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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY AND SHIPPING.

MINERAL RESOURCES SURVEY.

REPORT No. 1944/28 .

Plans Nos. 1073, 1074, 1091.

GEOLOGICAL REPORT ON A SITE FOR A BRICK PIT AT DEAKIN.

- By -

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DEPARTMENT OF [illegible]

Mineral Resources Survey Branch

GEOLOGICAL REPORT ON A SITE FOR A BRICK PIT AT DEAKIN.

Report No. 1944/28. Plans Nos. 1073, 1074, 1091.

I. INTRODUCTION.

At least as early as 1940, it was realised by the Department of the Interior that the reserves of suitable rock (shale or slate) in the pit adjacent to the Canberra Brickworks were limited. A decision was made to find a temporary site to provide sufficient material to supply the brickworks for two years.

Choice of a site for the temporary quarry was limited by economic considerations. Bricks are a low priced product and raw material should be obtained from as near the brickworks as possible. A site at Deakin, 1700 yards by road east from the existing brickworks was selected and was recommended by Dr. W. G. Woolnough in 1940 as suitable, subject to testing by costeans and pits. Some of this testing was carried out and a small quarry opened. This quarry has yielded over 2,000 cubic yards of slate (equal to 1 million bricks) which, presumably, was suitable for brick-making, and a lesser quantity of obviously unsuitable rock which was quarried by necessity and dumped.

The main pit and the brickworks were closed down in 1942 and until recently bricks were supplied from existing stocks.

The Department of the Interior has to supply about 20,000,000 bricks in the near future and it is necessary for the Canberra brickworks to operate at maximum capacity for two years to make the bricks.

A preliminary geological survey was made by Mr. F. Canavan, Geologist, of this Branch, and showed that the position regarding reserves was as already stated.

A survey of the area in the subdivision of Deakin, Canberra City Area, was then arranged and was made during March and April, 1944, the object being to determine if there were sufficient reserves of suitable material to supply the Canberra brickworks for a period of not less than two years. This report describes the results of this survey. The maximum output of the plant is 12,000,000 bricks per annum, which expressed as raw material is equivalent to 48,000 tons of slate or 25,000 cubic yards in situ. Therefore, it was necessary to prove a body of suitable shale or slate containing at least double these figures.

The provision of reserves for only two years is a temporary expedient to provide supplies while the whole question of brick-making at Canberra is reviewed. Geological surveys and investigations of wider scope will be made with a view to determining quarry sites with large possible reserves. A further and more comprehensive report will be then made.

II. DESCRIPTION OF THE AREA.

1. General. The area surveyed in detail is in the subdivision of Deakin and on the southern side of the roadway of Adelaide Avenue (see Geological Plan: Plate I). This area is approximately a square with sides 1,200 feet long and with its northeastern corner on the junction of Hopetoun Circuit with Adelaide Avenue. Within this area, mapping, including contouring, was carried out by plane-table and stadia alidade; northerly and southerly extensions were mapped approximately by compass and pacing.

2. Topography. Two low hills separated by a saddle occupy most of the area and are shown by topographic contours at a vertical interval of 5 feet. Near the eastern side a narrow deep watercourse flowing north-northwest has cut through the alluvium and exposed bed-rock in most of its channel. To the south of the area mapped in detail, the ground rises at a moderate slope towards Red Hill which dominates the local landscape.

The northern-most of the two low hills bears a beacon of the local minor triangulation system and is known as Brick. The beacon stands at an elevation of 1947.6 feet above sea level, and the elevation of the summit of the southern hill is 1953.6 feet.

III. GEOLOGY.

1. General. The rock formations present include:-

Sedimentary	Recent	Alluvium - clay, sand etc. Ironstained gritty clay.
	Silurian	Slate with interbedded limestone, greywacke (grit and tuff), and silicified bands.
		Greywacke (grit and tuff).
Igneous	Intrusive	Porphyry.

2. Recent.

a. Three areas of alluvium are shown on the plan (Plate I). This alluvium lies in depressions along drainage channels and where it is dissected by watercourses has an average thickness of about 5 feet. It is composed of dark gritty soil with some lenticular beds of gravel, and, on the southern margin of the map, contains numerous boulders of hard siliceous rock up to one foot in diameter. The boundaries shown are somewhat arbitrary as a sharp line cannot be drawn between alluvium and the thin soil cover on the hill slopes.

b. The gritty clay forms a thin sub-horizontal sheet which is exposed in shallow road cutting in Adelaide Avenue. This gritty material contains small concretions of ironstone and on weathering these are liberated and are found scattered over the surface. Unfortunately, this deposit masks the junction between the slate and the underlying stratified greywacke at a point where otherwise the junction might have been well exposed by the road cutting.

3. Silurian. The Silurian rocks are divisible into two formations. The central and western parts of the area are occupied by slate with interbedded limestone, grit, tuff and silicified bands. The eastern part of the area is occupied by massive greywacke - this term is used to include grits and tuffs. The boundary between the slates and the greywacke is everywhere obscured by a thin mantle of soil and detritus, but it is apparently a conformable one with the greywacke underlying the slate.

Brief general descriptions of the rocks will be given below. Detailed descriptions of some of the types are given in Appendix I.

(a) Slate and types interbedded with the Slate.

