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DEPARTMENT OF MINES

UNDERGROUND WATER SUPPLY

PAPER No. 5

THE UNDERGROUND WATER RESOURCES OF THE SMITHTON DISTRICT

by

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Fig. 1.—Circular Head and Stanley. (Courtesy Tas. Govt. Photo. Lab.)

FOREWORD

In this, the first Underground Water Supply Paper published by the Department since 1926, an assessment is made of the prospects of finding suitable groundwater supplies in a rapidly developing district in the far North-West of the State. Previous major investigations of this nature have been confined to the Midlands and East Coast regions.

Although the Smithton District receives a moderately high annual rainfall, precipitation is at a minimum during the hottest part of the year when extra water is required on the dairy farms. Even now considerable strain is placed on the limited available resources of surface water, the quality of which is in many cases unsuitable for either domestic or agricultural use. Therefore this survey has been undertaken with foresight to the time when agricultural development will have reached such a stage that supplementary supplies of underground water will be essential in maintaining efficient production.

Of particular interest to farmers will be the sections describing briefly the mode of occurrence of underground water and the influence of various dissolved salts on its usefulness. The regional geology as determined from this and previous surveys is summarized and the water-bearing potential of each geological formation examined.

For the purposes of this investigation the district has been divided into several areas whose local hydrology is studied, details of all previous drilling being shown in tables and maps. In addition, recommendations are made regarding future bore sites and precautions to ensure continued production from successful bores are emphasized.

Information obtained from this survey will enable the occurrence and probable quantity and quality of groundwater in each locality to be predicted more accurately.

J. G. SYMONS, Director of Mines.

Department of Mines,
Hobart, 24th August, 1959.

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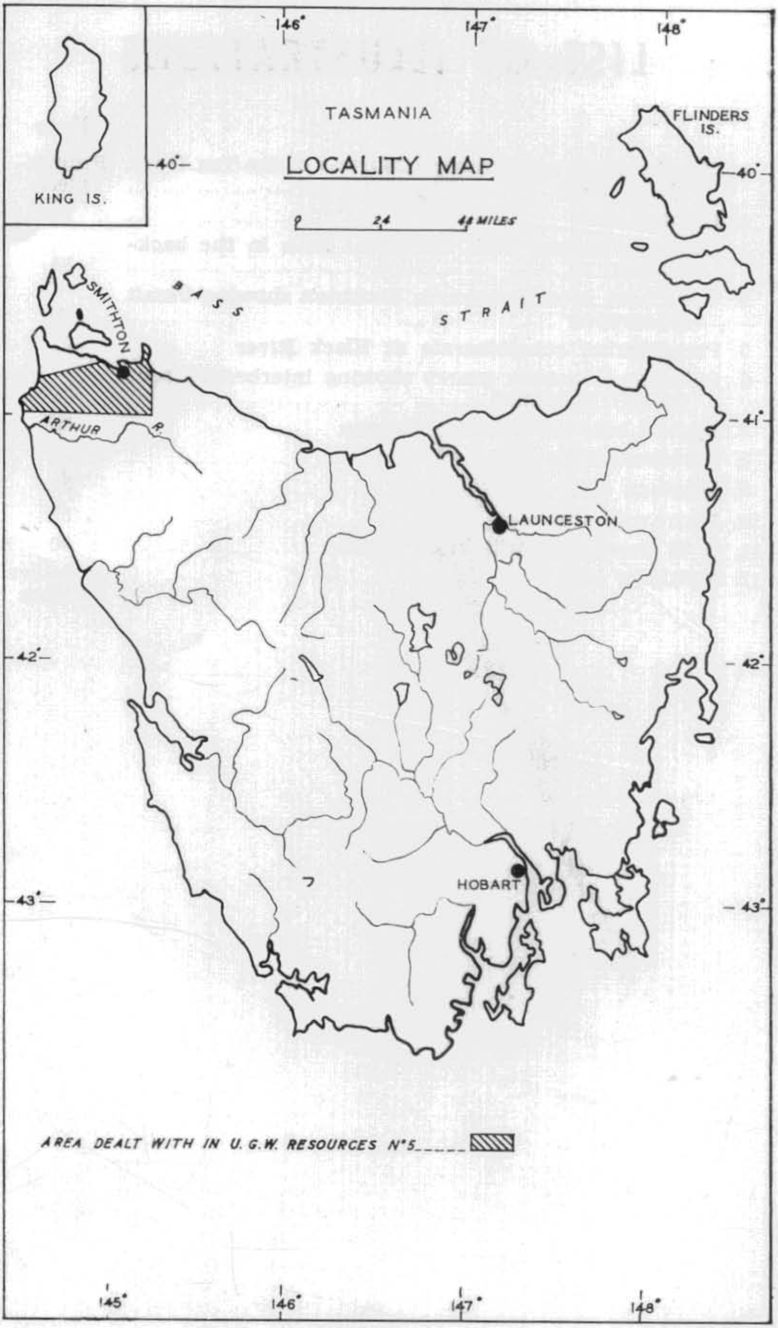
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LOCALITY MAP
0 24 48 MILES
KING IS.
FLINDERS IS.
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ARTHUR R.
LAUNCESTON
HOBART
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41°
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145°
146°
147°
148°
AREA DEALT WITH IN U. G. W. RESOURCES N°5

Fig. 2.

5 cm

THE UNDERGROUND WATER RESOURCES OF THE SMITHTON DISTRICT

1. INTRODUCTION

I. LOCATION (Fig. 2)

The district with which this paper deals is located in the North West of Tasmania in the County of Wellington, Circular Head Municipality. It is readily accessible by all means of transport.

The boundaries of the area investigated were determined by the existing state of agricultural development and the regions capable of future development. Thus there are some areas where the geology has been investigated in detail whilst for the remaining country only a general picture is given.

Principal towns in the district include Smithton, Marrawah, Forest, Edith Creek and Stanley.

In the area east of Smithton to the Black River and south to Nabageena, mapping has been more detailed as the developed area there is much larger and more continuous than elsewhere.

II. PURPOSE AND SCOPE OF INVESTIGATION

Although the muncipality receives a high annual rainfall it has dry periods during the summer months. Such dry periods have little effect on towns with reticulated water supplies but they do affect the dairying industry which uses large quantities of water for flushing purposes and for stock. In most cases surface water and dam water are unsuitable for these purposes and reticulation from the town supply is uneconomic.

The extensive development being carried out by the Closer Settlement Board almost exclusively for dairying purposes suggests that present water supplies may be inadequate and it is possible that underground water will provide supplementary supplies as it has done in other parts of the municipality.

It is for these reasons that an evaluation of the underground water resources has been made. With the information gained from the survey, future bore sites may be selected with some certainty of obtaining water and with some knowledge of its probable quality and quantity.

The investigation was carried out at intervals between July, 1956, and August 1957. Where possible mapping was done on aerial photographs but interpretation was necessary in many places because of lack of outcrops.

Bore records contributed much information reiating to the geology and to the occurrence of underground water. The quality of the water samples taken from the bores was determined by analyses done at the Department of Mines Laboratory, Launceston.

III. PREVIOUS INVESTIGATIONS

Previous investigations in the district have been directed towards the development of the known dolomite occurrences and detailed geological maps of the north-east and south-east Smithton quarter sheets have been compiled by Nye, Finucane and Blake (1934).

In 1944 and 1945, fifteen diamond drill bore-holes with a total footage of 968 feet were put down to test the dolomite deposits and during the years 1946 and 1947 a number of bores were completed to augment local water supplies.

Other geological investigations have been made by A. B. Edwards (1941), Carey and Scott (1952) and Gill and Banks (1956). However there has been no previous systematic investigation of the underground water resources and this survey should assist in the evaluation of available supplies.

2. GEOGRAPHY AND PHYSIOGRAPHY

I. CLIMATE

The district under review is one of low relief. Its position in relation to pressure systems in Bass Strait renders it subject to high winds and rapid weather changes. The climate is moderately cold to mild, snow is almost unknown and frosts are generally light. Annual rainfall ranges from thirty five to seventy inches, precipitation decreasing from west to east and from south to north. The driest months are January to March and the wettest June to August.

II. TOPOGRAPHY

The most striking features of the district are the plains which extend from the sea coast inland for as much as twelve miles. These low-lying areas of Tertiary and Quaternary sediments occasionally merge with the river valleys and in such cases swamps result, as are seen in the densely timbered Mowbray, Montagu and Welcome swamps. (Fig. 3). The plains probably result from the fairly uniform resistance to erosion of the underlying Cambrian and Precambrian rocks; the more resistant members of these systems occur above the plains as ridges and hills. The general level of the plains is broken by the occurrence of dunes and spring mounds.

The older rocks have been exposed to erosion for a long period, probably from Devonian to Tertiary times, and consequently the hills seldom exceed 500 feet in height, although exceptions of up to 900 feet do occur. The highest topographical features of the district result from the preservation by basaltic lavas of hills of Precambrian and Cambrian sediments, the basalt occurring as cappings on isolated peaks or as more extensive areas of plateau country.

Basalt plateaux occur in the far west at Marrawah and Redpa, Forest is situated on one, and a third extends from Irishtown in the north to Nabageena in the south and eastwards over an area of approximately twenty square miles. Other extensive basalt hills occur at Stanley, Montagu and south east of Mengha.

From the edges of the basalt plateaux and hills the country slopes steeply to the valley floors and plains and in this feature the topography is one of youth. (Fig. 4). However apart from the youthful features resulting from the basalt the topography is generally mature.

