-42)
10A.	Profiles of Turam ratio and phase difference Area No.2, 8 W - 23 E. Traverses 0 - 40 S		(E53/B7-43)
10B.	Contours of Turam ratio Area No. 2, 8 W - 23 E. Traverses 0 - 40 S		(E53/B7-44)
10C.	Contours of Turam phase difference Area No. 2, 8 W - 23 E. Traverses 0 - 40 S		(E53/B7-45)
11A.	Profiles of Turam ratio and phase difference Area No. 2, 8 W - 23 E. Traverses 44 S - 80 S		(E53/B7-46)
11B.	Contours of Turam ratio Area No. 2, 8 W - 23 E. Traverses 44 S - 80 S		(E53/B7-47)
11C.	Contours of Turam phase difference Area No.2, 8 W - 23 E. Traverses 44 S - 80 S		(E53/B7-48)
12A.	Profiles of Turam ratio and phase difference Area No.2, 23 E - 54 E. Traverses 0 - 40 S		(E53/B7-49)
12B.	Contours of Turam ratio Area No.2, 23 E - 54 E. Traverses 0 - 40 S		(E53/B7-50)
12C.	Contours of Turam phase difference Area No.2, 23 E - 54 E. Traverses 0 - 40 S		(E53/B7-51)
13A.	Profiles of Turam ratio and phase difference Area No.2, 23 E - 54 E. Traverses 44 S - 80 S		(E53/B7-52)
13B.	Contours of Turam ratio Area No.2, 23 E - 54 E. Traverses 44 S - 80 S		(E53/B7-53)
13C.	Contours of Turam phase difference Area No.2, 23 E - 54 E. Traverses 44 S - 80 S		(E53/B7-54)
14A.	Profiles of Turam ratio and phase difference Area No.2, 54 E - 92 E. Traverses 0 - 44 S		(E53/B7-55)
14B.	Contours of Turam ratio Area No.2, 54 E - 92 E. Traverses 0 - 44 S		(E53/B7-56)
14C.	Contours of Turam phase difference Area No.2, 54 E - 92 E. Traverses 0 - 44 S		(E53/B7-57)