(1) Slate. The rock which provides the raw material for brick-making, although termed 'shale' by those engaged in making it into bricks is rather a slate with an imperfectly developed slaty cleavage, but with schistosity sufficiently pronounced to mask bedding in places. In its unweathered condition, it is too hard and too lacking in plasticity for use by the local process. This condition imposes a limit to the amount of suitable material which can be won in a given area, and usable 'shale' is confined to a comparatively shallow zone

of weathering. The weathered slate is yellowish-brown or buff at the surface and is tinged with green at a depth of 4 or 5 feet (Spec.9) and is probably grey-green at greater depth below the surface.

The rock is soft and very fine in grain and has a slightly glossy appearance on cleavage faces due to the development of microscopic flakes of sericite (mica). In places the rock contains narrow bands of coarser material (Spec.6) and a considerable development of arenaceous (sandy) shale is showing in the road cutting on Adelaide Avenue. Near the quarry site, slate is exposed for 1,000 feet in a direction at right angles to the strike; this indicates a thickness of 700 feet, but the maximum development is more than this figure.

(ii) Greywacke. The greywacke, which is interbedded with the slate, ranges in composition from a highly felspathic rock with the typical appearance of a tuff to a quartz grit. The two extreme types merge into one another and no sharp boundary can be drawn between them. The bands range in width from less than one inch to 10 feet and are lenticular. One of the widest of such bands has been traced along its strike for 250 feet, but others appear to be shorter.

The felspathic bands are light in colour and contain yellowish or straw-coloured particles resulting from the alteration of felspar. These bands differ from the more quartzose examples only in having an apparently greater felspar and ferromagnesian content, and, generally, smaller grain size. Also they are narrower and more numerous and may occur finely interbedded with slate.

The gritty quartzose bands consist of grains of clear quartz up to 1.5 mm. diameter and which may be loosely cohering or firmly embedded in a slaty matrix (Spec.6). One band of grit outcropping west of the quarry (Spec.5), consists of grains of milky quartz, but this is not typical of the gritty rocks developed elsewhere in the area.

(iii) Limestone. Only small exposures of limestone were found and these lie outside the area available for quarrying as will be explained below. The limestone in the floor of the western entrance to the quarry is a dense bluish rock of fine grain. The limestone which outcrops to the south-east of the quarry is a denser rock and appears to be more siliceous.

(b) Greywacke. The term 'greywacke' has been used to cover all the gritty rocks occurring in the area (except the ironstained gritty clay) whether underlying the slate on the east or interbedded with it in various places. The passage from felspathic to quartzose grit that has been mentioned in connection with the interbedded occurrences is also present in the massive beds underlying the slate and exposed in the creek bed.

The rock is well exposed in the creek bed and north of Adelaide Avenue. Stratification is well defined and rare water-worn quartz pebbles up to ¾ inch diameter may be observed in the rock. Weathered surfaces of the rock are dark brown, but somewhat fresher faces, notably those exposed to scouring in the water-course, are grey passing to greyish brown with increase of ferromagnesian minerals.

4. Igneous (Intrusive). The name porphyry has been applied as a field term which is descriptive of the intrusive rock present in the western part of the quarry and in the bed of the creek near Hopetoun Circuit. The rock is extensively weathered, brown in colour and contains numerous quartz phenocrysts embedded in a fine matrix. Mica (biotite?) is also present. The rock has not been studied in any detail, but is probably related to the rhyolite or quartz-porphyry rock (Spec.7), which outcrops at 1,000 feet south of Adelaide Avenue and 400 feet east of the area shown on the plan and is described in the Appendix.

5. Structure.

(a) General. Silurian sedimentary rocks occupy the greater part of the area and are folded and faulted. They are intruded by porphyries in the form of narrow dykes or thin sills. Very thin deposits of Recent alluvium, etc., overlie the above rocks.

(b) Folding. The bedding of the fine sediments which now form the slate is partly masked by the development of slaty cleavage. The direction of bedding planes may, however, be followed where textural or compositional changes in the rock are apparent, for example, the coarser gritty beds are easily followed and mapped where not covered with soil, and coloured bands in the slate may similarly be observed and mapped. Measurements of dip were possible only in the various shallow excavations in the slate, and at some outcrops of greywacke in and near the creek on the eastern side of the area. Most of the excavations in the slate are only 6 to 12 inches, and consequently the measurements of dip are not as dependable as they would be for deeper excavations.

The general direction of strike is west-northwest to north-northwest and dip is to the southwest. On the western side of the area, the dip is high and ranges between 50° and 70°. Towards the east and north, however, lower dips of between about 20° and 45° are evident, with one isolated measurement of 10°.

The rocks have, therefore, been moderately folded along general northwesterly axes and the area under review appears to occupy the western limb of an anticline. Minor folding is superimposed on the above folding, the axes striking about northeast. Thus very open synclinal folding is indicated by the curved outcrops of gritty beds on the southern hill and by the exposures of greywacke north of Adelaide Avenue. An anticline between the synclines may be inferred in the depression between the two hills, but there is no satisfactory evidence for it farther to the northeast.

(c) Faulting. Faulting is not much in evidence. The porphyry exposed in the quarry is bounded on the east by a fault which dips west at 80°, and is parallel or sub-parallel to the strike of the slate. This fault can be traced in the wall of the quarry for 300 feet and at the northern end appears to swing to the west. Another steeply dipping fault occurs near the crest of the southern hill. It is sub-parallel to the strike of the slate and grit beds and dips steeply to the southwest.

