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REPORT ON CEMENT MATERIALS IN THE BEACONSFIELD AND FLOWERY GULLY DISTRICT.

INTRODUCTION.

It has been known for many years that enormous quantities of highgrade limestone exist in the Flowery Gully and Beaconsfield district. The limestone has been usedfor flux in connection with the iron smelting operations and also burnt for quicklime at several localities. At present two kilns in operation and producing considerable quantities of quick-lime. Naturally attention has been givento the possible utilisation of the limestone for the manufacture of cement, and investigations were carried out with the object of locating deposits of clay or other suitable material to mix with the limestone. These investigations were limited in area and scope and were only partly successful. Accordingly the present examination of the district was undertaken in order to locate, if possible, suitable clay, shale etc. to mix with the limestone as attention has recently been directed towards the erection of cement works.

LOCATION AND ACCESS.

The Beaconsfield and Flowery Gully district is situated on the west side of the River Tamar near the junction of its estuary (Port Dalrymple) with Bass Strait which separates the northern portion of Tasmania from Victoria.

The most convenient means of access is from the city of Launceston which is situated at the head of the River Tamar. Launceston is the port of call for interstate passanger boats from Melbourne and is also the centre of the railway system of the State. A first class motor road connects Launceston with Beaconsfield (26 miles) and Beauty point (29 miles) and there is a daily service of passenger and goods cars both ways. Flowery Gully can be reached by a good motor road from Beaconsfield, four miles in length, or more directly from Launceston via Exeter and Winkleigh.

Beauty Point, the present deep-water port of the Tamar, is only three miles from Beaconsfield. Ocean-going steamers to and from Great Britain etc. call at Beauty Point.

PHYSIOGRAPHY.

The district is generally of low relief as will be seen from the Geological Sketch Map accompanying this report. The greater part of the country in the vicinity of Beaconsfield does not exceed 800 feet above sea-level, and similar altitudes are maintained along the course of Johnson's Creek as far inland as Flowery Gully. Cabbage Tree Hill and Blue Tier rise to altitudes of about 500 feet above the sea. The Blue Peaked Hill (1150 feet) and the hills between Flowery Gully, Winkleigh and Holwell (1300 feet) rise to greater heights.

The whole of the drainage flows into the River Tamar by means of several major streams. The largest stream is the Supply River which occurs to the south of the area investigated, but some head-water tributaries of which rise in the vicinity of Winkleigh. The main stream rises near Frankford and flows in a general north-easterly direction to join the Tamar near Exeter. Anderson's Creek drains the western portion of the district and flows in a northerly direction into the West arm at York Town. The greater part of the district is drained by the Middle Arm or Blyth's Creek and its tributaries. The most important of these tributaries

are Johnson's Cree, Blyth's (or Limestone) Creek, and Owens Creek, all of which unite to the west of the Gorge between the Cabbage Tree Hill and Blue Tier. The country along the course of Johnson's Creek is known as Flowery Gully. Sassafras Creek is another important tributar which drains the area to the east of the Blue Tier.

GEOLOGY.

A large number of rock systems and formations of different periods outcrop within the district. The oldest rocks are the schists of Pre-Cambrian or Proterozoic age which occur to the immediate west and south of the district examined. Succeeding these the oldest rocks within the district examined are those of the Cambro-Ordovician System. To the west of the district and near the Blue Tier, these have been intruded by Devonian basic and ultrabasic rocks (now serpentinesed). Succeeding all the above and overlying them, the Permo-Carboniferous system occur.

Upper Mesozoic diabase intrudes the above formations buy is not largely developed within the district. Lower Tertiary sediments occur on the flat country to the east of Beaconsfield and also in the deep land at the foot of Cabbage Tree Hill. Tertiary basalt is represented by a flow or flows in the vicinity of Beauty Point. Uper Tertiary sands and gravels cover a large area of the surface to the North and North-West of Beaconsfield. Recent alluvium occurs along the streams and around the shores of the Tamar River at some localities.

A geological sketch map based on the land and mineral charts of the district is attached to this report. The greater part of the area shown was examined and mapped by the writer, therremainder being taken from the map prepared by Loftus Hills in 1922.

THE SEDIMENTARY ROCKS.

(a) CAMBRO-ORDOVICIAN. The rocks of this system cover a large part of the area under review and are, economically, the most important developed in the district. The auriferous quartz lodes of the Beaconsfield district occur in these rocks, and the beds of limestones and slate are important materials in the manufacture of cement.

The rock types comprising this system are slates, sandstones, grits, conglomerates, limestones, and types intermediate between the above. The general strike is north-west to south-east, and the dip is to the north-east at angles of 40° to 60°. Minor folds occur along the axis of Cabbage Tree Hill, but do not interfere greatly with the general dip of the system. The sequence of the strata in the vicinity of the Cabbage Tree Hill has been determined by previous investigators from the information available in the underground mine workings and the creek and road sections. These differ but little and the latest by Mr. W. H. Twelvetrees is given below with slight alterations. The section is taken in ascending order from west to east.

1. Lowest. Light-coloured sandstones and quartzites.
2. Dark-blue and black slates to the west of Cabage tree Hill.
3. Dark sandstones, grits, and conglomerates on the top of the Cabbage Tree Hill and in the Gorge.

4. Grey and whitish limestone in Tasmania and Wonder Mines.
5. White sandstone.
6. Dark sandstones and conglomerates on east side of hill.
7. Light-coloured sandstones.
8. Bluish limestone. East end of Tasmnaia Mine, East Tasmania Bare, Dally's United, Blyth's Creek etc.
9. Dark grey and green slates. East Tasmania mine.
10. Grey sandstones.
11. Slates and sandstones.

The section to the east of the bluish limestone is better seen going easterly from Mr. Dally's quarries on Blyth's Creek and is as follows. (in ascending order)

Bluish limestone. Dally's Quarry. 500 feet wide
Slates with small beds of sandstones. about 1200 feet wide. Somewhat calcareous on east side.
Quartzite. 15 feet.
White limestone or marble. Old quarry on Sassafras Creek.

Sandstones and quartzites occur to the east of the above and outcrop east of Mittle Arm Creek, east of the Launceston Road. To the west of the Creek at this place contorted slates with a thin bed of limestone occur. The Cambro-Ordovician strata further east are obscured by Permo-Carboniferous and more recent rocks.

The same general sequence of beds has been found to occur on the Blue Tier as on Cabbage Tree Hill of which it represents the northern continuation. The blue limestone would then extend up the open valley of Sassafras Creek, northwards from Dally's quarry. It is stated that this extension has been more or less proved by shafts etc. but this was not verified or otherwise.

Considerably difficulty has always been experienced in correlating the strata of the Blue Peaked Hill and Flowery Gully with those of Cabbage Tree Hill and the Blue Tier. The succession (ascending) from west to east across Flowery Gully's.

Iron-stained sandstones
Blue limestones
Slates and sandstones
slates.

This series terminate at Johnson's Creek on the south. The limestone and slates should, if they continue further south, be found on the Blue Peaked Hill, but instead only sandstones and quartzites occur. These field relations prove conclusively that a fault occurs roughly along the course (north-east to south-west) of Johnson's Creek where it continues to the north-east would pass approximately through the saddle at the North end of the Blue Tier. As it is probable that the limestone of Beaconsfield and Dally's quarry extends up the valley of the Sassafras Creek, and the possibility of this belt representing the faulted portion of the Flowery Gully limestone has to be considered. The two limestones are as far as external appearances go, indistinguishable from one another and might easily be different portions of the same bed. The sequences of the strata at the two localities is similar viz sandstones, limestones, slates in ascending order, but the thicknesses are somewhat different The limestone at Flowery Gully is 20 chains. Further the slate belt seems wider at Flowery Gully and has not been proved to contain limestone beds such as occur above the blue

limestone in the Beaconsfield area. Between Dally's quarry and the northern end of Sassafras Creek valley. (a distance of 2¼ miles) it is possible that the section of the limestone and enclosing strata changes to one similar to that at Flowery Gully.