Tier Hill, a prominent ridge composed of resistant Cambrian rocks trends southerly from Smithton to Edith Creek, a distance of 10 miles. It has a maximum altitude of some four hundred feet and an average width of one and a half miles. Towards the south it broadens out forming low hills which extend to the basalt hills in the south-east. In an easterly direction the country falls towards Irishtown valley and Deep Creek plain, whilst in a westerly direction the fall is steep towards Duck River.

Fig. 3.—Mowbray Swamp with Christmas Hills in the background.

The low hills of Cambrian rocks to the west of Mowbray Swamp separate swamplands from one another. East of Smithton quartzite hills rise above the plains over small areas between the coast and the basalt plateaux.

The coastal plains are almost continuous from Stanley Peninsula to Woolnorth Point. Certain features exhibited by the coastal plains indicate oscillating shorelines during the Pleistocene followed by gradual emergence up to the present time. Off shore and land-tied islands and the presence of marine shell beds in the Quaternary deposits of the plains are indications of oscillation of the shorelines. The marine beds reach several miles inland and together with the more extensive alluvial deposits have given rise to the plains. This suggests that although the shoreline was oscillating, the overall movement was one of gradual emergence.

Sand dunes fixed by vegetation indicate that the surface of the plains is now static and in topographic old age. The swampy condition of the inland reaches of the plains is due to the flat country causing rivers to be at grade, as in old age.

III. DRAINAGE

In the Marrawah-Redpa area the Welcome River and its tributaries form the only important drainage system except for a few small streams and springs which run into the sea from the western slopes. The Welcome River rises two miles south of Marrawah and flows east along the edge of the basalt to the Welcome Swamp where it is temporarily at grade. It then flows northward and enters the sea about three miles east of Woolnorth Point. Because there is little run-off from the flat areas the river is small, suggesting that a large volume of underground water could be present. The Welcome River is in a mature state, except for the headwaters which have youthful characteristics.

The Montagu River rises south of Montagu Swamp and flows north through the swamp and plains to reach the sea midway between Montagu and West Montagu. The fact that the estuary extends for about one mile from the coast indicates submergence, but two and a half miles inland entrenchment occurs and this suggests later emergence of the land. The volume of water in the river and its velocity do not increase rapidly after heavy rains so part of the rainfall must find its way to the sea as underground water. The Montagu River is in a mature stage of development.

The Duck River and its eastern tributaries form a rectangular drainage pattern. The main eastern affluents, Edith Creek, Allen Creek, Copper Creek and Perkins Creek flow westwards across the strike of the rocks and drain the western and southern portions of the basalt plateau, the Irishtown valley and the intervening country east of Mowbray Swamp. Duck River, its western tributaries and excavated conduits remove surface water from Mowbray Swamp and the hills to the west. Flowing north along the eastern edge of Mowbray Swamp, the Duck River discharges into Duck Bay at Smithton.

This drainage system is in various stages of development, the eastern tributaries exhibiting youthful characteristics and the main river and western tributaries being in a state of maturity.

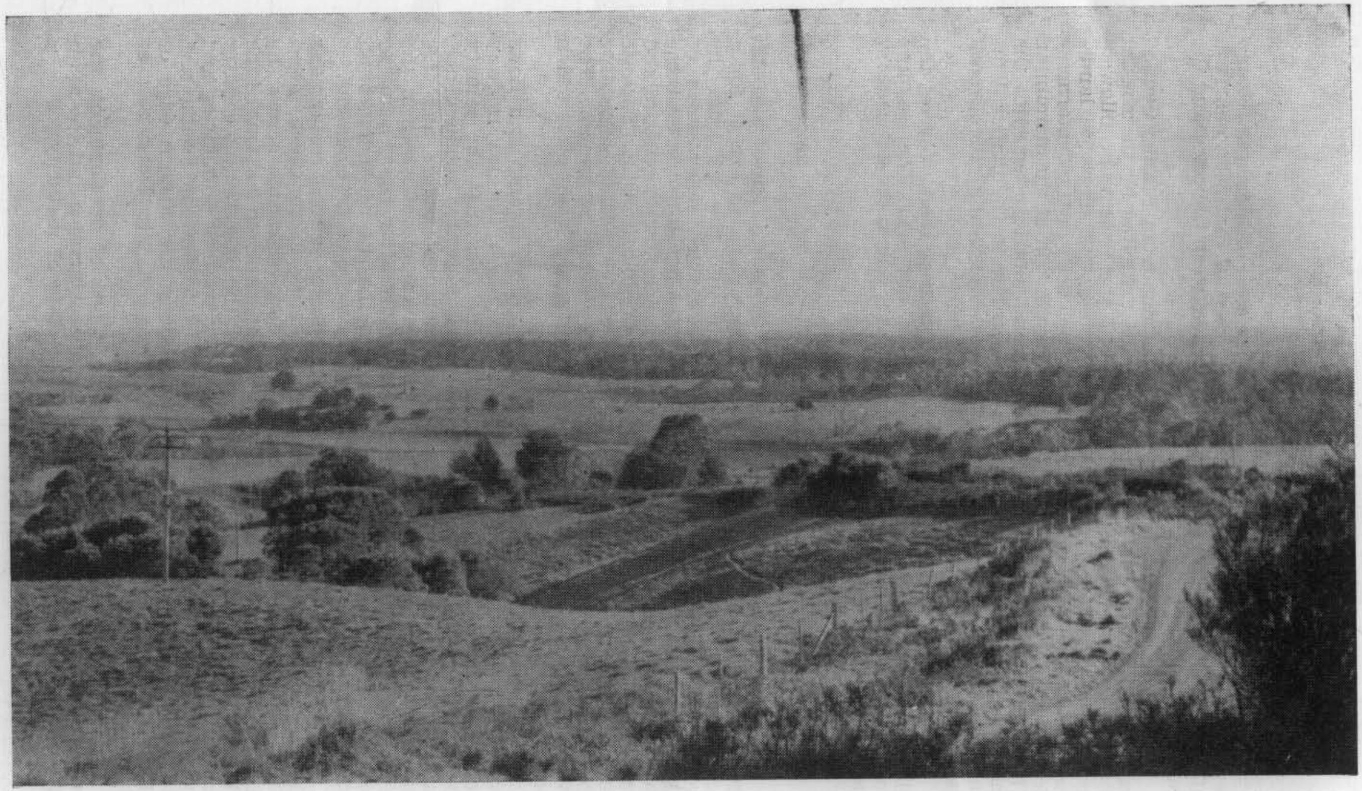


Fig. 4.—View from Alcomie towards Smithton showing basalt topography.

The Deep Creek system, consisting of Deep Creek and its tributaries, Serpentine Creek and Sedgy Creek flows approximately north-west to enter the eastern end of Duck Bay. Deep Creek and Serpentine Creek drain the basalt plateau north and east of Alcomie and Deep Creek and Sedgy Creek rise in basalt hills to the south-east of Mengha. Sedgy Creek also removes the surface water from the western slopes of the basalt around Forest. There are numerous small streams flowing eastwards to the Black River from the Forest basalt plateau and several flow northwards into the inlets on either side of Stanley Peninsula. In the elevated areas this system is in a youthful stage but it becomes mature on reaching the plains. The presence of underground water in this area is assured by the combined effects of small streams, a large catchment area and a low run-off.

Although the Black River does not traverse the mapped area, some of its tributaries rise in the basalt hills and drain the lower country east of Mengha and South Forest. This river has an estuary but it is deeply entrenched inland and shows more youthful characteristics than other rivers in the district.

Many of the streams draining the basalt country rise as springs, emerging from under the basalt or between basalt flows. Mineral springs occur on some of the plains, particularly on the Mowbray Swamp and north of Irishtown. Those that are flowing are conducted into the excavated drainage channels. Most of these springs have built up mounds of mineral deposits generally consisting of calcium and iron compounds.

As previously mentioned, the Duck River system has a rectangular drainage pattern but this is not the case with the other systems, which generally follow the lowest levels of the plains and do not appear to have any regular pattern. Irregularities on the plains control the position of the watercourses to some extent and it can therefore be said that they are insequent streams. Small watercourses are numerous over the larger areas of Dundas Group siltstones and tuffs. Some of these are permanent, others mostly dry, but all are deeply entrenched because of the soft nature of the rocks. The resulting drainage pattern is complex and dendritic.

IV. VEGETATION, SOIL AND WEATHERING

As these features are not particularly important to this investigation, they will be discussed only briefly. The uncleared plains are covered with a natural flora of button grass, tea-tree and varieties of heath indicative of saturated and poor sandy soil derived from quartzite rocks.

The quartzites themselves support a wider variety of vegetation which includes eucalypts, prickly wattle and *Bauera*, as well as the plains assemblage.

The swamps, gullies and river banks carry a rain-forest type of vegetation, consisting of eucalypts and myrtle with an understorey of sassafras, leatherwood, blackwood, dogwood, tea-tree and manuka. This rain forest flora also occurs on areas of rich soil derived from basalt and Dundas Group rocks.

Overall there is a good soil cover, rock outcrops being small and discontinuous, indicating that erosion has been in progress for a long period. The general flatness of the district allows the products of weathering to accumulate and form soil.

At present research is being carried out on the undeveloped sandy plains, and it appears that in time the best of these will be made suitable for agricultural purposes. Swamp soils are generally acid but in this area the alkaline water from the springs and from the underlying dolomite has prevented acidity to some extent.