(d) Igneous Intrusions. The two intrusions of porphyry are in the form of thin sills or narrow dykes with strike in close agreement with those of the slate and greywacke.

IV. QUANTITY OF SLATE AVAILABLE.

It will be seen from the geological map (Plate I) that the greater part of the two hills comprising the proposed site for a pit, is occupied by slate. This mapping is based on outcrops, exposures in the shallow workings excavated for road blinding, exposures in the two test trenches and shaft and the presence of numerous slate fragments in the soil. Fringing this area on the eastern, northwestern and southwestern sides, there are narrow tracts in which there are no outcrops, but in which the underlying rock is most probably slate.

The lower parts of the eastern and northeastern slopes of the hills are occupied by greywacke. The junction is almost certainly a conformable one, the greywacke underlying the slates and, therefore, limiting their extent to the east and northeast. On the west central portion of the site, the slates extend as far as the western side of the existing quarry. Slates also occur farther west,

but they contain interbedded grits and limestones. There are no outcrops in the northwestern portion of the site, but it is probable that the underlying rocks are slates. South from the two hills, outcrops and exposures are not numerous, but those which exist indicate that the slates extend in that direction, but that they contain beds of limestones and silicified types (cherts). These beds are probably present in sufficient quantity to considerably reduce the amount of slate and render this portion of the area generally unsuitable for obtaining slate.

The above descriptions indicate that there is a considerable area (at least 10 acres) from which slate could be quarried. However, there are other factors which restrict the area in and depth to which quarrying can be conducted.

The proposed quarry-site lies within the Canberra City Area and consequently is under the control of the Minister for the Interior, who, in matters such as this, acts on the advice of the National Capital Planning and Development Committee. The following conditions under which excavation may be carried out at this site have been imposed. Firstly, any excavating must not go deeper than the 1930 feet contour and, secondly, that everything above this level must be completely removed and thus leave a levelled site suitable for building purposes. These conditions affect the proposed quarrying in several ways:-

i. The restriction of the lower limit of operations to the 1,930 feet contour necessarily reduces the depth, and also the area, of slate than can be quarried.

ii. The removal of all rocks above the 1,930 feet contour necessitates the removal of rocks other than the slate required for brickmaking. This will add to the cost of mining and transport.

iii. As the 1,930 feet contour does not close in the south-eastern portion of the area, it is not known how far quarrying will be permitted in that direction.

Fortunately, these conditions have little effect on the area of the slate to be quarried on the eastern side of the site. In that part, the western boundary of the greywacke or eastern boundary of the slate approximately coincides with the 1935 contour. Consequently, it will be possible to quarry almost all the slate existing there and further only a comparatively small amount of waste rock will have to be removed.

On the western side the slate extends below the 1930 foot contour and greater quantities could be obtained by deeper workings. The quarry, which has been opened on this side, has been excavated down to a level of about 1,924 feet.

South of the southern hill, it is probable that appreciable quantities of slate could be quarried above the 1,930 foot contour.

In addition, it would of course be possible to mine slate below the 1,930 foot contour in the area in which quarrying would be permitted to that depth.

After considering the geological and other factors, it has been decided to assume for the purpose of calculating the quantity of slate available, an area generally defined as follows:-

(a) On the eastern side by the boundary between the slate and greywacke or between the slate and the area of no outcrops, or by the 1,930 foot contour where it is west of the above lines.

(b) On the northern side by the 1,930 foot contour.

(c) On the western and southwestern sides by either the boundary between the areas of slate and of no outcrops or by the 1,930

foot contour, dependent on which is situated farther to the east.

(d) On the southeastern side by the boundary between areas of slate and of no outcrops (this agrees generally with an arbitrary line which may be decided in accordance with the topographical features when quarrying to the level of of the 1,930 foot contour).

If the areas of no outcrops and the alluvial above the 1,930 foot contour are considered to have slates beneath them (and this is a reasonably safe assumption), a somewhat larger area would be available. It would be bounded on the east by the slate-greywacke boundary or the 1,930 foot contour; on the northwest, west and southwest by the 1,930 foot contour; and on the south-east by the arbitrary line referred to immediately above.

The first area is of 10 acres and the second of 12.5 acres.

Calculations of quantity were restricted to the area of 10 acres. It is about 1,100 feet from north to south and ranges up to 700 feet wide. For purposes of calculation, cross-sections were prepared along twelve parallel cross-section lines (A-A' to L-L') which are shown on Plate 1. The lines are in general east-west directions and are spaced at intervals of 100 feet.

The cross-sections are shown in Plate 2 and indicate the volume of slate available down to the 1,930 foot contour. The cross-sectional areas of slate which have been used in the following quantity calculations, are coloured dark green while probable extensions of slate beyond these areas are shown in light green. The light green areas represent slate lying below 1,930 feet, and those parts of the sections where the surface is under a mantle of soil or alluvium, but the presence of slate is inferred from the character of the soil or from other observations.

The gritty bands intersected by Sections I-I' and J-J' have not been excluded from the calculations although it is realised that the rock contained in these beds alone would not be suitable for brickmaking. These bands have been ignored because, firstly, their volume is too small to greatly affect the final figure, and, secondly, it is probable that the grit, if mixed with slate, in the proportions in which they occur could be used without deleterious effect.