It is thus possible that the Beaconsfield and Flowery Gully limestones represent different portions of the same bed, the fact that they do not occur on the same line of strike being explained by a large fault. That a fault which could produce this effect does exist, is shown by the occurrences at the south end of the Flowery Gully limestone. The direction of such a fault would be from north-east to south-west and the heave about two miles.

With regard to the age of this system no very definite conclusions can yet be arrived at. The slates and sandstones have generally been assigned to the Cambrian or Ordovician, or more recently the Cambro-Ordovician, systems, while the limestones have been referred to as Silurian. More recently Dr. Hills referred some of the thin beds of limestone to the Cambro-Ordovician, and the thick blue limestones and other thin beds to the Silurian. As far as the field occurrences are discernible, there is no apparent reason to separate the rocks into two systems, as the sandstones, slates, limestones, etc. form one conformable series. A few fossils have been found in the sandstones of Cabbage Tree Hill may be either Ordovician or Silurian in age. For the present it is preferrable to refer the series to the Cambro-Ordovician in common with other rock series in Tasmania.

(b) PERMO-CARBONIFEROUS. Rocks of this age cover a large part of the southern portion of the district and also outcrop at the northern extremity. They were formerly continuous over the whole of the district but have now been largely removed by denudation.

The strata consist of conglomerates, sandstones, pebbly mudstones, mudstones and limestones together with types intermediate to the above. On the elevated land which forms the watershed between Flowery Gully and the Winkfield area, the basal conglomerates are found over-lying the Cambro-Ordovician rocks at altitudes between 500 and 600 feet above sea-level. These conglomerates consist of numerous water-worn pebbles of hard rock types in a sandy matrix. The pebbles are well-rounded and some show facetting but no grooving, so that no definite evidence of Glacial action is present although in common with other Permo-Carboniferous glacial beds in Tasmania they are probably of glacial or fluvio-glacial origin. The basal conglomerates do not exceed 50 to 100 feet in thickness and are succeeded by pebbly mudstones in which the contained pebbles decrease in numbers as the higher of the series are reached. These mudstones contain highly fossiliferous beds crowded with the remains of fenestallae, protoretepora, and stenopora, and to a less extent other typical fossils such as aviculopecten, productus etc. No beds of limestone appear to have been formed in the southern portion of the district. This mudstone series represents the Lower Marine series of the Permo-Carboniferous. Mudstones and argillaceous sandstones overlie the Lower Marine series and occur up to altitudes of 1300 feet on the elevated country above Holwell, thus making the total thickness over 700 feet in this part of the district. The Greta or Lower Coal Measures series doesnot appear to be represented here as far as the present knowledge of the system extends.

To the south-west and west of the Blue Peaked Hill the pebbly mudstones and fossiliferous mudstones occur t altitudes of 400 feet and less above sea-level. Whether

this is due to the uneveness of the Cambro-Ordovician basement on which they were deposited or to faulting cannot be definitely stated, although both causes may have operated.

In the Beaconsfield and York Town areas, the Permo-Carboniferous rocks occur at sea-level. They are generally found fringing the coasts and inland are overlain by later sands and gravels. Along the western shore of Middle Arm and the eastern part where examined the strata consist of mudstones, sandstones, argillaceons sandstones and limestones. The limestones occur on the eastern side of the Middle Arm but are of no great thickness or extent. All of these outcrops may be referred to the Lower Marine series, and the basal beds do not outcrop. Similar strata outcrop around the coast of the River Tamar. as far as East Arm where limestone beds are also found. The fossiliferous mudstones and contained limestone beds represent the Lower Marine Series. The Greta or Lower Coal Measure series is not in evidence unless it be represented by the sandstones without any development of the carbonaceous deposits.

The Permo-Carboniferous strata are either horizontally bedded or dipping at small angles only. In the old tram cutting the dip is to the west at angles of 5^{o} to 10^{o}. Around the shores of Middle Arm the strata dip to the north, north-west or north-east at angles up to 10^{o}.

It would appear from the above descriptions that the Greta Series with its associated coal seams and oilshales which should overlie the Lower Marine is not developed as in adjacent parts of Tasmania such as the Mersey Valley etc. This series is probably represented by the sandstones without any associated coal or oilshale seams as in the Lilydale district.

(c) TERTIARY. Strata of this age occur on the flat country to the east of Beaconsfield. They consist of gravels, sands and clays and the maximum thickness does not exceed 100 feet. The bedrock over this area is formed by the Permo-Carboniferous strata. The western boundary of these rocks is the foot of Cabbage Tree Hill, and is approximately along the junction of the Permo-Carboniferous and Cambro-Ordovician Systems.

In the road cutting on the Sidmouth road east of Beaconsfield the following section is exposed:-

2 - 3	feet	Sandy soil with quartz grit
0 - 5	"	Light-bluish clay
2 - 3	"	Coarse gravels
1 - 6	"	Variegated clays

In a shaft sunk on the Tasmania Tram near Digney's corner the section was

1	foot	Sandy soil with gravel
2	feet	Brown clay
10	"	White clay in places stained brownish by oxides of iron.
		Sandy clay.

In addition to the above, clay outcrops at a large number of localities, and also sands to a less extent. The rocks are only slight consolidated and the beds are lying horizontal.

In addition to the above, the gravels, sands and clays of the "deep lead" along the eastern flank of Cabbage

Tree Hill are also of Tertiary age. These deposits are not apparent on the surface of but have been proved by shafts and bore-holes to extend to a total depth of 400 feet (about 300 feet below present sea-level). Fossil leaves and fruits have been found in the clays and have been described by previous investigators. It is a difficult matter to locate the northern and southern extensions of this lead and boring would be essential to determine its exact course.

The above strata are regarded as being of Lower Tertiary age, because of their position relative to the basalt at Beauty Point, and the fact that their extension in the direction of Beauty Point is overlain by basalt. Basalt in Tasmania is generally regarded as closing the Lower Tertiary Period and hence the above sediments are classified as Lower Tertiary.

(d) UPPER TERTIARY OR PLEISTOCENE. On the more elevated country to the north of Cabbage Tree Hill there occurs a series of grits and gravels, which cover part of the area between the Middle and the West Arms of the River Tamar. The thickness of these beds vary considerably at the present time due mainly to denudation. Generally they are a few feet thick, but on the ridge to the south of Brown's farm on the York Town Road a thickness of about 60 feet is attained.

The material consists almost entirely of quartz the pieces of which vary in size from that of ordinary sand grains to that of pebbles one inch and more in length. The pebbles are well-rounded and water-worn.

On ascending the hill west of the Beauty point Road at a point one mile south of the wharf, the Tertiary sands and clays are passed over, then basalt (30 feet) and finally sands and gravels (60 feet thick.) From this occurrence it is evident that the gravels overlie the basalt and are therefore either of Upper Tertiary or Pleistocene age.

The waste from these gravels has spread over the surrounding country and it is difficult to distinguish the actual boundary between the gravels and the waste from them.

(e) RECENT. Recent alluvium has formed around parts of the coasts of Middle Arm, and along some of the streams of the district. The largest deposit is that along the course of Johnson's Creek from the Gorge upstream to nearly the head of Flowery Gully. It is possible that the formation of this alluvium began even before, but continued into recent times. In places the present creek has cut into the alluvium for a depth of 12 feet and has exposed sandy clays to that depth.