TO ACCOMPANY RECORD No. 1964/159

ABEM

PLAN OF Mc ARTHUR RIVER AREA, N T

AXES OF ELECTRICAL CONDUCTORS

LOCATED BY TURAM SURVEY

E53/B7-18

APRIL 1964	Y.L / L.K		PLATE 1

SCALE

FEET 200 0 200 400 600 FEET

ABEM

Mc ARTHUR RIVER AREA, N T

PROFILES OF TURAM RATIO AND PHASE DIFFERENCE

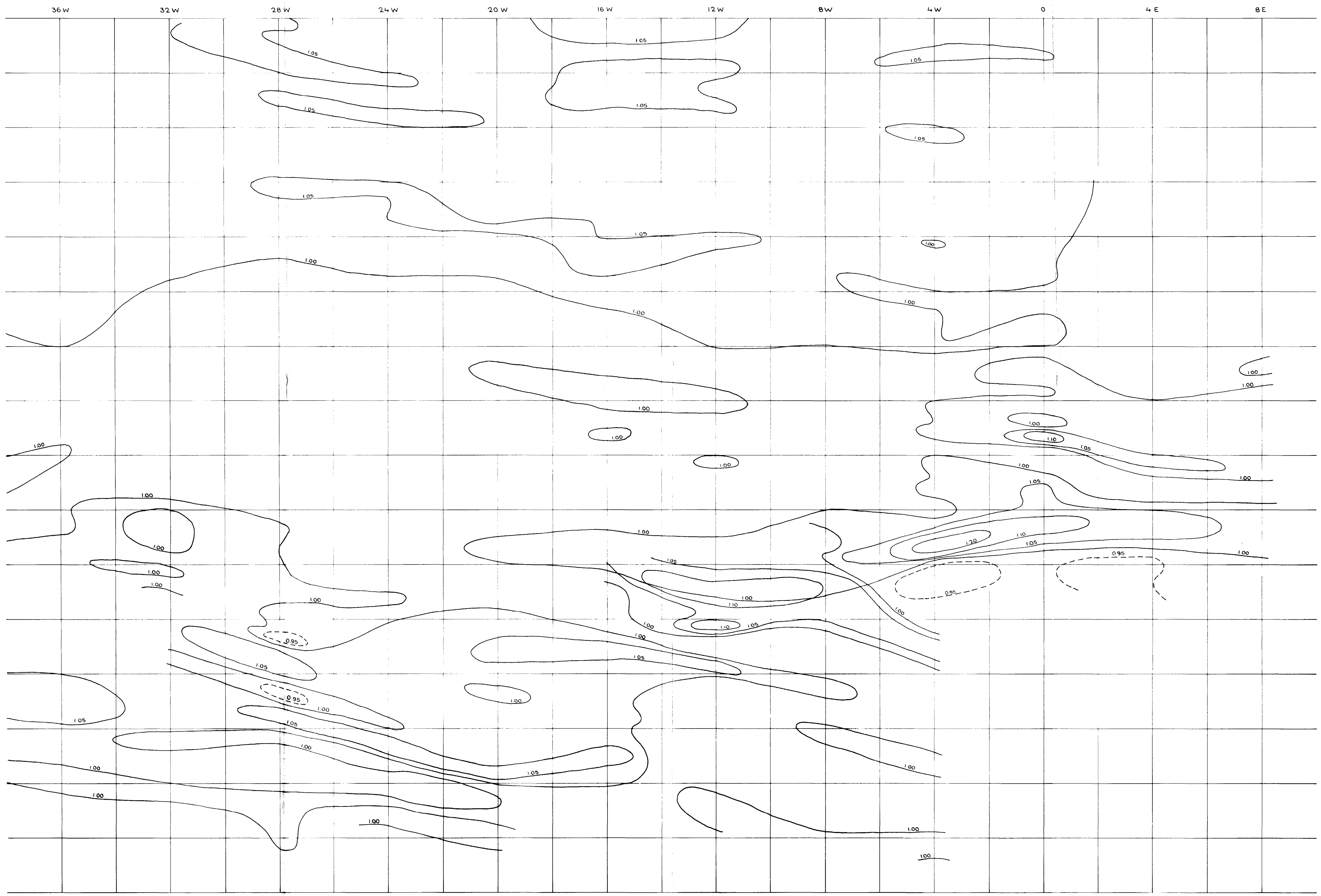
AREA No. 1S. TRAVERSES 8E-36W

E53/B7-19

APRIL 1964	Y.L/MB.J		~~PLATE 2A~~

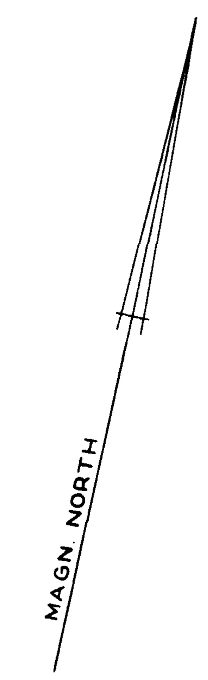
TO ACCOMPANY RECORD No. 1964/159

PLATE 3



LEGEND:

CONTOURS OF TURAM RATIOS
1.05, 1.00, AND 0.95 PER 50 FT.



SCALE

200 0 200 400 600
FEET FEET

ABEM

Mc ARTHUR RIVER AREA, N.T.