The areas on the cross-sections were determined by calculation of areas of triangles and the results are given in the following table:-

Section.	Area Sq.Ft.
A-A'	Nil
B-B'	450
C-C'	2,000
D-D'	3,400
E-E'	4,270
F-F'	3,050
G-G'	2,800
H-H'	5,550
I-I'	7,850
J-J'	7,600
K-K'	4,100
L-L'	300

The total volume of slate in the block represented by the cross-sections was calculated between sections and by the prismoidal formula. Results were obtained ranging from 153,000 to 155,000 cubic yards, and the amount of 154,000 cubic yards will be adopted. On the basis of 1.93 tons per cubic yard, this amount represents 297,220 tons. Assuming 9 lb. of slate makes one brick, this tonnage of slate represents about 74,000,000 pressed bricks. When it is considered that the brick quarries at Yarrawunga are stated

to have yielded material sufficient for 80 million bricks only, the above figures may appear high, but the Yarralumla quarries, though probably somewhat deeper than the proposed one, occupy an area of only 8½ acres, while the area available for quarrying at Deakin amounts to 10 acres excluding those portions above the 1,930 foot contour which are occupied by greywacke or masked by soil and alluvium.

If the 1935 foot contour is taken as the base of the quarry, the amount of slate available for quarrying is 163,500 tons. If the 1937 foot contour is taken, the amount available is 113,000 tons.

V. QUALITY.

The material being used from the pit adjacent to the brickworks at Yarralumla is a partly weathered slate. It is stated that the harder, unweathered slate is not suitable for the process of brickmaking in use. The calcareous (limy) slate is not used because the calcium carbonate content is too high and the consequent evolution of carbon dioxide when bricks of this material are burnt produces a swollen and distorted brick with a vesicular texture. The sandstone and grit are also rejected on account of their lack of plasticity.

The slate grades into calcareous slate and into sandstone and there must be intermediate types which it would be difficult to class as suitable or unsuitable. There is no chemical testing conducted and apparently experience based on the results obtained is relied on for the purpose of selecting satisfactory material.

The slate at the Deakin site is very similar in appearance to that at Yarralumla. It is apparently suitable for brick-making as 2,000 cubic yards were quarried and used. The slate in the small quarry thus opened is somewhat hard, and the more weathered slate which outcrops on the two low hills should be even more suitable as regards the hardness factor.

At Deakin there are no beds of calcareous slate, similar to those at Yarralumla, which contain numerous holes representing former fossils. However, the slate contains calcite in appreciable amounts. Thus a microscopic examination of a specimen (9) from the quarry revealed about 8 per cent. of calcite and one (Spec.6) from near the top of the southern hill revealed about 5 per cent. of calcite. As the slate from the quarry has proved to be suitable it would appear that a calcite content of 8 per cent. is not detrimental.

For purposes of comparison two specimens of slate from the Yarralumla quarry were examined microscopically. These specimens were obtained from sites indicated by the Manager as yielding the best slate, and the most calcareous slate that had been used with satisfactory results, respectively.

The first specimen is slightly finer/in grain than either of specimens 6 and 9 from Deakin and contains less quartz. The specimen contains a few external casts of fossils. Fine threads of white transparent material may be calcite. The slate is more weathered than Specimen 9 from Deakin.

The calcareous slate is very similar to that described above, but is crossed by veins of calcite and contains calcite scattered throughout the rock. The section contains about 5 per cent. of calcite, but is much less calcareous than a representative sample from this section of the pit would be.

Both specimens contain grains of biotite, many of which have their cleavage oriented at right angles to the cleavage of the slate.

The slate at Deakin contains a few narrow beds of greywacke (grit and tuff). While these rocks would not, in themselves, be suitable for making bricks, the proportion of them is so small that if

mixed with the slate they would have no appreciable effect on the bricks.

Northwest from the Brick Trig. the slate is more siliceous than elsewhere and approaches a very fine-grained sandstone. This slate would have to be tested to determine whether it would be suitable, but even if unsuitable it is not present to an extent sufficient to reduce very much the total amount of slate present.

In general, therefore, it would appear that the slate at Deakin is just as suitable as that at the Yerralumla pit. This has been verified as far as the small quarry is concerned because 2,000 cubic yards of slate have been used from there. As regards the remainder of the slate, verification could be made only by practical tests.

VI. TESTING CAMPAIGN.

Any testing to be conducted should be by trenches and shallow shafts and perhaps in some of the deeper testing by drill holes instead of shafts. Separate schemes for the three levels to which quarrying may be conducted will be given. The positions and lengths of the trenches and the positions and depths of the shafts for each of the three schemes are shown on Plate 3. The sites of the trenches and the shafts are not pegged on the ground.

Quarry Floor at 1937 foot Contour.

			Length		
Trenches.	Depth to be such that 6 to 12 inches of rock or weathered rock are exposed.	Line D	300 Feet		
		" F	306 "		
		" H	380 "	plus cleaning 100 feet workings	
		" J	380 "	plus cleaning 100 feet workings	
			1,360 "		200

			Number	Depth
Shafts.	To be sunk from the trenches, but depths from surface given.	Line D	1	4 feet
			1	5 "
		" F	1	5 "
			1	3 "
		" H	1	7 "
			1	5 "
		" J	1	8 "
			1	15 "
			1-	5 "
		TOTAL	9	57

Also cleaning out shaft near Brick Trig. Station.