2. IGNEOUS ROCKS.

(a) DEVONIAN. Between the Launceston road and Sassafras Creek south of Dally's Lime-kiln, a decomposed basic or ultrabasic rock outcrops. It forms a narrow belt 2 to 3 chain wide and striking from north-west to south-east. Similar rocks occur in some of the mines on the eastern side of Blue Tier. The rock occurs in some of the mines on the eastern side of Blue Tier. The rock occurs in the Cambro-Ordovician strata and is probably intrusive into them, and relative to the Devionian Oasic and ultra-basic intrusions in the Anderson's Creek area.

(b) UPPER MESOZOIC. The diabase of Upper Mesozoic age which is common throughout Tasmania, occurs to only a slight extent in the Beaconsfield district. A few small and narrow dykes have been discovered but no large intrusions are known. One such dyke occurs on the hills south of Mr. A. E. Cowie's house. Flowery Gully, It intrudes Cambro-Ordovician slates, but remants of Permo-Carboniferous conglomerates are found in the vicinity.

Another dyke is visible on the road between Flowery Gully and Beaconsfield, and according to the plan of Dr. Hills extends some distance to the west. A small exposure is visible on the flats near the old limestone quarry south of the Blue Peaked Hill, and may be connected with the above dyke.

Large boulders of diabase on the west shore of Middle Arm suggest a sill or dyke, probably the former.

Larger intrusions occur in the Frankford district to the South, and at the Stockyard Hills to the North.

The diabase is the typical medium-gained rock composed of augite and felspar found in Tasmania, and so often described that repetition is not necessary.

(c) TERTIARY. Basalt of Tertiary age outcrops near the coast to the north and south of Beauty Point for a length of about a mile. It overlies Tertiary sands and clays and is itself probably overlain by the later gravels. The basalt is a dense fine-grained basic variety but no olivine is perceptible to the naked eye, and it is probably composed of augite and felspar only. In common with other basalt flows in Tasmania, it is regarded as closing the Lower Tertiary Period:-

5. ECONOMIC GEOLOGY

The geological investigation upon which this report is based was carried out with a view to the location and examination of deposits of material suitable for cement manufacture, consequently this subject will be the only one dealt with.

The essential constituents of cement are lime (CaCO, silica (Si_{O_2}), and alumina (Al_2O_3) while small quantities of other constituents such as ferric oxide (Fe_2O_3), magnesia (mgO) etc. are also present. The raw materials by which the lime is supplied are limestone, cement rock, mart, chalk etc., of which limestone is the only one known to occur in Tasmania. The silica and alumina are generally added together in the form of clay, shale or slate which possess the correct proportions of these two constituents.

Large quantities of high grade limestone were known to occur at Flowery Gully and Beaconsfield, and the problem was to discover suitable material to mix with it. The occurrences of limestone, clay, shale, and slate will therefore be fully dealt with. Reference will also be made to other materials and factors connected with the manufacture of cement, particularly those affected by local conditions.

(1) Limestone.

Limestones occur in two rock systems within the district viz:- Permo-Carboniferous and Cambro-Ordovician, of which the latter are by far the more important.

(a) PERMO-CARBONIFEROUS. Limestones are found in this system along the eastern shore of Middle Arm to the east of Beaconsfield. They are exposed in the road cutting beyond the bridge over the Arm on the road from Beaconsfield to Sidmouth. The beds are thin and of little lateral extent, forming lenticular masses in the fossiliferous mudstones or shales. Further north they are possibley more prominent, as a Government kiln was errected in which the limestone was burned in formed times.

The material used was clacareous conglomerate, and the burning operations ceased when the better grade Cambro-Ordovician limestone was discovered.

Similar limestones and calcareous shales have been described by Twelvetrees in the vicinity of West Arm and York Town. These beds were investigated in connection with cement manufacture but were unsuitable.

(b) CAMBRO-ORDOVICIAN. The Cambro-Ordovician system contains a thick bed, or beds, of limestone, as well as several thinner ones, the former being, of course, of greater economic importance. One thin bed or calcareous zone was intersected in the 800 foot level of the Tasmanian Mine. This bed does not outcrop at the surface, or appear to have any lateral extent. The other thin beds occur to the east, and higher in the series, than the thick bed of blue limestone. Some of these beds were penetrated in the mine workings and bore-holes east of the Tasmania mine.

The most important of these thinner beds is that of the white limestone formerly quarried and brunt for lime near the site of Mr. Dally's present kiln. It was about 60 feet wide and of good quality. It does not appear to have been traced far to the north or south although similar limestone was once quarried below the flats to the north of the Middle Arm Creek, near an old lime kiln. This latter bed is, however, slightly higher in the series than the former.

The thick beds of blue limestone occur at two localities as described in dealing with the geology of the district. At Beaconsfield the limestone outcrops at only one place, the remainder of the belt being covered by more recent deposits, its prenence being proved by underground workings and bore-holes. At Flowery Gully the limestone outcrops along a considerable tract of country. These two limestone belts are not on the same line of strike although the material is identical in appearance and they might easily be different, portions of the same bed. This occurrence has been explained above by the probable presence of a large fault, the "heave" of which has separated the faulted ends a considerable distance.

(i) THE BEACONSFIELD LIMESTONE. This limestone was first discovered below the alluvial flats of the Middle Arm Creek, and quarried for lime-burning purposes. Later it was found that the limestone outcropped on the hill to the eastof the flats, and quarrying operations were transferred to that locality. There the limestone is about 400 feet wide, although measurements are not possible.

The limestone does not outcrop on the surface to the north being covered for the most part by the Tertiary deposits of the "deep lead". It has however been cut in the eastern end of the Tasmania Mine workings, and in the East Tasmania bore where itsthickness is about 350 feet.

Nothing further is known of the limestone in a northerly direction although it probably extends that way.

To the south of Dally's quarry the limestone should extend below the flats of the Sassafras Creek, but it does not outcrop at the surface. Mr. Dally states that it has been cut in shaftsin that direction and this is probably correct.

There thus exists a belt of limestone with a length of one and a half miles and possibly as much as three miles and a width of 350 feet at least. The quality of the limestone is to all appearanceidentical with th t at Flowery Gully. (see below) and therefore satisfactory for cement manufacture As noted above however, facilities for quarrying exist at only one locality (the present one) and it is along a length of only 15 chains that such operations could be carried out. The working facilities in this limestone deposit are therefore unsatisfactory, exce t for one small part, as underground quarrying or mining would have to be resorted to. The cost of obtaining the limestone would be necessarily high thus rendering it unsuitable for cement manufacture on a commercial basis.

(ii) The Flowery Gully Limestone. This limestone occurs near the head of Johnson's Creek in the Flowery Gully district. It outcrops boldly on both sides of the Flowery Gully to Winkleigh road on the ascent of Adams Hill. The northern end of the belt is practically the recent alluvium along Johnson's Creek although limestone outcrops at a few places in the creek bed. As seen above the limestone does not appear to the north of the alluvium and it is undoubtedly cut off by a fault. At the Southern end of limestone passes below the Permo-Carboniferous strata and it must have an extension in the direction of Winkleigh, but just how far this occurs could only be proved by exploratory work such as boring.

The western boundary of the limestone is generally concealed by Permo-Carboniferous conglomerates, but at the southern end ferruginous sandstones are visible underlying it. At its eastern boundary the limestone underlies a thin series of slates and sandstones which further east, give place to a wide belt of slates. The whole of the series of limestone and enclosing strata have a strike of north-west or north-north west and a dip to the north-east at angles of 40° to 50°.

QUANTITY. The outcrop of the limestone at Flowery Gully is 110 chains long and with a maximum width of 20 chains. The width at the outcrop is somewhat less in places due to a covering of Permo-Carboniferous basal conglomerates, the minimum being 12 chains. An average width of 16 chains could be taken for working purposes without involving the removal of any large thickness of overburden. (it must be remembered that it is the width at the outcrop that is 20 chains and the actual thickness of the bed at right angles to the dip would be approximately 14 chains.) The total area over which the limestone outcrops is therefore about 160 acres.