3. GENERAL GEOLOGY

I. STRATIGRAPHIC TABLE

Era	System Period	Group	Formation	Units	Approx. Thickness
Cainozoic	Quaternary			Aeolian sand and alluvium. Paludal deposits. Disconformity. Littoral deposits.	20 ft. +
	Unconformity				
	Tertiary			Alluvial gravels. Brown coal and siltstone. Unconformity. Limestone (Marine).	100 ft.
Palaeozoic	Unconformity				
	Cambrian	Dundas		Basic lavas (spilites), tuffs, breccias, greywackes. Conglomerate, siltstone.	5,000 ft.
	Disconformity?				
Proterozoic	Precambrian	Carbine	Smithton Dolomite, Bryant Hill Quartzite.	Slate, chert, dolomite. Quartzite, conglomerate	3,200 ft.
	Older Precambrian			Undifferentiated slates, cherts and quartzites.	

II. STRATIGRAPHY

The oldest rocks in the district are Precambrian sediments which outcrop in the east near South Forest, Mengha and the Black River. They have undergone low grade regional metamorphism to slates, quartzites and cherts. A finely laminated chert occurs about one mile south of Mengha and appears to be a silicified varve. In the west at Woolnorth Point and Marrawah small outcrops of massive quartzite occur which are thought to be Precambrian but their stratigraphic position is uncertain.

(a) Precambrian

Carbine Group

Correlation of rocks in this area with the Carbine Group at Dundas is possible on similarities of lithology and stratigraphic position.

Where the base of this group was seen in the Smithton district, it overlies Precambrian slates with apparent conformity; however the extent of these exposures is not sufficient to establish whether the sequence is conformable or unconformable. The upper contact with the Dundas Group was not observed but dip and strike measurements near the contact give no indication of an unconformity.

Although the complete succession does not occur as a continuous outcrop, good sections can be seen at the Black River bridge and in the South Forest area. The individual members outcrop from the Black River to near Redpa.

The naming of the formations follows Carey and Scott (1952) with the Smithton Dolomite overlying the Bryant Hill Quartzite.

Bryant Hill Quartzite

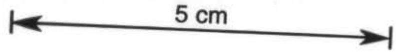
An additional unit not visible in the previously mapped districts is a conglomerate which occurs at the base of the group, but as it is not always present and varies markedly in thickness, it will be considered as part of the Bryant Hill Quartzite.

The conglomerate outcrops to the east of Deep Creek and with the overlying quartzite forms ridges and isolated hills due to the resistant character of the two rocks. Generally the conglomerate, (Fig. 5) consists of well rounded quartzite pebbles and boulders up to one foot in diameter in a siliceous matrix. The matrix varies from completely silicified with no visible grains, to less silicified consisting of rounded quartz grains of even size about one quarter of a millimetre in diameter. At one exposure clay in the matrix causes the rock to be quite friable. This friability may also be a result of stress as some of the quartz pebbles show signs of having been 'stretched'. The colour of the conglomerate is white to pink and reddish depending on the amount of iron oxide in the matrix.

A maximum of one hundred and sixty feet of thickly bedded conglomerate was calculated from dips and surface exposures at the Black River.

In the Bryant Hill Quartzite formation are combined the white quartzite and grey-green quartzite stages described by Nye, Finucane and Blake (1934) and the conglomerate described above.

Fig. 5.—Precambrian conglomerate at Black River.



The typical units of this formation outcrop at Bryant Hill, from White Hills to Fahey's Lane, at the Black River and in the south-east of the district. The quartzite varies considerably from thickly to thinly bedded, from granular to amorphous and because of fracturing it is generally very friable.

Smithton Dolomite

This formation shows several variations due to silicification. It is made up of thick beds of dolomite, silicified oolitic dolomite, thickly bedded and laminated cherts and dark grey slates. The Smithton Dolomite appears to overlie the Bryant Hill Quartzite conformably.

Its distribution is extensive, variants occurring in limited outcrops from Redpa to the Black River. West of the Duck River dolomite predominates and variations are less numerous. Slaty forms occur in one outcrop downstream from the Montagu River bridge and silicified oolitic dolomite outcrops on the property of C. Wilson at Harcus Farm, several miles west of West Montagu. East of Smithton and Irishtown little is seen of the normal dolomite as it occupies the valleys under a cover of recent material.

The silicified beds appear to have been incompetent and during folding they were contorted and crushed, a feature not nearly so pronounced in the normal dolomite or the underlying quartzite.

The thickness of the formation varies greatly, increasing from east to west to a possible maximum under Mowbray Swamp. Further west, at Montagu Swamp, the thickness cannot be estimated because of lack of outcrops.

Estimates of the maximum thickness have been made in the past, the results varying somewhat owing to insufficient data on the structures present. To the east of Smithton more accurate thickness determinations of the formations of the Carbine Group are possible. West of Mengha the values estimated from steeply dipping beds are:—Smithton Dolomite 2000 feet maximum—Bryant Hill Quartzite 1250 feet.

At the Black River the formations are much thinner and the thickness varies owing to compression during folding.

The Bryant Hill Quartzite has a maximum thickness of 250 feet at this point and is overlain by Smithton Dolomite, part of which has been removed by erosion.

The upper beds of the dolomite formation are slaty cherts and slates which at Nabageena appear to grade into the lowest beds of the Dundas Group. The section is not continuous but there does not seem to be an unconformity. However, although a fossil fauna occurs low in the Dundas, no fossils have been found in the dolomite. It is therefore suggested that there was an interval of non-deposition between the times of formation of the Carbine and Dundas Groups and a disconformity is postulated but not proved.

The Carbine Group is of indefinite age and it may extend into the Cambrian from Upper Precambrian.

At Dundas the Carbine Group is divided into the following formations (Elliston 1954):—

Higgins Slate and Quartzite;
Platt Dolomite;
Maestries Dolomite Conglomerate.

Elliston suggests the Maestries Dolomitic Conglomerate as the base of the Carbine Group. This conglomerate consists of " rounded quartz pebbles up to two inches in diameter in a finer silicified or dolomitised matrix ", and may be compared with the conglomerate in the Black River area where the quartz pebbles are up to one foot in diameter and the matrix is siliceous. There is no evidence for suspecting a tillite (as at Dundas) as all boulders examined were well rounded and without facets or striations.

The dolomite at Smithton could be the equivalent of the Platt Dolomite. It passes into a chert and slate stage which possibly corresponds with the Higgins slates but no true quartzites have been seen which would compare with the quartzites of the Higgins formation. In the Carbine Group at Dundas there is no formation corresponding with the Bryant Hill Quartzite.

(b) Cambrian

Dundas Group

The Dundas Group in the area under investigation resembles that of the type area at Dundas in its stratigraphical position and fossil content.

Rocks of this group are widely distributed over the area as they occur from Redpa to Wiltshire and extend southwards beyond the southern boundary of the mapped area. Outcrops are poor, the best exposures being seen along the shoreline east of Smithton, at the mouth of the Montagu River and at Stony Point, Montagu. The sediments are fairly soft and weather readily to produce a reddish-brown to light orange-brown clayey soil. This cover of soil and weathered rock sometimes reaches a depth of over 50 feet and generally the only good rock exposures are in recent cuttings. The volcanic rocks are more resistant to erosion and exposures of these are well defined. Hence the sediments result in an extremely dissected topography while the volcanic rocks usually form ridges and prominent hills.

In the district under investigation the sedimentary assemblage consists of tuffs, siltsones, greywackes, breccias and conglomerates, the igneous rocks being basic lava, volcanic breccia and agglomerate. Siltstones, tuffs, greywackes and lavas are the most common rocks. The volcanic breccia was seen only at the mouth of the Montagu River and the agglomerate at West Montagu.

Because of the poor exposures the sequence is difficult to determine. As far as can be seen the basal unit of the Dundas Group is a siltstone. It is thought that a conglomerate of quartzite and chert pebbles and tuffaceous matrix overlies the siltstone, followed by tuffs, siltstones, breccias and lavas. This has not been proved so that correlation with the different units at Dundas is not justified at this stage.

The thickness of the Dundas Group in the area west of Mowbray Swamp is difficult to estimate but it is considered to be a fairly thin layer of gently folded rocks overlying the Carbine Group. In the Christmas Hills area an horizon of Upper Middle Cambrian fossils was found in siltstone. This horizon is 150-200 feet higher than the dolomite at the Duck River and about 150 feet above a quartzite outcrop one quarter of a mile distant. As the dips measured were shallow in both easterly and westerly directions the maximum thickness of Dundas Group rocks to the top of the fossil horizon was estimated at about 300 feet. By a similar estimate the conglomerate at Christmas Hills and Scopus would occur 100 feet above this horizon but no section could be found to the base of the group. At Montagu there is a sequence of siltstone, breccias, greywacke and tuff 2,500 feet thick and 2,500 feet of sediments similar to these plus 2,500 feet of volcanic rocks occur near Smithton.

The assemblage constituting the Dundas Group is typical of a eugeosynclinal environment.

The Dundas Group appears to conformably overlie the Smithton Dolomite. No abrupt change in the rock types can be found between the top of the Carbine Group and the base of the Dundas Group and no section was exposed sufficiently to determine whether there was any break in deposition between the two groups.