Quarry Floor at 1935 foot Contour.

			Length		
Trenches.	Depth to be such that 6 to 12 inches of rock or weathered rock are exposed.	Line D	350 Feet		
		" F	335 "		
		" H	400 "	plus cleaning 100 feet workings & 50 feet trench.	
		" J	400 "	plus cleaning 100 feet workings	
			1,485 "		250

			Number	Depth
Shafts. To be sunk from trenches, but depth given from surface.	Line	D	1	6 Feet
			1	7 "
	"	F	1	7 "
			1	5 "
	"	H	1	5 "
			1	9 "
			1	7 "
	"	J	1	10 "
			1	17 "
			1	7 "
			10	80 "

Also cleaning out of shaft near the Brick Trig. Station.

Quarry Floor at 1930 Foot Contour.

			Length	
Trenches. Depth to be such that 6 to 12 inches of rock or weathered rock are exposed.	Line	D	420 Feet	
	"	F	420 "	
	"	H	420 "	plus cleaning 100 feet of workings and 150 feet of old trench.
	"	J	600 "	plus cleaning 100 feet of workings.
	"	L	220 "	
			2,080 "	350

			Number	Depth
Shafts. To be sunk from the trenches but depths given from the surface.	Line	D	1	11 Feet
			1	12 "
	"	F	1	12 "
			1	13 "
			1	5 "
	"	H	1	10 "
			1	14 "
			1	12 "
	"	J	1	15 "
			1	22 "
			1	12 "
			1	5 "
	"	L	1	8 "
			13	151 "

Also cleaning out of shaft near the Brick Trig. Station.

VII. CONCLUSIONS.

The geological survey of the Deakin site indicated that, from the surface evidence available, there is an area of 10 acres of slate with probably an additional area of 2.5 acres.

Subject to the conditions imposed on quarrying in that vicinity, the quantities of slate available are:-

	Cubic Yards	Tons.
Down to 1937 Contour	58,600	113,000
" " 1935 "	84,500	163,500
" " 1930 "	154,000	297,200

As a two year programme of brickmaking requires 50,000 cubic yards or 96,000 tons, there is available at the site and down to the 1937 contour a quantity of slate of approximately three times that required.

In general, the slate is very similar to that at the Yarralumla pit and 2,000 cubic yards of it has already been used for brickmaking. There is an absence of the calcareous fossiliferous type of slate present in the Yarralumla pit and only thin beds of greywacke etc., are interbedded with the slate. It would appear that the slate is likely to be suitable.

It should be realised that the reserves of slate indicated above are not reserves definitely proved to exist both as regards quantity and suitable quality. The figures to the 1930 contour are based on depths ranging up to 23.6 feet, but the only exposures deeper than 2 feet are the small quarry, the shaft near the Brick Trig. and a small excavation on the southern hill. The results of earlier testing by the shaft (now infilled to within 5 feet of the surface), the costeans (now largely infilled) on the southern hill and the line of drill holes on the southern hill are not known. If all of these intersected slate of suitable quality, the position regarding the reserves would be more definite. The higher the base to which quarrying is carried the less is the depth involved and more reliance can be put on the estimates based on surface outcrops and shallow exposures.

In view of the above, the Department of the Interior might decide to quarry to the 1930 foot level without further testing. There would be little doubt that the amount of slate required (96,000 tons) would be obtained and under ordinary conditions of quarrying this procedure would no doubt be followed. However, under the conditions imposed it would be necessary to quarry all material above the 1930 foot contour and, if there proved to be more unsuitable material than anticipated, the removal of it would add to the cost of quarrying and, therefore, of the bricks.

If the Department of the Interior desires to commence operations without further testing, it would be preferable to quarry at first down to the 1935 or 1937 foot contour. Such quarries would have faces ranging up to 16.6 and 18.6 feet depending on whether the quarry floor was at the 1935 or 1937 foot contour. The prospects of the estimates of quantity being realised are much better in these cases. The estimated quantities are in excess of those required (96,000 tons) and it is reasonably certain that the latter quantity could be obtained. There would also be available some further quantities in the areas without outcrops, which are not included in the estimated quantities. Further, even if there happened to be more unsuitable material than anticipated, the amount to be removed would be much less than for a quarry to the 1930 foot contour. The working to the 1935 or 1937 foot contour would give much information and enable reliable estimates to be made of the quantity and quality of slate down to the 1930 foot contour.

RECOMMENDATIONS.

In view of the above conclusions, it is recommended that:-

1. The Department of the Interior decide the amount of slate it desires to remove from the Deakin site and consequently to decide the depth to which it requires the quarry to be taken.

2. If the amount required is only that for about two year's supply of bricks, the level of the bottom of the quarry should be either the 1935 or 1937 foot contour. There is little doubt that the amount of slate would be obtainable except in so far as there might be unexpectedly large amounts of unsuitable material present. Testing as outlined would provide against this possibility, but if not conducted, the Department of the Interior would have to accept the responsibility and risks attendant on such a procedure.