The altitude of the limestone at its north end is 290 feet above sea-level. The surface rises along the road to Winkleigh to an altitude of 690 feet but the limestone to the east and west of the road occurs at greater heights. The greatest height attained by the limestone is 710 feet. It is difficult to estimate the average depth of limestone available down to the depth of 290 feet in order to determine the quantity of rock which could be obtained by quarrying methods It is safe to assume, however, that 200 feet would be a conservative estimate.

Using the above figures the quantity of limestone to be obtained by quarrying methods above the 290 foot level deducting 33 per cent for cavities, loss in working etc. would be 70,000,000 tons. In addition, every 100 feet in depth over the area below the 290 foot level would add a further reserve of 43,000,000 tons.

Of the total area, 80 acres on the property of Mr. F.M. Beams and 30,000,000 tons would be available under the above conditions.

About 50 acres occurs on the property of Mr. C. McKercher, being situated on the 100 acre block charted in the name of J. Ellis. The amount to be obtained by quarrying on this property is approximately 10,000,000 tons.

The remainder of the limestone occurs on the properties of Mr. Quigley, E.L. Douglas, A.E.Cowie, etc. but the quantities are small compared with those on the above two properties.

QUALITY. The limestone is a dense bluish-grey type with veins and bunches of white crystalline calcite which, however, form only a small part of the rock. Except for the veins of calcite, the rock appears to be of a very uniform nature and composition.

The following analyses taken from the report by the late W.H. Twelvetrees (Mineral Resources No.2, 1917) show the compositon of it.

	Total	Calcium Carbonate	Magnesium Carbonate	Oxides of iron and aluminium	Silica ox Insoluble	Moisture
Cutwyche's Quarry	99.98	95.40	1.22	1.79	1.44	0.13
Caves	99.91	95.65	0.83	1.70	1.61	0.18
Quigley's Quarry	99.91	94.75	1.17	2.81	0.98	0.20
Main Outcrop	100.00	95.45	1.1	1.65	1.85	1.05
Outcrop at Face	100.00	94.00		3.15	0.98	1.87
Outcrop over Caves	100.00	93.72		0.55	5.53	0.20

These analyses prove that the limestone contains 93 to 96 per cent of calcium carbonate and is therefore a very high grade one. As far as appearances go the rock should maintain this composition over the greater part of its outcrop. At several localities, however, it contains impurities in the form of veins of white quartz and black chert. The white quartz veins were observed at one place only viz along the road cutting near the foot of Adams Hill. They are not numerous and would have only a small effect on the quality of the limestone in that vicinity. A few Chart veins also occur at the above locality.

At the south end of the limestone outcrop the chert

veins are very numerous. They are exposed in road cuttings near the top of the hill at the head of Flowery Gully, and pieces are strewn over the surface in that vicinity. In a small quarry for road metal south of the road junction on the hill between Flowery Gully and Winkleigh, the chert veins occur to the almost total exclusion of limestone. Pieces of limestone on the dump at the north end of the tunnel also contain vein of chert. Where the veins are plentiful, as indicated above, large quantities of the limestone would be useless owing to its high silica content. The western side of the limestone appears to be free from the outcrop would be of the usual high quality, but care would have to be exercised that quarries were not opened up in the portions containing the chert vein.

WORKING FACILITIES. The conditions over the whole of the area are suitable for working the limestone by quarrying methods. The best point to commence would be at the northern and where the altitude of the surface is lowest, thus making available the greatest depth of rock. This commencement point would be on the property of Mr. F. N. Beams on which the greatest amount of limestone is available. Quarrying operations could also be commenced on Mr. V. Mcfecher's property (100 acre block) from the road level, but a smaller "face" would be obtained.

(c) TUFACEOUS LIMESTONE. Limestone was formerly quarried on Blyth's or Limestone Creek at a point due south of Beaconsfield on the 100 acre block charted in the name of R. de Little and C. Blyth. The quarrying operations were carried out below the level of the flat country in the vincity. The quarry cannot be inspected, but pieces of rock are obtainable nearby. These consist of a white limestone of fine texture and containing numerous cavities. It is undoubtedly of secondary origin, but what formation the material has been obtained from cannot be determined. Rock exposures are few in the vicinity owing to the covering of recent alluvium and soil. Slates are exposed in the creek a few chains downstream and it is possible that the material was derived from Cambro-Ordovician limestones which do not outcrop. Diabase also outcrops nearby and Permo-Carboniferous strata may be present below the plain.

The limestone is of remarkable purity as it contains 97.73 per cent of calcium carbonate, but as its extent, depth etc. cannot be determined it is of no economic importance at the present time.

11. CLAY, SHALE, SLATE ETC.

The Flowery Gully Limestone is a high grade one and it is therefore necessary to mix with it clay or similar material containing the correct proportions of silica, alumina and oxide of iron in order to obtain a mixture suitable for cement manufacture.

Clay consists of a mixture of Kaolin with more or less sand and other impurities. Kaolin is a hydrated silicate of alumina ($2H_2O.\ Al_2O_3.\ 2Si_1O_2$). Clay is in the first place formed by the weathering of igneous rocks containing minerals such as felspar, augite, Hornblende etc. which consist largely of alumina and silica. The clay thus formed may remain where formed or be transported and deposited under water as sedimentary clay. A large proportion of the sedimentary rocks of the earth's crust are thus formed.

As the clay becomes burried under thickness of

strata it becomes more consolidated and passes through various stages forming mudstone shale and slates. Earth pressures and metamorphism also help in these changes particularly in the formation of slate and may even carry the change further and cause schists to be formed from the strata. This latter process involves a change in mineral composition but except for this the mudstone, shale and majority of slates have practically the same chemical and mineral composition as the original clay differing from it only in physical properties. Thus mudstones, shales and many slates are materials just as suitable for cement manufacture as the original clay.

In addition to the above processes clay is also found by the weathering of such sedimentary rocks as were formed from clay.

Practically all of the above argillaceous rocks (clay, mud-stone, shale, slate) occur in the Beaconsfield and Flowery Gully district at various localities, being located as a result of the present investigation. They were examined and sampled in order to determine their suitability or otherwise for mixing with the Flowery Gully limestone. The samples were analysed in the Assay Laboratory Launceston and the results are given in the attached table.

These deposits will be discussed separately below.

(a) RECENT ALLUVIUM, JOHNSON'S CREEK

A narrow tract of alluvium extends along the course of Johnson's Creek from the Gorge as far upstream as Adams hill, a distance of nearly three miles. The greatest width is 30 chains but the average is 10 to 15 chains. An average of 10 feet of this material is visible in some of the creek banks and it extends to greater depths below the present bed of the creek. The alluvium appeared to be generally of a clayey nature, and the bottom layers in particular seemed to be a very stiff clay. At every locality however a large amount of grit could be detected in it.

Samples Nos. 13 and 14 were taken from the creek bank to the west of Mr. A. E. Cowie's house. No. 13 represents the upper 3½ feet exclusive of 1 foot of soil. No. 14 represents a depth of 2 feet vertically below No. 13. The analyses show that the silica content is altogether too high in comparison with the combined ferris oxide and alumina, owing to the sand mixed with the clay. The material is therefore unsuitable for mixing with the Flowery Gully limestone unless a supply of low silica and high alumina clay was available to mix with it. Further the material would have to be obtained by underhand quarrying which is relatively expensive. Water trouble would be encountered in this method of working.