The age of the Dundas Group in the area is Cambrian but as yet there is not sufficient information to place lower and upper limits on its age. Upper Middle Cambrian fossils were found in a road cutting in the vicinity of Christmas Hills (Aerial Photo No. 48570, Woolnorth Run 5, (30 chains) 3.1 inches from the centre point on a bearing of 176°.)

(c) Tertiary System

Marine and fresh water Tertiary sediments occur over small areas in the low lying parts of the district and some lake or swamp deposits are to be seen between and on the Tertiary basalt flows.

Limestone is the oldest of the Tertiary deposits and occurs at low altitudes, frequently extending to below sea level along the northern coastline. Outcrops are present in the west around Marrawah and Redpa and also in the Montagu River and Harcus River. Water bores have penetrated the limestone at Montagu and Irishtown and angular blocks of this rock are contained in the basalt at the northern end of Brittons Swamp. The most extensive exposures are near Redpa and Mt. Cameron West. The limestone varies from fairly pure to sandy, is light buff to grey in colour, and contains many marine fossils. In one outcrop, however, a considerable thickness occurs where macroscopic examination failed to reveal any fossils.

The formation is generally flat lying. It overlies the Cambrian and Precambrian rocks unconformably and is overlain by Tertiary basalt and Quaternary marine and freshwater sands and gravels. From fossil evidence the age of the limestones in the Redpa-Marrawah area is Upper Oligocene to Lower Miocene (Gill & Banks 1956). The total thickness is unknown but at least 100 feet occur to the south of Redpa. Beds of Tertiary tuff occur around part of Circular Head at Stanley.

Tertiary fresh water sediments are exposed between basalt flows in the vicinity of Irishtown and Lileah and the fossil flora from the peat and siltstone indicates a pre-Pleistocene age for these sediments. One bore, (No. Y7) on the basalt plateau at Lileah penetrated about 40 feet of mudstone before striking basalt and it is assumed that this sediment was deposited in a Tertiary-Quaternary lake. Gravels of considerable depth have been intersected during drilling for water at Brittons Swamp and Redpa. Up to 100 feet of clay and gravel occur at Redpa although some of this may be Quaternary.

(d) Quaternary and Recent

The deposits of these systems have filled the swamps and flat lying parts of the area since the Pliocene. There has been little consolidation except in the calcareous deposits and pre-Pleistocene peats. A marine or littoral deposit of sand and shells was laid down in the Mella area unconformably overlying the Smithton Dolomite and Cambrian sediments. A similar deposit has been penetrated by water bores around Montagu where it lies unconformably over Tertiary limestone. Disconformably above this deposit are interbedded sand, clay and peat of alluvial and paludal origin. At Pulbeena a fresh water marl composed of small gastropod shells and containing thin layers of peat, indicates deposition in a shallow lake. Small calcareous spring deposits occur on Mowbray Swamp and near Irishtown and a limonite deposit at Scopus is probably the precipitate of spring waters. Sand dunes now fixed by vegetation represent the last stage of sedimentation on the plains.

The Quaternary deposits are up to 40 feet thick and range in age from Upper Pleistocene to Recent. The age has been calculated from terrestial fossils and radio-carbon datings (Gill & Banks 1956).

III. IGNEOUS ROCKS

An outcrop of dolerite was observed on the southern side of Deep Creek about two miles west of South Forest. In appearance and weathering it is similar to the Jurassic dolerites but some alteration has occurred and native copper is present. This outcrop occupies about five acres but its relation to the intruded sediments cannot be seen. The age of the rock is also uncertain but it is no older than Upper Cambrian as it intrudes basal Cambrian sediments causing slight induration.

Tertiary basalt occurs in a large portion of the area east of Smithton and at Montagu, Marrawah, Brittons Swamp, Redpa and Christmas Hills. Several variations exist due to extrusion in different environments. Much of the basalt in the west near Marrawah is tachylitic and vesicular, the vesicles and fractures often containing calcite and zeolites. The Nut at Stanley consists of coarsely crystalline basaltic rock which is believed to be the remnant of a volcanic neck. The plateau basalts are a more normal type, finely crystalline and occasionally vesicular. Basalt overlies the Tertiary limestone at Marrawah and Redpa and Tertiary sediments occur between flows in the vicinity of Irishtown and Lileah. Flows are present from sea level up to 850 feet indicating that basalt was extruded over the hills of older rocks as well as into the pre-existing valleys. The maximum thickness observed was about 450 feet between Lileah and Nabageena.

The age of the basalt, which was extruded at intervals, is shown to be pre-Pleistocene from determinations made on fossil flora from sediments between the flows.

IV. STRUCTURAL GEOLOGY

The structure of the area is dominated by folds and several major faults. Only in the area from Montagu Swamp east to the Black River were there sufficient outcrops from which the structure could be elucidated.

(a) Folding

The fold axes strike approximately north-west in the west to north-east in the east and plunge slightly in those directions. There are several major folds with many folds of smaller magnitude which have the same axial trend. All folding seen was open except at the Black River where slight overturning occurs. Here the fold axis strikes north-east and the south-eastern limb of the syncline is generally steeply dipping while the north-western limb has a shallow dip. Between this fold and the strike fault along the eastern edge of Mowbray Swamp the axes diverge from the south to give much more open folding between Smithton and the Black River.

West of Smithton to the Montagu River the structure appears to be one shallow syncline cut off on each side by strike faults. Minor folds are present on this syncline and these all have the same axial trend. Overall the folding is very asymmetrical but a complete picture cannot be obtained because outcrops are few and yield little information. Doubtless some folding did occur before the Cambrian but because of limited exposures this cannot be distinguished. The major folds were probably initiated in the Precambrian and were very shallow at the time of deposition of the Dundas Group but became more pronounced during the subsidence of the Cambrian eugeosyncline and during later orogenies.

This view is supported by the fact that the contact between the Carbine and Dundas rocks appears to be conformable which would not be the case if the Precambrian was folded prior to the deposition of the Dundas Group.

The minor folds in the Cambrian rocks have the same axial strike as the major folds on which they were seen and it appears that this minor folding is mainly a result of the Tabberabberan orogeny.

(b) Faulting

Faulting is difficult to establish except where there have been extensive movements, and the period in which faulting occurred is not certain as no deposits remain of sediments laid down between the Cambrian and the Tertiary.

One fault, older than the rest, occurs at South Forest. Its age is uncertain but because of the large vertical and transcurrent movement it is assumed to be older than Tertiary. Its exact position is obscured by Recent deposits. Three strike faults of considerable magnitude are present and as these are not mineralised and the topography is still influenced by them, they are considered to be of

Tertiary age. One occurs in the Deep Creek valley west of South Forest and its position is clearly defined by the topography and geology. Two strike faults with considerable throws occur, one along the north-western edge of Mountagu Swamp and the other along the eastern edge of Mowbray Swamp. The effect of these was the raising of the country between them.

Many minor faults are indicated by slickensides, drag dips and crush zones but exposures are limited and the effects of the faults are so small that no direction can be determined for many of them.

(c) Other Structural Features

Cleavage is poorly developed in the Carbine and Dundas Group rocks. In some Dundas siltstones at Montagu the cleavage directions are related to the compressional and tensional forces acting during the folding of the rocks.

Joints are present but the majority are irregular and only those normal and parallel to the fold axes can be related to the structure.

Dolerite intruded the Cambrian sediments in one locality and may have caused local structural features but these are not exposed. Submergence of the coastal and very low regions occurred early in the Tertiary as a result of Tertiary faulting, and limestones were deposited during the Miocene on the submerged areas. Later in the Tertiary, basalt was extruded over much of the land surface, filling valleys and covering hills. It is this rock which governs much of the present topography.

Gradual emergence of the land began after the Tertiary subsidence and in the Pleistocene a rise in sea level resulted in the deposition of marine sands on most of the plains area. Recession of the sea resulted in swamps on the flat areas and terrestial and paludal deposition occurred leaving the surface of the plains much the same as they are today.

V. ECONOMIC GEOLOGY

(a) Metallic Minerals

Native copper

Native copper occurs in the Cambrian volcanic rocks and in the dolerite as disseminated particles. It has not been investigated as a commercial source of copper.

Chromite

This mineral occurs in extensive alluvial sands and gravels on the Montagu Swamp. The thickness of the alluvium containing chromite varies, the deepest test hole being twenty feet deep. Deeper deposits have been found but the concentration of the chromite appears to be greatest where there is only a thin deposit of fine, well sorted sand.

Sampling of the deposit was carried out at one site only and two methods of concentration were used.

The results obtained by first sizing the sample and then separating the heavy minerals by jig and table concentration were:—

% Heavy minerals	% Chromite	% Cassiterite, Rutile, Gold
2.86	2.83	0.03

Using a Humphrey's Spiral to concentrate the heavy minerals from a two ton sample resulted in a recovery of 1.777% as heavy minerals.

The present price and demand for chromite is not sufficient to permit economical working of this deposit.

(b) Non-Metallic Mineral Deposits

Dolomite

This rock occurs extensively under Mowbray and Montagu Swamps and near Irishtown, South Forest, Nabageena and in the Black River.

Previous analyses show that almost pure dolomite suitable for agricultural purposes, is present in large quantities.

The Duck River Dolomite Co. Ltd., Smithton, produced 788 tons of ground dolomite in 1956. This figure is low because of a close-down during which a railway siding was constructed to facilitate loading.

Prior to 1956 a total of 8,670.26 tons of ground dolomite had been produced.

Resources of dolomite are very large and are easily accessible. However the flat nature and low level of the country create a problem in the removal of water.