3. If the maximum amount of slate obtainable is desired, the level of the bottom of the quarry should be the 1930 foot contour and a decision made by the Department of the Interior whether the quarry should be operated in one or two benches. If it is to be operated

in one bench down to the 1930 foot contour, it would be unwise not to conduct the testing outlined for working to that level. If it is decided to operate in two benches, the position regarding the upper one (down to 1935 or 1937 contour) and the testing thereof has been outlined in 2. above. The testing of the lower bench (from 1935 or 1937 to 1930 contour) could be reviewed, in accordance with the results obtained from the upper bench.

4. If any testing is conducted -
   (a) The Mineral Resources Survey examine geologically the trenches and shafts dug and report on same.
   (b) The material from the shafts and from suitable places in the trenches be tested in the Brickworks to determine its suitability for the making of bricks.

P B Nye

CANBERRA, A.C.T.
12th June, 1944.

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Geologist.

Detailed Descriptions of the Rock Types.

(1) Slate.

(a) Specimen 6. This is a light brown slate from the surface and contains glassy quartz grains and straw-coloured specks roughly arranged in a band parallel to the bedding.

Under the microscope the larger grains (up to 3mm.) are seen to be rounded and the smaller ones, which have resulted from the shattering of bigger particles, are angular. The shattered fragments are scattered along the direction of cleavage of the slate, but are not drawn out in well defined lines. Long narrow fragments of quartz are not oriented with their longer axes parallel, but lie in haphazard direction. The straw-coloured specks are calcite presumably replacing felspar.

The slate in this section contains many fine grains of quartz evenly distributed throughout. Foliations show puckering and folding in the vicinity of quartz and calcite grains, and calcite replacement occurs in some cases about the quartz grains, and forms a large proportion of coarser grained crushed matrix which surrounds groups of quartz fragments. Calcite amounts to about 5 per cent. of the rock.

(b) Specimen 9. Greenish-brown slate from the eastern wall of the quarry 4 feet below surface. This slate is slightly softer than Specimen 6 and smoother to the touch. The grain is very fine and small glistening flakes of mica can be seen in places.

Microscopically, very small pieces of quartz calcite, muscovite (sericite) and biotite can be recognised under high magnification embedded in an argillaceous matrix. Apatite is also present in small amount. Calcite forms part of the fine matrix and may amount to as much as 8 per cent. of the whole rock.

(2) Greywacke.

(a) Specimen 1. This is a greenish-grey rock of speckled appearance with a few glistening quartz grains. It is moderately fine-grained, but individual grains are easily distinguished by the unaided eye. The outcrop has a uniform texture and bedding is not evident.

Under the microscope, it is seen that rounded to angular quartz grains, ranging from 1.5 to 0.12 mm. in diameter make up 50 per cent. of the rock. The quartz contains a few blebs of glassy matter, and, in part of the section, shows parallel streaks of fine inclusions. Some of these streaks plainly continue across several neighbouring quartz grains, but can be traced across the intervening matrix only faintly. About 25 per cent. of the rock consists of felspar (0.6 to 0.15 mm.) in varying stages of replacement by calcite. Some grains have been wholly altered and others contain only flecks of calcite. The unaltered grains are recognisable as a plagioclase. The bulk of the groundmass is green or stained brown with iron oxide, and is microcrystalline forming fibrous bands surrounding the large grains. Much of it is chlorite probably resulting from the alteration of biotite.

The rock may be regarded as a quartz tuff.

(b) Specimen 2. In the hand specimen the rock is similar to No. 1 but is brown in colour owing to a greater degree of weathering and oxidation. The grain size is larger and quartz is more prominent. Incipient banding is noticeable in large specimens.

The appearance under the microscope is similar to that of No. 1 with the following differences. The quartz grains, which also contain a little glass, amount to about 70 per cent. of the rock and felspar is less altered although much calcite is present. The felspar includes both orthoclase and plagioclase, and some biotite embedded in chlorite occurs in the groundmass.

(c) Specimens 3 and 4. These specimens differ from No. 2 in the comparative coarseness of their textures. No. 3 is only a little coarser than No. 2 and No. 4 contains quartz grains exceeding 3 mm. in diameter.

In other respects their appearance is similar to that of No. 2.

(d) Specimen 5. The rock is composed of coarse (1 to 3 mm.) particles of white quartz with very little cement between the grains. The quartz is sub-angular and amounts to about 90 per cent. of the rock, the remainder being interstitial cement which is yellowish-brown in colour.

(e) Specimen 8. This is a light coloured granular rock which contains veinlets of calcite and is encrusted with calcite filling joints. It is yellowish-brown in colour with very numerous glassy quartz grains.

The main difference between this rock and Specimens 1 and 2 is the rarity of felspar and the complete replacement of the ground mass by calcite. Rounded and shattered grains of quartz make up about 65 per cent. Many of the few grains of plagioclase have thin laths of calcite developed along twin lamellae. The calcite in the altered felspar and in the matrix amounts to about 25 per cent.

(f) Specimen 10. This specimen was chosen for examination on account of its gritty appearance and apparent lack of felspar. The rock is greyer in colour than any of the others that have been described and consists of closely packed grains of quartz in a light-coloured matrix. The quartz grains measure up to 2 mm. in diameter and constitute about 90 per cent. of the rock.

In thin section the rock is seen to be a more quartzose variation of the other specimens and bears a close resemblance to No. 2. A little felspar is present and some biotite, partly chloritized. There does not appear to be any calcite. Most of the quartz grains contain rows and bands of dust-like inclusions. Unlike the inclusions noted in the quartz grains of No. 1 specimen these bands have random orientation and are, in some instance, branched and curved. They are associated with areas of strain within the crystal.