(b) TERTIARY SEDIMENTARY CLAYS. Tertiary sediments containing clays occur on the flat country to the east, north-east and north of Beaconsfield. The surface is covered by a layer of gravels varying in thickness from a few inches to two feet and the clays are only exposed in quarries, road and tram cuttings and other works. From the sections along the Middle

Arm and a few inland the bedrock is in every case, Permo-Carboniferous strata. Although clay can be obtained beneath the surface at almost any point, the greatest development and thickness occurs along the tramway to the north of Brandy Creek. The upper layers of clay are exposed in the cuttings along the tram in this area.

QUANTITY. The clays extend along the tram fora length of at least 30 chains. To the north the clays may be regarded as terminating at the flat plain 10 to 20 feet above sea-level. Clay possibly occurs under this plain but would be of no great depth. To the south, the clay beds give place to more sandy beds as seen in the tram and Bowen's Jetty road cuttings.

From the tram the clays extend as far to the east as the Bowen's Jetty road and probably a similar distance further east. To the west they probably extend as far as the Beauty Point road. The total width is, therefore, about 60 chains.

The total depth of the clay beds is not known with any degree of certainty. A shaft sunk on the tram near Digney's corner exposed 11 feet of the beds. Towards the bottom the beds were becoming somewhat sandy, but still suitable, and such material might extend several feet at least further in depth. Should it be desired to use these beds it would be a necessary preliminary step to determine by boring or otherwise the depth over the remainder of the area.

Assuming an average depth of 10 feet, and deducting 25% for unsuitable portions, loss in working etc. the amount available would be 4,200,000 tons.

QUALITY. The upper layers are brownish in colour by oxides of iron which have been concentrated near the surface. As exposed in the shaft, the brown colour only continues to a depth of two feet, and the underlying clay becomes lighter in colour containing at first patches of iron-staining which, however, does not continue to the bottom.

The average clay is a pale bluish grey colour and of very compact appearance. It was dry and formed a comparatively tough yet crumbly body. The upper layers were entirely free from grit, but the lower one or two feet were somewhat gritty.

Samples 4, 19 and 20 in the attached table show the composition of the clay. Sample 4 was taken from the upper three feet of the clay in the cutting before the shaft was sunk. Sample 20 represents the four feet immediately underl ing the upper two feet which were not taken. Sample 19 represents the lower five feet immediately below No. 20. These analyses show clearly that the silica content is increasing and the oxide of iron and the alumina are both decreasing with depth.

Combining the analyses of Nos. 20 and 19 in the proportion of their depths, the result obtained is that opposite No. 24. This material is quite suitable for mixing with the Flowery Gully limestone. Should a higher silica content be desired it could be obtained by including a further depth of themore sandy lays at the

bottom of the deposit but it would be essential to determine the degree of fineness of the contained sand in these layers.

WORKING FACILITIES. The clay occurs under the slightly elevated country to the north of Brandy Creek. The deposits could be worked by quarrying methods from the north, east or south in which directions the land does not exceed 10 to 30 feet above sea-level. The beds are lying horizontaland no water trouble in quarrying is anticipated.

CONCLUSIONS AND RECOMMENDATIONS. The quantity and quality are such that the clay could be utilised to mix with the limestone at Flowery Gully. The working facilities and its position on the tram line would permit of the clay being obtained cheaply by quarrying methods. An essential preliminary step before deciding to work this deposit would be to sink shafts or bore-holes (by hand plants) to determine the extent, depth, and quality of the clay over the whole of the area.

(c) PERMO-CARBONIFEROUS MUDSTONES OR SHALES. Permo-Carboniferous strata outcrop over a large area in the southern part of the district, chiefly to the west and south of Flowery Gully. As described above the strata consist of conglomerates, sandstones, mudstones, shales and intermediate types. It was thought possible that some of the mudstones or shales would prove of suitable composition and so they were examined where the facilities were favourable. The best exposure of shales which might be of suitable compsoition is in an old tram cutting to the south of Blue Peaked Hill (The Sugarloaf). The strata here consist of thinly bedded white fossiliferous shales which dip to the west at angles of 5°. The beds do not contain any pebbles although judging by the water-worn pebbles on the surface, the overlying beds must do so.

QUALITY. Samples Nos. 6, 15, 16, 17 were taken from the above shales. Samples 6 was a preliminary one over a depth of four and a half feet. Samples 15,16, 17 represent a total thickness of 14 feet 6 inches taken in three sections not immediately below one another. The analyses show that the strata are very uniform in composition throughout the thickness sampled. The silica is high compared with the total alumina and oxide of iron content, the average ratio being 4 to 1. This high ratio represents the extreme one for clays to be mixed with high grade limestone for cement manufacture. While a clay with such a ratio might be used successfully, it is preferrable to have one with a lower ratio. The oxide of iron is also a trifle high compared with the alumina but it is desirable to avoid such a mixing if possible.

A factor which, though not present where the shales were sampled, might have a large effect on the quality is the presence of pebbles of hard rock types in these strata. Not only would they increase the silica content but would also effect the fine grinding of the shales.

QUANTITY. Although not altogether satisfactory as regards quality it is worth recording that fairly large quantities of these shales occur. A thickness of 14½ feet was sampled but it is probable that a total thickness of 30 feet or more of

similar material occurs. The shales will occur along the eastern flanks of the hills to the west of Johnson's Creek (Flowery Gully) and its western headwater stream, for a length of a mile or more. From this outcrop the beds will extend to the west, but the length of the extension cannot be definitely stated.

The quantity would also be greatly influenced by the nature of the underlying and overlying beds which might be of similar or better material.

WORKING FACILITIES. Where the shales outcrop along the eastern flanks of the hills, they could be obtained by quarrying methods. As the workings progressed to the west, however, the beds would pass below others and mining operations would have to be employed, entailing more expensive working costs.

CONCLUSIONS AND RECOMMENDATIONS. The quality of the shales is not quite suitable for their use for cement manufacture owing to the high silica content. The working conditions are not ideal although this would depend to a large extent on the nature of the overlying bedsand their suitability. These shale deposits are therefore not entirely suitable, but taking into account the fairly large quantities available and their closeness to the limestone deposit they are worth considering should other deposits in the district not prove

(d) CAMBRO-ORDOVICIAN. SLATES AND THE WEATHERED PRODUCTS THEREOF.

Slates occur at numerous localities and these together with the clay derived fromthem by weathering, were investigated at several places in order to determine their composition and suitability.

(i) BROWN'S PROPERTY. This property is situated along the Paint Works Road, one and a half miles to the north-west of Beaconsfield. A white clayey material has been opened up at several localities and quantities have been sent away for pottery purposed. At the south-east corner of the 58 acre block (M. Brown) an adit, shaft, and several small trenches and shafts have been dug to test this deposit. The material is best exposed in the recent shaft sunk to a depth of 12 feet. Below two feet of soil and sub-soil, there occurs a white clay which gradually gives place in depth to less altered slates, some of the original dark slates showing in the bottom. These slates have a strike of 325° and a dip of 75° to the north-east. To the west a bed of argillaceous sandstone occurs, and the clay derived from this is very sandy. The fallen-in adit or trench is situated 50 to 60 feet to the east, and the same white clay is visible at some points although generally covered by fallen-in debris. At the head of the adit. 15 feet of sands and gravels occur overlying the decomposed slates. In all the other trenches, smaller thicknesses of these gravels overly the slates, and, in fact these Tertiary gravels cover the whole of the ridge at this locality.

The same decomposed slates are exposed in a low road cutting on the Paint Works road to the north-east of the above locality. The slates here are on the same line of strike as that described above and represent the same series of beds. They are exposed over a length

of two chains, but are covered by gravels at both ends of the cutting. Further west, brownish, undecomposed slates outcrop in another cutting.