Precambrian limestone

One isolated deposit of this rock occurs to the east of the Lower Scotchtown road 1½ miles from Smithton and another outcrops in the Duck River. The relation of the limestone to the dolomite is not clear. The quality is very high but overburden difficulties have caused production from the Scotchtown deposit to cease. The Associated Pulp and Paper Mills Ltd. quarried this limestone for a period and some thousands of tons were produced.

Quaternary limestone (Fig. 6)

This appears to be a swamp or lake deposit of layers of peat and marl, the latter consisting mainly of small freshwater gastropod shells. The deposit is extensive but the area and depth have not been fully tested. It is quarried by hand and then allowed to dry, the peat being discarded. The high lime content and the friable nature of the marl make it very suitable for agricultural purposes and as the railway linking Smithton and Irishtown passes over the deposit near Pulbeena siding, there is a minimum of handling. Production was carried out for some time by the Associated Pulp and Paper Mills Ltd. but output is now maintained by a small private company. The total recorded production from this deposit in 1956 was 5,503 tons of lime sands.

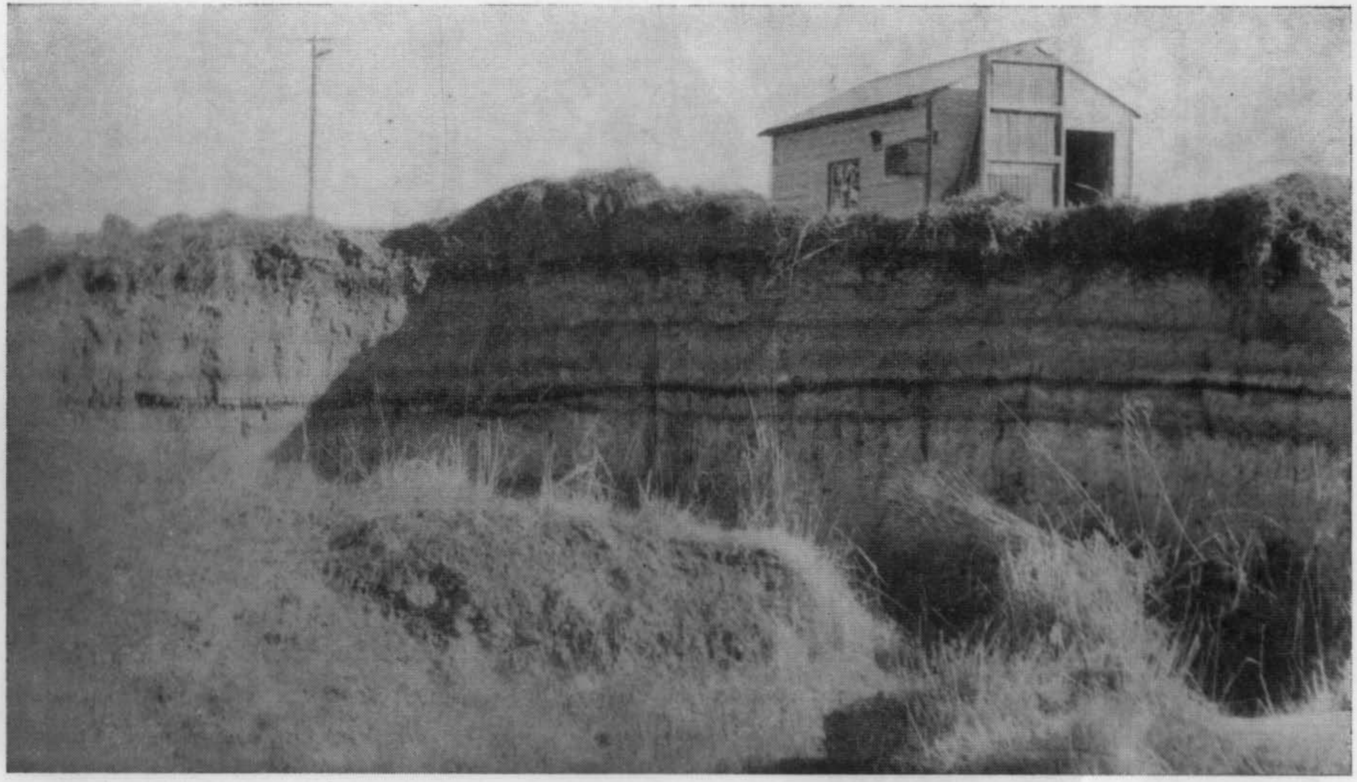


Fig. 6.—Pulbeena limestone quarry showing interbedded peat (black) and marl.

Ceramics

The possibility of a ceramics industry in Tasmania may lead to utilisation of clay deposits which occur near Mawbanna, along the Black River and at Harcus Farm.

Brown coal and peat

Occurrences of these are recorded from near Alcomie, Edith Creek and Myrtle Hill but they are small deposits and of no economic importance.

Road materials

Igneous rocks of Cambrian and Tertiary age are found in quantity and are suitable for use in bitumen-sealed highways. Some of the Tertiary basalt is unsuitable as it is soft and powders quickly. Gravel roads in the district are dressed with quartzite, silicified and impure dolomite and Cambrian siltstone and conglomerate. Deposits of these rocks are well distributed and extensive with the result that there is no shortage of road materials.

4. HYDROLOGY

I. GENERAL

The division of the earth with which this report is concerned is the outermost few hundred feet of the crust. This is generally made up of soil, subsoil, weathered and disintegrated rock, and solid rock. Water present in this region below the subsoil is known as underground water. Of secondary importance in this study is the hydrosphere which includes surface water occurring in the form of ice, snow, rain, rivers, lakes, and swamps. In most cases surface and underground water are derived by precipitation from the atmosphere.

II. SURFACE WATER

Rainfall in this district ranges between 35" and 70" annually. This is comparatively high and as the topography is not conducive to rapid run-off, swampy conditions exist over much of the plains and isolated areas of the higher ground.

Mowbray, Brittons, and Montagu Swamps and other plains country which has been developed for agricultural purposes, have deep artificial drainage systems to dispose of excess surface water.

The rainfall is reliable for eight months of the year but periods of drought have been known when summer temperatures and high winds dry out the surface of the land. Under such conditions the dairying industry suffers because of lower milk production. Surface water on the plains is generally unsuitable for use as it is dark and acid owing to the presence of iron, tannin, and decaying organic materials and to its sluggish movement. Permanent rivers, however, do supply nearby farms with water suitable for stock. The surface water in the highlands is of better quality. Numerous wells and dams are used in these localities to augment the usual tank storage but under drought conditions surface supplies become negligible and the shortage has led to the use of sub-surface or underground water.

III. UNDERGROUND WATER

Groundwater is either of meteoric origin, i.e. derived from rainwater, or of juvenile origin. The latter refers to water which reaches the surface from a deep-seated source and is generally highly mineralized and warm, e.g. in areas of present and recent vulcanism. Some of the mound springs on the Mowbray Swamp and adjacent areas may be fed by juvenile water.

Part of the water falling on the land surface is absorbed by the soil and, if the underlying material is permeable, it percolates down until it reaches an impervious layer of rock. Water builds up above this layer to form a zone of saturation. The top of this zone, if it is not enclosed upwards by an impervious stratum, is called the water table. Thus the water table is the free surface of the zone of saturation (Fig. 7).

Above the water table, water may rise in the capillary openings of the rock to form a capillary fringe.

On the plains, drilling records occasionally suggest that water is present as a " perched " water table at a higher level than the main source of underground water. This feature is due to a layer of impervious material which prevents the downward movement of water to the main water table underlain by bedrock. In such cases replenishment of the main water table takes place outside the area in which a perched water table is found.

The highest water table has not been tapped for supplies on the plains owing to the unconsolidated nature of the walls of the bores and because the lower water table gives a bigger supply. In other areas underground water may be struck at several levels and the water generally rises in the bore suggesting that only the top water-bearing horizon is a free water table, the others being confined and under pressure to some extent. When water rises in the bore above the level at which it was struck it is sub-artesian.

It can be seen therefore that it is possible for the water table to have an area almost equal to that of the land surface and that underground water is not generally limited to narrow streams as believed by water diviners. Only in particular cases do streams occur. Limestones and dolomites sometimes weather to leave solution channels but from the drilling records there is no evidence of these in the dolomite of the Mowbray Swamp.

(a) Storage in Rocks

Strata which carry water underground are referred to as aquifers or water bearing beds. The volume of water which they carry and the freedom with which the water moves is dependent largely on the form, size and continuity of pore space in the formation. These characteristics vary with different rocks according to grain size, packing, cement, materials, and the degree of fracturing and jointing. Uniformly sized, well-rounded grains as in a sandstone provide ample pore space for water but a mineral cementing material may fill the pores and make the rock impermeable. A bed of unsorted or poorly sorted grains offers little pore space as the packing is closest due to small grains filling spaces between larger grains. Water in fine compact rocks such as the Cambrian siltstones is carried mainly by open joint planes and fractures. The Cambrian tuffs are poorly sorted but their porous constituents allow the passage of underground water. The capacity of some types of rocks such as limestone and dolomite is often increased by solution along joints and easily weathered planes such as fault zones. Some siltstones give good supplies because of the solution of thin interbedded clay bands. Elsewhere a zone may be almost dry owing to clay filling interstices in the formation.