(3) Porphyry.

(a) Specimen 7. The intrusive rock in the creek is very weathered. Megascopic examination of the specimen shows the rock, in its weathered state, to be light brown in colour with glassy quartz phenocrysts embedded in a fine matrix which also contains small yellowish streaks and laths. Owing to the weathered state of the rock no specimens from the creek bed were sectioned for microscopical examination, but a thin section of an apparently identical but fresher rock from an outcrop farther east was prepared.

Under the microscope this section showed that the quartz phenocrysts are much corroded and invaded by groundmass along fractures and in the embayments caused by corrosion. Felspar is very rare, but numerous inclusions of opaque straw-coloured mineral are apparent. This mineral occurs in bunches of fine lace-like lines which are surrounded by ground mass and appear to be derived from plagioclase by kaolinization along twinning lamellae. Occasionally these inclusions are seen to retain an outline suggestive of idiomorphic felspar crystals, but most are distorted and crumpled. Apatite is abundant throughout the rock and some biotite is present in very minor amount. The groundmass is microcrystalline and exhibits flow structure.

PLATE I.

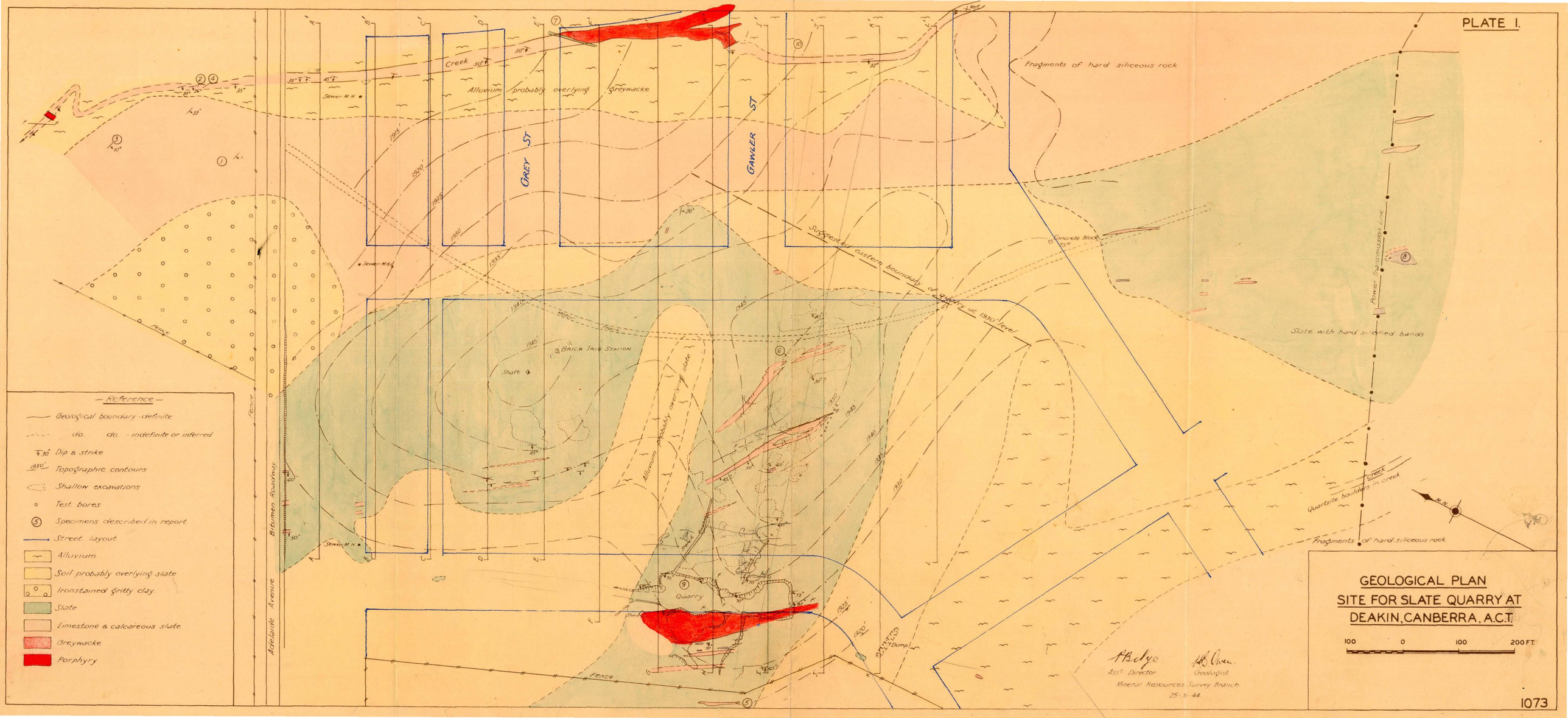

Reference
Geological boundary - definite
do. do. - indefinite or inferred
Dip & strike
Topographic contours
Shallow excavations
Test bores
Specimens described in report
Street layout
Alluvium
Soil probably overlying slate
Ironstained gritty clay
Slate
Limestone & calcareous slate
Greywacke
Porphyry
Adelaide Avenue
Bitumen Roadway
Alluvium probably overlying Greywacke
Creek
Grey St
Gawler St
Fragments of hard siliceous rock
Suggested eastern boundary of Quarry at 1930 level
Concrete Block
Power Transmission Line
Slate with hard silicified bands
Brick Trig Station
Shaft
Alluvium probably overlying slate
Quarry
Dump
Fence
Sewer M.H.
Quartzite boulders in creek
Fragments of hard siliceous rock
GEOLOGICAL PLAN
SITE FOR SLATE QUARRY AT
DEAKIN, CANBERRA, A.C.T.
100 0 100 200 FT.
A Belye
Asst. Director
H.B. Owen
Geologist
Mineral Resources Survey Branch
25-5-44
1073

PLATE 2

SECTIONS A-A'-L-L'
SITE FOR SLATE QUARRY
DEAKIN, CANBERRA, A.C.T.