QUALITY. Samples Nos. 1, 2, 3 and 18 show the composition of the clay, Sample No. 2 was taken across a width of 26 inches at a depth of 8 feet and No. 1 across 28 inches of the same slates at a depth of 11 feet in the shaft. Sample No. 3 was taken across 21 inches of the sandy clay lying against the above. Sample No. 18 was taken from the road cutting.

Samples Nos. 1 and 2 are similar although the more solid slates of No. 1 show an increase in silica content and a decrease in iron, alumina and moisture. The ratio of silica to alumina and oxide of iron is about the lower limit of that for clays used in cement manufacture, but it would not prevent the clay being utilised. The content of iron is low and would not prevent the clay being utilised. The content of iron is low and would tend to produce a less coloured product. Sample No. 3 is altogether to high in silica to be used alone though it might be suitable to mix with material low in silica. The particles of sand were very fine but would require investigation to determine their actual size.

Sample 18 contained numerous narrow veins of quartz which rendered the silica content much too high, and the material unsuitable. Thus the only suitable in this area is the decomposed slates and the clay derived therefrom which do not contain any quartz veins.

QUANTITY. It is difficult to estimate the quantity of theabove material available. The material on the hill and that on the road belong to the same beds of slate, and it thus occurs over a length of at least 30 chains. The greatest width exposed is the two chains shown in the road cutting. As regards depth the white material would give place to unaltered slates which are probably just as suitable (if not more so) as the decomposed material.

WORKING FACILITIES. The material on the hill is 100 feet above that on the road. A tract of flat land intervenes between the two, however, and quarrying operations could be carried over a length of 15 to 20 chains on the north side of the hill. The maximum "face" to be obtained would be 100 feet.

The greatest drawback to the working of these deposits is the overburden of sand and gravel. These occur up to a thickness of 20 feet and would have tobe removed in order to obtain the underlying material.

CONCLUSIONS & RECOMMENDATIONS. The clay and underlying slates wherefree from quartz veins are suitable for mixing with the limestone. They occur in quantities which cannot, owing to lack of information, be expressed in figures. A considerable amount of explanatory work would be essential to determine the extent and width of the slate belt. The working facilities are not advantageous, owing tothe overburden, and the small area which could be quarried. Care would have to be exercised in

working not to include inter-bedded sandstones layers, or portions of the slates containing quartz veins.

(11) LITTLE WONDER DAM. Material identical in all repsects with that described above, occurs on the west bank of Brandy Creek, near the Little Wonder Dam. Surface workings have been carried out on this material and quantities of it have been sent to Launceston for pottery manufacture. White clay passing downwards into altered slates is visible inthese excavations. These slates are not situated on the extension of those on Brown's Land, but are half a mile to the north-east at right angles to the line of strike.

QUALITY. Sample No. 21 was taken over a depth of 7 feet from the top of the clay. One narrow quartz vein was included in the sample. The composition is generally similar to that at Brown's but on the whole the clay is slightly more suitable for cement purposes.

If the quartz veins occur to any large extent, however, they will render the material unsuitable.

QUANTITY. The decomposed slates are exposed over a width of nearly 100 feet. Slates are exposed in the old mine workings for a considerable distance to the south, but do not appear to be decomposed to the same extent near the surface. The slate belt will extend along its strike of 320^{o} but has not been opened up. It is stated that the white clay and altered slates extend to a depth of 15 feet at least, and the slates will, of course, extend to greater depths.

WORKING FACILITIES. The slate belt occurs on a low ridge between the two headwaters streams of Brandy Creek, and the maximum "face" to be obtained by quarrying operations would not exceed 60 feet.

The surface is covered by a layer of sands and gravels and this overburden would have to be removed thus increasing working expenses.

CONCLUSIONS AND RECOMMENDATIONS. The clay and altered slates are ofsuitable composition and probably the unaltered slates would also be suitable, but these materials are likely to be rendered unsuitable should the quartz veins be proved to be numerous. The working facilities are not greatly favourable, especially as regards overburden. The deposit has only been opened up at one locality and exploratory work would be necessary to prove the extent.

(111) BLYTH'S PROPERTY. On the north bank of Middle Arm Creek, 10 chains upstream from the Launceston road bridge, a quarry has been opened up in undecomposed slates. Sample No. 22 was taken over a width of 10 feet and No. 23 over a width of 6 feet at a point 20 feet distant from No. 22. These two samples are similar in composition and are rather high in alumina and oxide of iron, particularly the latter, compared with the silica. Also the magnesia content is higher than usually contained in clays suitable for cement

manufacture, although the low magnesia content of the Flowery Gully limestone would tend to reduce this defect.

Considerable quantities of these slates could be obtained along their line of strike. They could be won by quarrying methods with a face of 50 to 60 feet, but overburden of gravels would have to be removed to the north of the quarry.

(iv) FLOWERY GULLY. The limestone at Flowery Gully is overlain to the east by a mixed series of slates and sandstones, which further east give place to a wide belt of slates. The sandstones are in evidence between Johnson's Creek and the small tributary from the south which flows near Mr. Cowie's house.

On the east side of this small tributary, the slates occur on the blocks charted in the names of W. Palmer (50 acres) and A. E. Cowie (179 acres) but both owned by A. E. Cowie. The slates do not appear to the north of the alluvium along Johnson's Creek but the sandstones of Blue Peaked Hill occur in faulted relation thereto. The belt of slates can be traced to the south-east through the two blocks mentioned above, and also across the blocks charted as J. Ellis, 50 acres (now C. McKercher) and B. W. Champion where they become covered with Permo-Carboniferous rocks. The eastern limit of the slates was not closely examined but the belt is at least 20 chains and possibly 40 chains wide.

This belt of slates therefore forms one, parallel to, but about 20 chains to the east of, the Flowery Gully limestone, and is roughly of the same dimensions as the latter.

QUALITY. The slates weather at the surface and yield a light brown clay which covers the greater part of the belt. Solid and unweathered slates outcrop at very few localities and not in any great quantity. The facilities for sampling the slates were therefore absent, but the clay and the mixed clay and slates were sampled.

Sample No. 5 represents a 2 foot width of slates and weathered slates No. 7 a 2 foot depth of clay, No. 8 a 2½ feet depth of clay and slates, No. 9 a two foot depth of clay, and No, 10 a fifteen inches of solid slates. These samples were taken from various places on the flanks and summit of the hill south-east of Mr. Cowie's house. Samples 11 represents 2 feet of cla, and slates, 9 inches of soil being rejected and No. 12 represents 18 inches of clay and slates 12 inches of sandy soil being rejected both samples being taken on the base of the hill east of the small creek.

The samples vary slightly in composition but represent the same general features. The silica content ranges from 61.80% to 70.60%, but the latter is somewhat exceptional as the sub-soil where No. 9 was taken from was slightly sandy. The alumina ranges from 15.50% to 20.17%, and the ferric oxide from 5.81% to 8.70%. The ratio of silica to total alumina and ferric oxide ranges from 2.16 6o 3.24, although the latter is probably exceptional, and 2.63 is nearer the true upper limit. The corresponding average ratios

would be 2.72 and 2.47. This ratio is at the limit of the range generally allowed for clays to be mixed with limestone, but clays with similar ratios have been used successfully in operating plants. The ferric oxide is somewhat higher in proportion to the alumina than the ideal (1 to 3) but similar clays etc. have been used successfully.

The above analyses are of samples of the derived clay weathered slates and solid slates and mixtures thereof. In depth, only solid unweathered (more or less) slates will be met with and these will form the greater portion of the material to be mixed with the limestone. An examination of the analyses in conjunction with the nature of the samples does not indicate any marked difference between the various classes of material, and to all intents and purposes the slates would appear to be of similar composition to the clay and weathered portions thereof. Whether this would be verified or otherwise by more exhaustive sampling cannot be definitely stated. The slates are, however, not metamorphosed and there is no reason to expect them to show any great variation from the clay derived from them.