To help determine quantities of water, figures for porosity of several types of rocks are available from tests carried out on typical aquifers. These do not necessarily apply to the area dealt with in this report. Porosity is the ratio of the aggregate volume of the interstices to the total volume of the rock.

Type of Rock	Porosity %
Recent sand and soils	≤ 40
Sandstone	4.8 — 22.8
Limestone	0.5 — 13.4
Dolomite	0.5 — 13.4

Igneous rocks of the district usually form higher ground owing to their resistance to erosion and therefore water drains from them. Where they are interbedded with sediments, water supplies can be expected since they are intensely jointed and thus have a fair water capacity.

Groundwater is preferable to surface water for several reasons. Dams and wells contain surface water which becomes stagnant and may be polluted. Underground water is moving so does not stagnate and although gases may be absorbed these are generally expelled on bringing the water to the surface. In addition, underground water has a vast reservoir and long periods without rain do not empty the aquifers although a slight decrease in yield may result. Regular rainfall is essential for dams and shallow wells which naturally will dry up without it.

(b) Movement of Underground Water

The chief factor influencing the movement of groundwater is gravity. Where the water table is free, this force acts in moving the water to lower levels until it eventually flows out of the rocks into river valleys or into the sea. If the water table is confined between two impermeable layers then gravity has a greater effect because hydrostatic head is built up. This water may be forced to the surface at a lower level as an artesian spring and such underground supplies when tapped will flow out of the bore at the surface. At least one bore on the Mowbray Swamp has shown this property while many are sub-artesian in that the water rises a considerable height in the bores.

Other causes of movement are transpiration by vegetation drawing up water, capillarity at the top of the free water table, convection due to temperature difficulties, and evaporation. Also the use of a number of bores in the one locality will cause movement and in some cases bores may rob one another if movement of the underground water is too slow. The velocity with which water moves depends mainly on the gradient of the water table and the porosity of the aquifer. Cases are known where slowly moving water has become unsuitable for use and continued pumping has purified it by the release of dissolved gases.

(c) Fluctuations of Water Level.

Under the conditions existing in the district the level of water in bores should remain fairly constant. There is little change in the level of the water table under the low-lying areas where bores have been drilled. The underground water reservoir is extensive and neighbouring bores are unlikely to affect each other. There could be some seasonal changes in the ground water level but it is known that even in drought conditions on the Mowbray Swamp bores in constant use have been no less productive than in times of regular rainfall.

Some of the bores are near estuaries or the sea, and in one bore salt water has become noticeable, suggesting that here tides could have some effect on the level of the water table. The fresh water floats above the salt water and a change in tide could cause a change in the water level in the bore. Under such conditions the fresh water may be contaminated but this may be rectified by slow pumping from a few feet below the surface of the water in the bore.

Fluctuations of ground water level may be more noticeable in the siltstones and tuffs of the Dundas Group, in the Tertiary basins on the basalt and in the basalt itself. Cambrian rocks are the main aquifers to the west of Mowbray Swamp. The supply from these rocks is generally not as great as from the swamp bores and the need for extra water is more frequent. The bores appear to be capable of satisfying all requirements but pumping may temporarily reduce the water level. Seasonal fluctuations slightly affect the water level possibly because small local folds divide the country into numerous separate underground water reservoirs. Their capacity is limited and continued use of a bore will temporarily exhaust them or lower the water level considerably.

Outcrops are insufficient to determine the limits and extent of these basins but if bores become too numerous in the area it is expected that they would adversely affect the supply available to each.

The height of the water table on basalt plateaux varies considerably with rainfall and as supplies in this type of country are initially relatively small a diminution and even complete failure of the supply may occur during periods of drought. Where Tertiary deposits and basins occur on the basalt plateaux a reliable supply can be expected but the number of bores should be limited as these features are generally small and fluctuations in the water level would result.

IV. ROCK UNITS AND THEIR WATER BEARING CHARACTERISTICS

(a) Precambrian

The oldest rocks occur at Marrawah and Woolnorth. They are dense quartzites and could not be expected to contain useful supplies in the unweathered state. Where they are overlain by Tertiary to Recent deposits water could be present in the disintegrated zone down to the solid quartzite, provided that the topography is favourable.

The slates and cherts of the Precambrian below the Carbine Group weather readily and as a result have a low relief. Silicification and resistant cap rocks are responsible for some more prominent features. The slates are compact and fine grained and water is present in fractures and joint planes which have been slightly enlarged by solution. The cherts appear to be silicified argillaceous varves. Seepage occurs through very thin interbedded silty bands but large yields could not be expected from such aquifers. Bores in the slates give a satisfactory yield of good quality water.

The Carbine Group has a conglomerate at the base and this rock is generally well silicified and compact, the only water in it being confined to joints and bedding planes. The thickness of the conglomerate varies considerably and it could not be considered as an aquifer. It is overlain by a well broken quartzite which may act as an aquifer sealed partly by the less permeable conglomerate beneath. However this quartzite has not yet been bored. On the plains where thick sand and soil covers are present water can be expected in the weathered zone of both types of rock.

At the top of this group is the Smithton Dolomite and its cherty and slaty variations. The formation usually occupies the valleys and is topographically in a favourable position to act as an aquifer. It has well developed joint systems and bedding planes which have been widened by solution, particularly in the unsilicified dolomite. Bore records show that underground water is struck in the weathered rock under recent deposits, but up to 50 feet into solid rock were bored in some cases before a satisfactory supply was obtained. This rock is probably the best aquifer as far as yield is concerned but the water is of relatively poor quality.

(b) **Cambrian**

Dundas Group rocks form a thick sequence and occur discontinuously over most of the district. Sediments present are siltstones, greywackes, conglomerate, and breccias together with tuffs and basic lavas. Some sandstone occurs but it has only been seen as chips from the bores and may therefore be in isolated lenses. The lava is frequently well jointed and permeable and where interbedded with sediments should act as an aquifer. Most of the sediments themselves are permeable.

Siltstones have open joints and bedding planes, whilst the tuffs and greywackes contain, porous material and clay minerals, the latter being easily removed by percolating water. These rocks are therefore good aquifers but in some cases clay material has accumulated in the joints and effectively seals out underground water. Supplies available from the Dundas Group are of fair to excellent quality and sufficient quantity.

(c) **Tertiary**

Limestone of this age varies in lithology and sandy and shelly bands carry the most underground water. The purer limestone is not so porous and most of the water in this is in open bedding planes which have been enlarged by solution. Reasonable supplies of fair quality underground water have been obtained from this aquifer.

Tertiary basalt sometimes has a water bearing zone at its weathered surface beneath a cover of soil and boulders. Where the catchment is large boring has met with some success but many bores have been dry due to the elevated position where gravity causes rapid downward migration of surface and groundwater. Where clay and peaty material have accumulated on one basalt flow before another sheet covered it, an effective dam is formed preventing the downward movement of water. Bores through basalt to these clay layers should yield a good supply of groundwater. However boring data does not record having struck these conditions and the supposition remains to be proved.

Tertiary fresh water lakes were formed on the basalt and sediments accumulated in them. One bore was located on a deposit of this type and a good supply of groundwater was obtained in the last five feet of the sediments which were 36 feet thick.