Hor. & Vert. Scale 1" = 100'

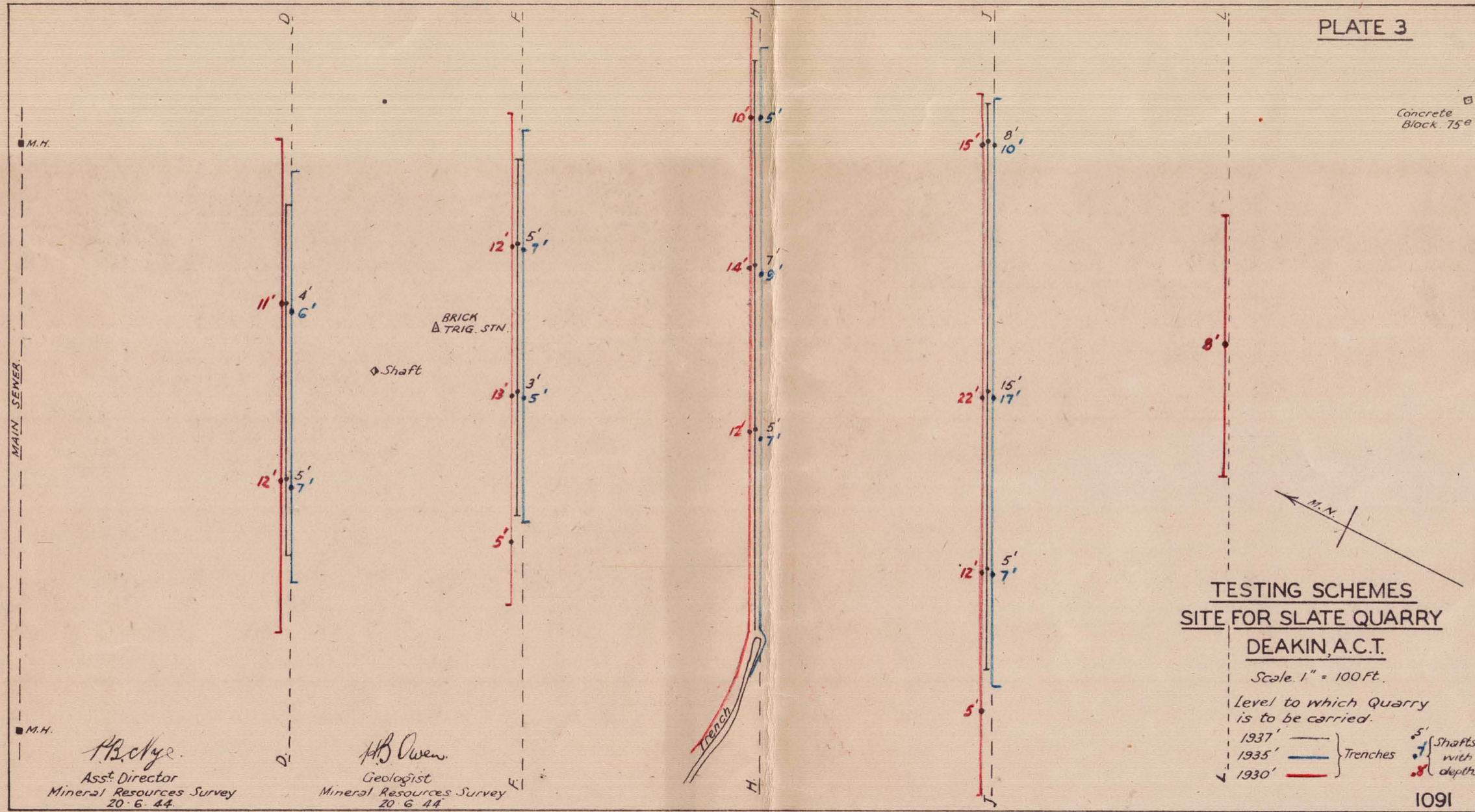
For reference see Plate 1
except as modified hereunder

Denotes areas used in quantity calculations

Probable extension of slate beyond above areas

P.B. Nye — Asst Director
H.B. Owen — Geologist
Mineral Resources Survey
25 5 44

PLATE 3



TESTING SCHEMES
SITE FOR SLATE QUARRY
DEAKIN, A.C.T.

Scale. 1" = 100 Ft.

Level to which Quarry is to be carried.

1937' —
1935' —
1930' —
} Trenches

5' 7' 8' } Shafts with depths

H.B. Nye.
Asst. Director
Mineral Resources Survey
20. 6. 44.

H.B. Owen.
Geologist
Mineral Resources Survey
20. 6. 44

1091