The only feature likely to affect the quality of the slates is the presence of barren quartz veins. These were observed at only locality by the wirter and their effect will be purely local.

QUANTITY. The average length of the slate belt is about 80 chains and the width at least 20 chains so that the total area would be about 160 acres. Of this, about 100 acres is situated on the property of A. E. Cowie.

The altitude of the flats along Johnson's Creek is 250 feet, while the highest point on the hills to the south is 750 above sea-level, while the average depth over the whole of the area down to the 250 level would be about 200 feet. On A. E. Cowie's property the average depth would be about 150 feet. Using these figures and deducting 25% for unsuitable portions, loss in working etc. the total quantity available would be 87, 120,000 tons, and on A. E. Cowie's property 54,450,000 tons.

WORKING FACILITIES. As stated above, the altitude of the slates where they junction with the alluvium of Johnson's Creek is 250 feet. On A. E. Cowie's land the surface of the outcropping slates rises to altitudes of 600 feet, so that faces of 350 feet could be opened up if required. Faces of 100 feet could be developed in a distance of several chains from the alluvial flats. To the south beyond A. E. Cowie's land, the surface rises still higher (750 feet) and greater faces could thus be formed.

Overburden is practically absent, as the clay derived from the weathering of the slates forms the soil which is of similar and suitable quality to the slates. In a few localities the soil is somewhat sandy and it might be necessary toremove 12 to 18 inches of this overburden.

CONCLUSIONS. Large quantities of the above materials are available on the areas described. There is practically no overburden and the topography is such that the material could be obtained by quarrying methods large faces being easily obtained. Every facility for economical extraction therefore exists. The quality is not absolutely ideal thematerial being

somewhat low in silica and high in ferric oxide, but it is quite suitable for mixing with the Flowery Gully limestone, and similar material has been used successfully in existing plants.

(v) RESIDUAL CLAY OVERLYING FLOWERY GULLY LIMESTONE. The weathering of the limestone results in the formation of small quanities of residual clay which forms the surface soil and sub-soil. Such material is also found in joints, cracks, solution cavities etc. near the surface.

An analysis of some of this from the road cutting near Beam's house is quoted by Twelvetrees and proves that the material is of suitable composition.

The quantity obtainable is relatively small, and the supply w uld have to be augmented by material from other sources. This would involve extra mixing of raw products which is to be avoided as far as possible, so that though the clay would be cheaply obtained in the quarrying of the limestone its use would be disadvantageious in other respects.

(VL) GENERAL CONCLUSIONS. The above investigations of all possible sources of clay, shale etc, for mixing with the Flowery Gully limestone, have shown that some are unsuitable while others are quite suitable as regards quantity, quality etc. although any particular deposit may not be necessary so in every respect.

Taking every factor into consideration, the slates and weathered products at Flowery Gully are undoubtedly the most suitable of all. The quantity of working facilities are all that could be desired, and the quality is similar to that of materials which have been successfully used in operating plants in America and in other parts of the world. These deposits have the further advantage of being situated near to the limestone deposits so that the whole project could be more efficiently controlled and supervised.

The Tertiaryclay to the eastof Beaconsfield is probably the next in importance. It is situated on existing transport facilities, and is present in considerable quantities which however would require preliminary investigation. A small thickness of overburden would have to be removed, but otherwise working facilities are fair as the clay could be quarried from low faces. The quality is suitable but the deposit would have to be worked in one face so as to mix the various layers, which detracts from its suitability.

The white clay and underlying slates at Brown's property and the Little Wonder dam are of suitable quality, which is however, adversely affected by the presence of quartz veins and sand stone beds. A large thickness of gravels would have to be removed in places which would greatly increase the cost of obtaining the material, while the quarrying facilities are only fair. The extent and quantities would require further preliminary investigation.

111. GENERAL REMARKS ON PROPORTIONING THE MATERIALS? PROCESS ETC.

	Silica	Alumina	Ferric Oxide	Calcium Carbonate	Lime	Magnesia
Limestone	1.34	Total	2.10	95.26	53.34	0.51
Slate & Clay	66.29	18.31	7.48	nil	nil	1.19

On the basis of a cement mixture with 75 per cent of calcium carbonate (42 per cent calcium oxide or lime), the proportion of limestone and slate in the mixture would be 3.75 to 1. or 78.95% limestone and 21.05% slate. Using this mixture, the approximate composition of the cement produced would be - silica 22.0% ferric oxide and alumina 10.6% lime 60.7%, magnesia 3.4%. This would give a ratio of lime to total silica, alumina and ferric oxide of 1.86, and the cement would probably be under-limed.

Using Mead's formula for proportioning the raw materials in order that the cement will conform to the following formula.

$$\frac{\%\ \text{lime}}{\%\ \text{silica} - \%\ \text{iron oxide} - \%\ \text{Alumina}} - 2.05$$

The ratio of limestone to clay or shale

$$- \frac{(\%\ \text{silica and}\ \%\ \text{ferric oxide and}\ \%\ \text{alumina in clay} \times 2\tfrac{1}{8} - (\%\ \text{lime in clay})}{}$$

With the above materials, the ratio of limestone to slate would be 4.5 to 1, or 81.81% limestone and 18.19% slate.

This proportion might possibly prove too high and the desired mixture of raw materials would be found to lie between the above limites. The exact adjustment of this proportion is a matter for the plant chemist and depends upon the conditions of manufacture. It is evident, however, that it is possible to produce a cement of standard composition from the above materials.

The limestone is a dense, hard rock containing little or no moisture. The slate is a compact rock but not so hard as the limestone, and contains a relatively small proportion of moisture. Both materials lend themselves to manufacture by the dry process. The crushed materials would tend to form a uniform mixture with little or no tendency to segragate when tipped into bins etc.

I½. FUEL. Pulverised coal will probably be the fuel used in the cement kiln while coal in the above or the solid form might also be used for power.

Goal seams do not occur anywhere within the district so fuel will have to be transported from another district. The Greta or Lower Coal Measures of the Permo-Carboniferous system are undoubtedly present in the district, but no coal seams were formed in them.

The nearest coalfield in Tasmania is the Mersey one situated 15 miles to the west. The coal in this field is of fair quality but has a high sulphur content. The seams are thin and greatly faulted, and the total reserve is not large.

In order to obtain a sufficient and constant supply, coal would have to be brought from the East Coast coalfields of Tasmania, or from Newcastle, New South Wales. The total cost of the coal and transport charges to Beaconsfield would in each case have to be considered against the respective calorific values in order to determine which source would be the most economical. The Tasmanian East Coast coals are suitable in every way for use as pulverised fuel.

The obtaining of crude oil from the oil shale field of Latrobe might also be a possibility of the future.

V. GYPSUM. No deposits of gypsum of commercial importance have so far been located in Tasmania. Adequate supplies could be obtained readily from South Australia.

VI. TRANSPORT FACILITIES. It is probable that the coal and other supplies would be obtained and a large part of the cement output exported, via Beauty Point. No matter therefore where the plant is located, cheap, means of communication will have to be established between Beauty point and Flowery Gully.

A good road connects the two localities and motor transportation is a possibility. It is more probable however that the construction of a narrow gauge rail - or tram-way would be a more satisfactory method. The length required would be from 8 to 9 miles depending on the route selected. Portion of the Old Tasmania tramway could be utilised and thus avoid 2½ miles of construction. This tramway is in very fair ordr order though quantities of sleepers and rails would have to be relaid. There would be practically no engineering difficulties in the way of construction and gardes would be easy as the portions of Flowery Gully where the limestone and slate deposits occur are only 250 & 290 feet above sea-level respectively. Two routes are available - one through the Gorge and along the valley of Johnson's Creek, and the other along the valley of Sassafras Creek and across a saddle into Flowery Gully.