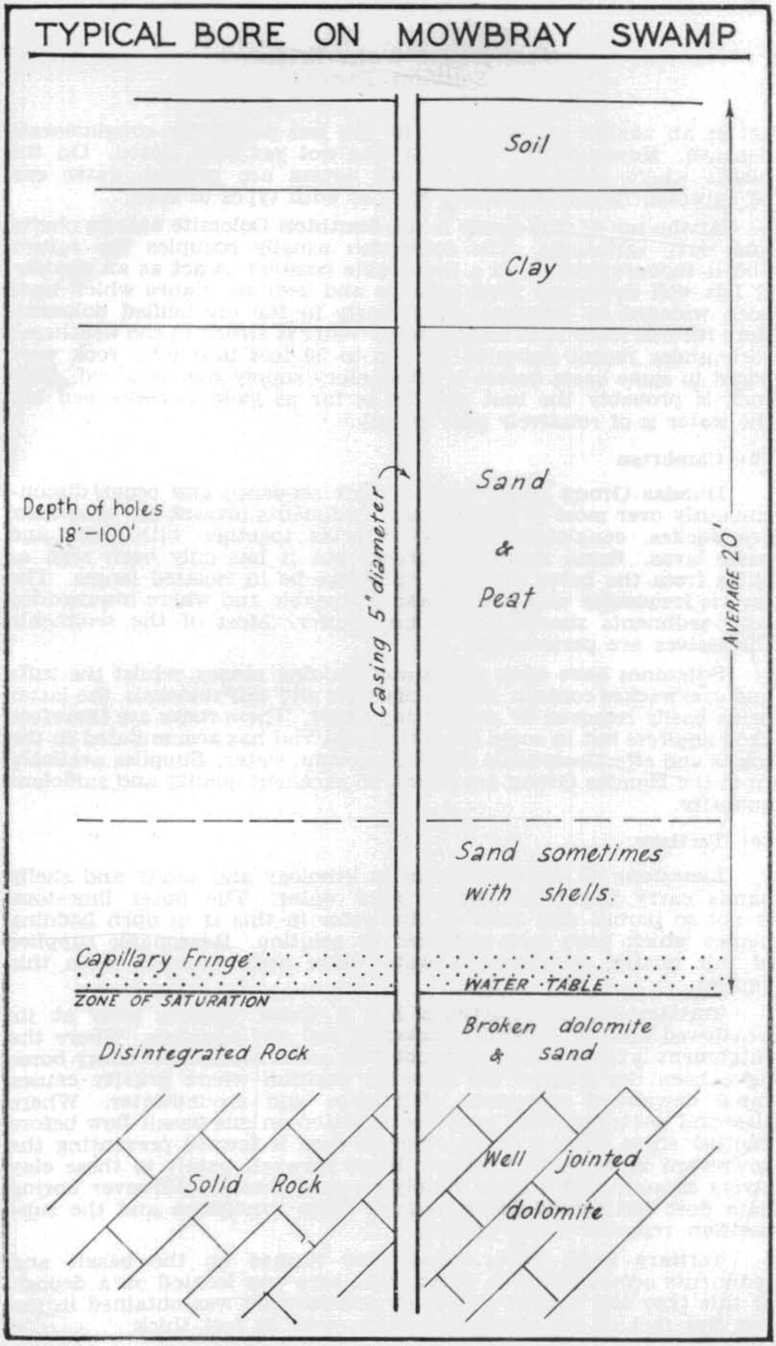

TYPICAL BORE ON MOWBRAY SWAMP
Soil
Clay
Sand
&
Peat
Depth of holes
18'–100'
Casing 5" diameter
AVERAGE 20'
Sand sometimes
with shells.
Capillary Fringe
WATER TABLE
ZONE OF SATURATION
Broken dolomite
& sand
Disintegrated Rock
Solid Rock
Well jointed
dolomite

Fig. 7.

5 cm

(d) Quaternary to Recent.

Sand, peat and clay deposits about 20 feet thick occur over much of Mowbray Swamp. Where the clay underlies sand small quantities of water may be obtained but the walls of the bores are liable to collapse. Only when the weathered surface of the underlying rock is reached are suitable supplies of water obtained. Gravels which carry underground water occur at Redpa. If coarse enough these gravels stand without casing and there has generally been some mineral cementing which has partly consolidated them. (Fig. 7).

The capacity of these deposits to carry groundwater is very large owing to their porosity and uncompacted nature.

V. CHEMICAL QUALITY OF UNDERGROUND WATER

No natural water is chemically pure. Rain-water is the purest but it contains dissolved gases and occasionally salt from sea spray. On reaching the ground, rain-water begins to act as a weathering agent on the rocks. The length of time it is in contact with the rocks and its temperature and pressure are factors in the solvent action of the water. The most common impurities in underground water are iron, calcium, sodium, magnesium, carbonate, sulphate, chloride and silica.

(a) Iron

This is present in most underground waters and is not desirable because 0.3 parts per million will stain utensils and fabrics. A high iron content results in reddish-brown growths which restrict and may eventually block the flow of water through pipes. Removal of iron may be accomplished by several methods:

—Aeration by spraying and then filtering.
—Neutralisation of the water with milk of lime. This is necessary where the iron is held in solution by carbonic acid. Then aeration and filtration will remove the iron.
—Precipitation by addition of alum.
—Precipitation by the Permutit process.

(b) Calcium

One of the principal elements contributing to water hardness and scale deposition in pipes and boilers is calcium. The addition of slaked lime $Ca(OH)_2$ will partially soften such water and will enable effective washing to be carried out with the use of less soap. Waters which form hard scale are improved by the addition of soda ash. Carbonate and sulphate waters containing calcium, which are predominant under Mowbray Swamp, may be preheated to remove calcium.

(c) Magnesium

Magnesium carbonate when present with calcium, forms a hard scale. This combination is common in bore water from Mowbray Swamp but the concentration is generally low.

(d) Sodium

The concentration of sodium must be fairly high before it affects the domestic use of the water.

(e) Carbonate and Bicarbonate

These are combined with calcium and magnesium to make up the greater part of the dissolved salts present in the ground water from the Mowbray Swamp. Such water is good until heated, when the precipitation of calcium and magnesium carbonates forms scale.

(f) Sulphate

This radicle is derived from pyrites, hydrogen sulphide, fertilizer and other sulphide minerals present in the area. Excess in the form of sodium and calcium sulphate imparts a bitter taste to the water.

(g) Chloride

Sodium and magnesium chlorides derived from rocks, sea spray and sewage are generally present in small quantities but are not noticeable below about 200 parts per million. Several bores in the localities of Scopus and Montagu exceed this value.

(h) pH

This is a measure of the acidity or alkalinity of water, neutral water having a pH of 7, acid less than 7, and alkaline 7 to 14. Water as used in this district should have a pH value between 5.5 and 8.6; otherwise corrosion of metalware will occur.

(i) Hardness

This is almost entirely due to calcium and magnesium salts plus iron, zinc and free acid in water. The presence of carbonates results in " temporary hardness " which may be removed by boiling the water. "Permanent hardness " is caused by other acid radicles which cannot be removed by boiling and special processes are used for purification of the water. Total hardness is the sum of both types.

Classifications of hardness vary with different authors but the following table may be used as a guide, the figures referring to calcium carbonate ($CaCo_3$) in solution.

Grains per Gallon	Parts per Million	Classification
3.5 — 7	50 — 100	Soft
7 — 14	100 — 200	Moderately hard
14 — 21	200 — 300	Hard
10.5	150	Low mineral content
10.5 — 35	150 — 500	Moderate mineral content
35 +	500 and upwards	High mineral content

From analyses of water samples taken from bores in different parts of the district the controlling factors in its use can be determined by comparing the analysis with tables compiled by various investigators in other parts of Australia. These tables apply primarily to South Australian areas with low rainfall but higher tolerances may be possible in the Smithton District where a high rainfall is experienced.

VI. USES

(a) Domestic Use

The rainfall is sufficient to supply domestic requirements except during dry periods. The tolerances for farms are given as:—

	Maximum (p.p.m.)
Total dissolved solids	3,000
Magnesium	120
Permanent hardness	500

From the tables of analyses it can be seen that none of the water except that from bore No. Y52 is unusable. However all underground water in the district has some unwanted characteristics such as the precipitation of scale and the staining of fabrics and containers. As iron is present in the dissolved state in quantities greater than 0.3 p.p.m. all local underground water will cause staining. Water with over 1.5 p.p.m. of iron is undesirable but not dangerous. In cases where surface water may contaminate shallow open bores it is advisable to boil water if it is required for drinking.

The increasing use of septic tanks requires greater water supplies than those normally stored for domestic purposes and the suitability of underground water for this purpose has been examined. Excess acidity is the only factor which renders water unfit for use in septic tanks, but it is not present in supplies from bores in this district.

(b) Agricultural Uses

Stock

R. Lockhart Jack determined from investigations in South Australia the following limits for dissolved solids:—

	Limit of Tolerance	
	Grains per gallon	Parts per million
Horses at grass	546.875	7,820.3
Horses in work	437.5	6,256.25
Cattle	656.25	9,364.4
Sheep on grass feed	1,093.75	15,643.6

No figures are available for pigs or poultry but pigs may be affected by water containing too much salt.

Minerals in solution have varying effects on stock. There may be no harmful effects from a highly mineralised water providing the animals have a much purer water supply as well. Bore water in the district is preferred to tank water by the stock and succulent grass and herbage probably offset any harmful effects which may arise from too hard a drinking water. The total solids in solution in all tested bores except one are well below the maximum values for water which may be used in an emergency.

The combination of salts in solution has a marked effect on these values. Sodium chloride is the least harmful while sulphates of magnesium and other elements are the most detrimental. Thus water from bores may carry equal amounts of dissolved solids but one bore may be useless because of the types of salts dissolved in the water.

Irrigation

The nature of the soil, drainage and rainfall are important factors to be noted when using bore water for irrigation. Well drained sandy soils are not harmed so much as heavy clay soils. Rainfall in the district is sufficient to dilute any concentrations of salts left by irrigation and little damage can be done.

The maximum concentration of salts in the underground water of the area is below the limit for the most delicate vegetables. Most of the water being alkaline helps to prevent the sandy soil of the drained swamps becoming acid. Limits of tolerance for vegetables (Ward 1946) are as follows:—

	Limit of Tolerance	
	Grains per gallon	Parts per million
French beans, lettuce, cucumbers	65-70	930-1000
Tomatoes under glass	70	1000
Flowers and shrubs	75	1070
Fruit trees generally	75-80	1070-1144
Most vegetables	80	1144
Rootgrowths -- potatoes, swedes &c.	90	1287

These figures are aproximately correct for water not containing too large a proportion of calcium and magnesium chlorides, sodium and magnesium sulphates and/or sodium carbonate. They apply to areas of good drainage with ordinary soil conditions and so are applicable to this district in dry periods. However seeds and seedlings should be well established before poor quality bore water is used for irrigation.

VII. LOCAL HYDROLOGY

(a) Stanley Peninsula (Fig. 12)

The agricultural area in this locality is the ridge known as Green Hills. The Nut and the town of Stanley lie on the eastern edge of the peninsula. Green Hills consists of Tertiary basalt, covered in most places by varying depths of soil and weathered rock. Along the foothills and flats Tertiary and Recent sands have accumulated and a much thicker cover overlies the bedrock.

The rainfall, as for most of the coastal strip, is about 35-40" per year with the highest falls in the winter months.

The ridge is steep sided and has a fairly rapid run-off as a result but flatter areas on the top of it provide a small catchment area and allow the water to percolate underground. At present water supplies are obtained from rainfall and surface water storage, and a few wells. In dry periods only the last are reliable.