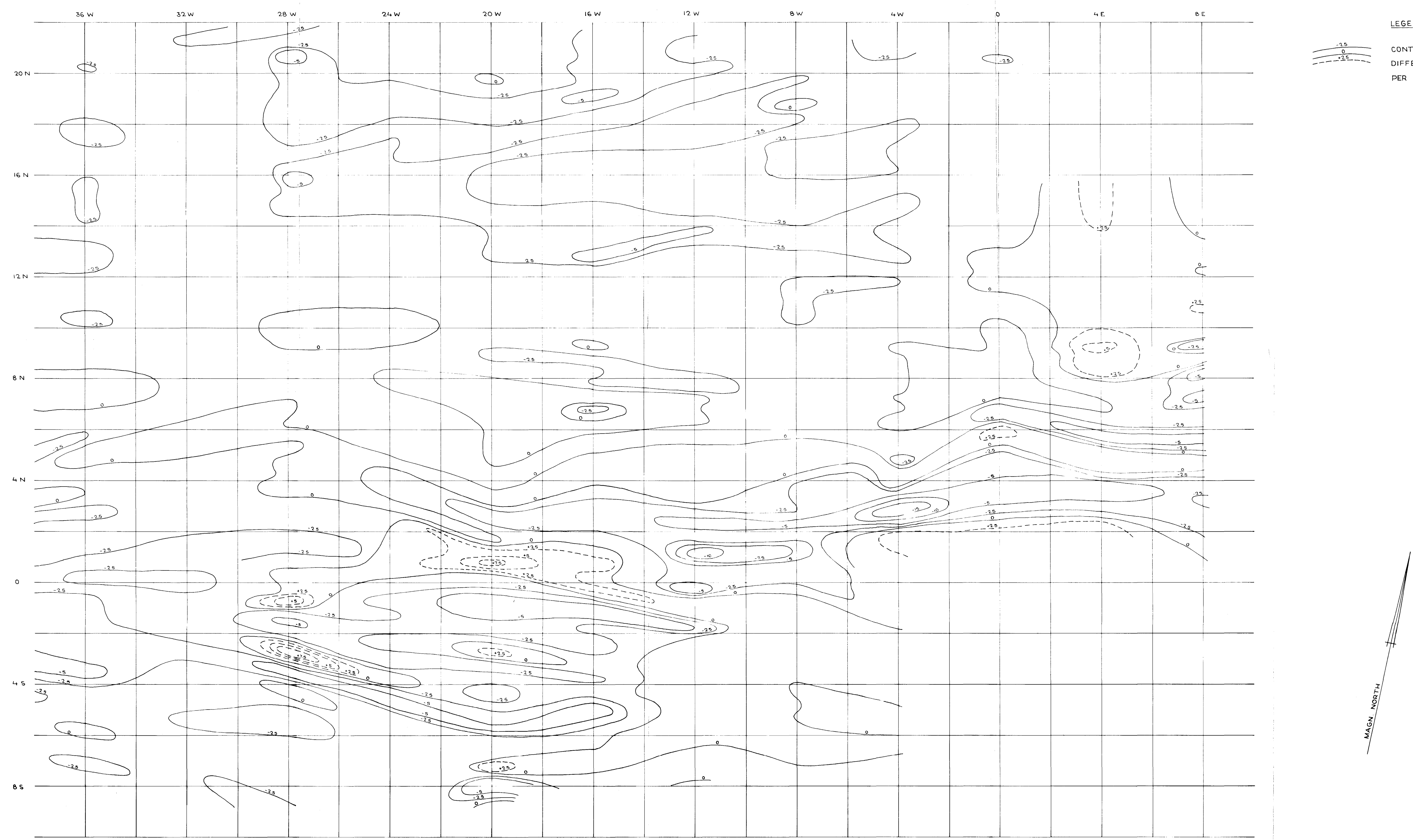
CONTOURS OF TURAM RATIO

AREA No 1S. TRAVERSES 8E - 36W

E53/B7-20

APRIL 1964 | Y.L./M.B.J. | ~~PLATE 2B~~

PLATE 4



LEGEND:

CONTOURS OF TURAM PHASE DIFFERENCE -2°5, 0°, AND +2°5 PER 50 FT.

SCALE

FEET 200 0 200 400 600 FEET

ABEM

Mc ARTHUR RIVER AREA, N T

CONTOURS OF TURAM PHASE DIFFERENCE

AREA No. 1S. TRAVERSES 8E-36W

E53/B7-21

APRIL 1964	Y.L/MBJ		~~PLATE 2C~~

TO ACCOMPANY RECORD No 1964/159

ABEM

M^c ARTHUR RIVER AREA, NT

EM GUN SURVEY

PROFILES OF REAL AND IMAGINARY COMPONENTS

E53/B7-64

APRIL 1964	YL/MBJ.BBn	~~PLATE 17~~

TO ACCOMPANY RECORD ~~No.~~ 1964/159