The former would be the more direct and therefore, shorter route. It would connect with the Tasmania or Wyett's tram near Beaconsfield, and pass through the Gorge on the north side of Middle Arm Creek. It could then run up either the east or west side of Johnson's Creek. The western route would be the shorter but would traverse private property all the way. The eastern one would traverse Crown land for a considerable distance which would be more easily and satisfactorily obtained than through private land.

The other route would cross the Middle Arm Creek below the Gorge and then follow the valley of the Sassafras Creek on its western side along the flank of Blue Tier. It would then cross a saddle at the north end of the Blue Tier at an altitude of 360 feet and run along the south and east sides of Johnson's Creek. Along the Blue Tier this route would traverse Crown Land for a part of its length.

Both routes would serve both the slate and limestone deposits with only short branch lines. Should the limestone at the head of Flowery Gully be worked, it would be better to cross a saddle to the south of A. E. Cowie's house into Flowery Gully, instead of following Johnson's Creek which would perhaps involve a tunnel.

VII. PLANT SITE. The limestone and slate occur close together at Flowery Gully. The coal would have to be brought inland a large portion of the cement exported, via Beauty Point. The cement plant might therefore be located either at Flowery Gully or Beauty Point.

For a plant producing annually say 30,000 tons of cement there will be required about 34,000 tons of limestone, 9,000 tons of slate, and 20,000 tons of coal. With the plant at Flowery Gully, the 20,000 tons of coal together with other supplies and stored would have to be transported against the grade, and the 30,000 tons (or part thereof) of the cement transported with the grade.

With the plant at Beauty Point, only mining supplies and fuel would have to be hauled against the grade, and the 34,000 tons of limestone and 9,000 tons of slate with the grade. Altogether there would be no great differences in the total weight to be hauled, though it would probably be greater with the plant at Flowery Gully, but it would be divided nearly equally in both directions. With the plant at Beauty Point, the greates part of the load would be taken with the grade.

Thus considered solely from the transportation point of view, the advantage is slightly in favour of Beauty Point. Also, the plant at Beauty Point would be in, and close, to, the established township of Beauty Point and Beaconsfield and thus nearer to a course of labour, and the necessity for establishing another township would not arise.

At Flowery Gully, however, the quarrying operations and manufacturing plant, if located there, would be concentrated and thus more suitably located for supervision. A plant site at Flowery Gully would also be less costly than one at Beauty Point.

VIII. WATER SUPPLY. If the plant be situated at Flowery Gully, only small supplies of water could be obtained locally from Johnson's Creek. These might not be sufficient for the purpose and supplies would have to be brough from other streams. The only stream from which a supply could be obtained in quantity and brought by gravitation is the Supply River 5 miles to the south. A race was once cut from this river to the head of Flowery Gully and the water then conveyed by a tunnel through the ridge, and by a race into the head of Sassafras Creek. From the tunnel the water could be delivered directly into the head of Flowery Gully.

The race has now been filled in and the tunnel might have fallen in in places but could be easily re-opened.

If the plant be located at Beauty Point, sufficient supplies could probably be

obtained from either Middle Arm Creek, or Anderson's Creek, but these sources would require investigation.

(6) CONCLUSIONS.

The deposits of limestone at Flowery Gully have been known for some considerable time to be suitable as regards quality and quantity and working facilities for cement manufacture. The difficulty in the past has been the location of supplies of clay, shale etc. with similar advantages and suitable for mixing with the limestone. This investigation has revealed the presence of several deposits which might serve this purpose, themost important and favourable of which is that of the slates, decomposed slates and clay at Flowery Gully. These materials are present in large quantities, and under conditions suitable for easy and economical extraction . The material is also of suitable quality and when mixed with the limestone will yield a cement of standard composition. This deposit and that of the limestone are situated within 20 chains of one another at Flowery Gully, thus permitting concentration of work.

The plant will be located either at Flowery Gully or Beauty Poin depending upon the factors outlined Above.

Coal does not occur in the vicinity and will have to be brought from other parts of Tasmania or from New South Wales. The same remarks applies to gypsum although only small quantities of this material is required. With these exceptions, however, the conditions are all favourable for the successful establishment of a cement industry within the district. Further the situation of the industry (where both interstateand overseas vessels can be accommodated without any difficulty) with which it can be easily connected by tram or railway in the above district, would give it an added advantage and importance.

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GOVERNMENT GEOLOGIST

Hovart,

5th May, 1924

ANALYSES OF CLAY, SHALE, SLATE ETC. FROM the BEACONSFIELD & FLOWERY GULLY DISTRICT.

~~164~~

Field No.	Reg. No.	Silica SiO_2	Ferric Oxide Fe_2O_3	Alumina Al_2O_3	Titanium Oxide TiO_2	Lime CaO	Magnesia MgO	Loss on Ignition	Total	Silica Ferric Oxide & Alumina
1	159	66.70	2.24	24.68		Nil	1.01	5.50	99.60	2.53
2	160	64.24	3.50	24.70		Nil	1.08	6.30	99.82	2.35
3	161	79.60	1.83	14.46		Trace	0.50	3.90	100.36	4.00
4	162	54.92	7.98	24.74		Nil	0.87	11.00	99.51	1.68
5	164	67.08	8.04	17.66	0.50	Nil	1.30	6.00	100.50	2.60
6	165	75.40	4.58	14.32	0.30	Trace	1.30	4.10	100.00	4.00
7	193	64.40	8.70	19.50	0.36	Nil	1.16	6.90	101.02	2.28
8	194	66.68	8.70	17.26	0.16	Nil	1.16	5.40	99.36	2.56
9	195	70.60	6.20	15.50	0.10	Nil	1.23	4.20	98.83	3.25
10	196	66.20	6.53	19.17	0.10	Nil	1.16	5.20	98.36	2.58
11	197	61.80	8.43	20.17	0.40	Trace	1.16	6.40	98.36	2.16
12	198	67.40	5.81	18.91	0.40	Trace	1.16	5.60	99.28	2.73
13	199	77.20	3.78	13.42	0.20	Trace	0.94	5.60	101.04	4.49
14	200	77.60	5.20	10.88	0.20	Trace	0.94	4.60	99.74	4.82
15	201	74.20	4.95	14.75	0.30	Trace	1.52	4.70	100.42	3.77
16	202	75.00	4.65	13.55	0.30	Trace	1.52	4.10	99.42	4.06
17	203	74.40	4.10	14.60	0.30	Trace	1.45	4.50	99.35	3.98
18	235	76.56	2.12	15.48	0.40	Trace	0.94	4.80	100.30	4.35
19	236	70.40	3.12	18.48	0.40	Trace	1.23	5.50	98.29	2.79
20	237	62.20	6.09	22.53	0.40	Trace	0.94	8.40	100.54	2.18
21	238	66.56	2.55	21.81	0.40	Trace	1.23	5.50	98.29	2.75
22	250	63.60	8.15	18.99	0.46	0.40	4.20	4.30	98.10	2.52
23	251	62.00	8.15	18.55	0.30	0.40	4.90	4.20	98.79	2.32
24		66.80	4.44	20.27				7.62		

LOCALITY

Field Number

1, 2, 3 18,	Workings on Brown's property, Beaconsfield. Road cuttings through Brown's property Beaconsfield
4, 19, 20	Tasmania Trem, near Gigney's corner Beaconsfield
5, 7-12	Hill behind A.W.Cowle's house, Flowery Gully
6, 15, 16, 17 13, 14,	Cutting, old trem Flowery Gully. River Flat near A.E.Cowle's House, Flowery Gully.
21, 22, 23	Little Winder Dam, Beaconsfield Middle Arm Creek, near Bridge on Launceston Road.