Boring has not met with much success owing to the elevation and lack of a suitable aquifer to supply underground water. In addition drilling conditions are difficult. Only one bore, of several in the area, has yielded a satisfactory supply, the aquifer consisting of basalt drift, i.e. weathered material close to the surface of the solid basalt. The depth of this bore is 45′ whereas another reached 200′ without striking water and was about 30′ below sea level.

It is therefore difficult to select suitable sites in this area but prospects are much better on the flats around the hills should these lower levels require an extra water supply.

Analysis of bore and well waters indicates that they are suitable for all agricultural uses and can be used for domestic purposes.

(b) Wiltshire

The Wiltshire district (Fig. 12) lies to the south-east of Stanley and extends over a small area on either side of the Bass Highway. The country is low lying and fairly flat with Recent sand overlying slates which appear to be of Cambrian age (Dundas Group). Towards the east Precambrian rocks occur.

The rainfall and catchment are favourable for good underground water supplies but rock outcrops are not numerous enough to obtain a detailed picture to indicate whether the structure is in any way opposed to the occurrence of ground-water. The slates, being well jointed with open bedding planes, should act as aquifers as found in areas to the west.

Conditions are favourable for drilling and the bore walls should stand for a long period without collapsing. One factor to be considered in this area is the close proximity of the sea and the low land surface. Deep bores may become contaminated with salt water and tides may cause fluctuation of water level in the bores. One bore was drilled in this area and yielded approximately 300 gallons per hour of good quality water from the slate aquifer.

(c) Mengha

The Mengha District (Fig 12) takes in an area south of South Forest. The country is fairly level and has an elevation of about 250 feet but rises sharply in the south and south-west to a maximum of about 700 feet. The town is sited on Precambrian slates and laminated cherts overlain apparently conformably by Precambrian conglomerate and quartzite which dip in a general westerly direction. The hills to the south are capped with Tertiary basalt.

Precipitation is about 40″ annually on the lower areas and increases with elevation.

Present supplies of water depend chiefly on rainfall with supplementary supplies derived from wells and in some cases from Deep Creek which rises in the hills to the south-west. The catchment area is large, extending to Alcomie in the south-west and the basalt hills in the east. Run-off and underground water move northwards through Mengha.

Drilling has been carried out at two sites and good conditions were encountered. In both cases the bore holes penetrate Precambrian slates in which underground water is present. The approximate yield was tested at 300 gallons per hour which proved quite adequate for supplementing domestic and dairy water supplies during the summer of 1956-57.

The water was analysed and found to be suitable for all purposes, bore No. Y37 containing 7.34 grains per gallon (105 p.p.m.) and No. Y38 containing 14 grains per gallon (199.2 p.p.m.) of dissolved solids.

The geology and catchment area indicate that the possibilities of striking groundwater are good in this area. The aquifer, which in bores Y37 and Y38 is slate, owes its permeability to open joint planes. The cherts also should be good aquifers as in road cuttings it was noted that water emerged along partly dissolved clayey layers interbedded with the chert.

(d) West Forest

In the West Forest area (Fig. 12) basalt overlies Cambrian siltstones and tuffs. These sediments outcrop in the southern part beyond the boundary of the basalt.

The rainfall and catchment are sufficient to give adequate supplies of underground water provided that the basalt topography is favourable. The Cambrian rocks form part of a synclinal basin and as they are permeable good supplies of underground water can be expected.

Drilling conditions are good in this district, the deep weathering of the basalt resulting in easy drilling while the Cambrian rocks are harder but not difficult to drill. Fully cased bores should be used here as collapse of the bore walls is likely.

Only one bore has been put down and this is in the basalt area. It was tested at about 300 gallons per hour yield and analyses showed that the water contained 162.2 p.p.m. (11.3grs./gallon) of dissolved impurities. This bore is used to supply water for all farm and domestic purposes and should not have any injurious effects on machinery and utensils for many years. Eventually accumulated deposits may cause trouble.

(e) Forest

The town of Forest (Fig. 12) lies four miles south of the turn-off to Stanley from the Bass Highway. It is situated on an undulating plateau about twenty square miles in area and at an average of 250 feet above sea level. The plateau is of basalt apparently occupying pre-basaltic valleys in the Dundas Group rocks and Precambrian sediments which it overlies unconformably. The basalt varies in thickness because it was not extruded over a flat surface. The catchment area is of reasonable extent but drainage systems extend in all directions in the form of small valleys which contain streams only in the winter.

Present supplies of water for domestic and agricultural purposes depend on rainfall, wells and dams. Several bores have been drilled near the town and have met with failure due to drilling difficulties. One bore, No. 45 produced a reasonable supply of water. It penetrated a deeply weathered zone in the basalt where a concentration of underground water is present. The aquifer is weathered basalt which is sealed below by clay and solid basalt. Future prospects are uncertain and only location of underground depressions and valleys will give satisfactory supplies. These features may not have any surface expression to suggest their presence.

Bore No. Y40 is at the edge of the basalt about one mile south of the town. This penetrated basalt and terminated in the siltstones of the Cambrian Dundas Group which form the aquifer. Tests carried out indicate that this bore has a yield of 3-400 gallons per hour and the quality of the water is the best recorded in the whole district. The analysis shows a total of 80.5 parts per million (5.6 grains per gallon) of dissolved solids and examination of the constituents shows none to be undesirable or injurious.

(f) North Forest

The North Forest district (Fig. 12) occupies the northern slopes and flats extending to the Bass Highway from the plateau. The higher parts are basalt overlying Cambrian lavas which slope off into the flats covered with recent material. Because of the hardness of the rocks drilling may be expensive in this area and dams and wells should be sufficient to augment rainfall supplies. Suitable sites for bores can be found over most of the locality of North Forest.

(g) Lileah

The Lileah district (Fig. 12) is located on a basalt plateau about 700 feet above sea level. In some places Tertiary basin deposits are present.

The rainfall is slightly above 40 inches annually and the catchment area is large but drainage is well distributed.

Several bores have been sunk in this area with varying degrees of success. Of the five bores drilled numbers Y6 and 7 yield reasonable supplies, No. 9 fluctuates alarmingly and is practically dry in summer while Nos. 5 and 8 were abandoned after failing to locate underground water. Number 7 bore records mudstone, probably Tertiary, above the basalt. The aquifer is in this mudstone which reaches a depth of 42 feet, the water table being first struck at 35 feet. The supply approximates 300 gallons per hour.

Location of these small Tertiary basins should be attempted in basalt areas as drilling conditions and underground water prospects are better than in weathered basalt.

Bores No. 5 and 6 to the west of Lileah lie at the edge of the basalt. The log of bore No. 5 showed pre-basalt Tertiary gravels and owing to difficult drilling conditions the bore was abandoned without striking water. No. 6 bore about two chains away did not strike these sediments but went through basalt clay to the Cambrian siltstones and a supply of 200 gallons per hour was obtained. Prospects here do not appear to be very good but may be expected to vary. The quality of the water from bore No. 6 is very good, the dissolved solids content being 90 parts per million.

(h) Nabageena and Sunny Hills (Fig. 12)

Nabageena and Sunny Hills to the south of Lileah have not been bored. The favourable topography and geology together with a high rainfall suggest that there is underground water available and high yields can be expected from bores in this district.

(i) Edith Creek, Copper Creek and Irishtown (Fig. 12)

These areas have good underground water prospects but up to the present no boring has been required possibly because other sources have given an adequate supply.

(j) Smithton and the Mowbray Swamp (Fig. 12)

Smithton, the largest town in the area, lies on the Duck River a few miles from its mouth and the Bass Highway runs through the town. To the south and west of Smithton the Mowbray Swamp has been drained and agricultural development has been carried out. The swamp area is now divided into Broadmeadows, Scotchtown and Mella.

Topography

The country is low lying and almost flat, the height above sea level being about 20′ at Leesville and rising slightly to the south inland. The eastern boundary of the swamp is formed by the southerly-trending Tier Hill ridge, while the western edge rises fairly sharply to the hills extending from Scopus to Christmas Hills.

Geology

Mowbray Swamp is underlain by Precambrian dolomite which has a general strike of a few degrees east of north, and in most outcrops appears to dip to the west. Outcrops are few and occur mainly on the eastern half of the swamp. The dolomite is a buff coloured, finely crystalline rock in the purer deposits but varies from massive to thinly bedded with slaty bands. It is well jointed and shows evidence of solution in enlargement of the joints. Overlying the dolomite to the west are Cambrian siltstones and tuffs which can be correlated with the Dundas Group. The dip and strike of these rocks have the same general directions as those of the dolomite which suggests that they overlie the latter conformably. Along the eastern boundary of the swamp a strike fault occurs with the down-thrown side to the east. The Cambrian Dundas Group rocks to the east of the fault dip in a general westerly direction.

Overlying the dolomite bedrock of the area are deposits of Quaternary and Recent age. These vary in distribution but where present consist of sand and shells, overlain by sand, clay, peat and surface sands and clays. There are also numerous small areas of spring deposits which usually form mounds at the surface.

Rainfall and catchment area

The annual rainfall for the past twelve years has averaged about forty-eight inches (48″) with a minimum of 36.19″ in 1949 and a maximum of 61.27″ in 1956.

The catchment extends many miles to the south of the developed land and much of the rainfall on the hills to the west runs off into the swamp. Water from the hills to the east drains into the swamp and the Duck River by numerous streams, the main ones being Copper Creek, Allen Creek, and Edith Creek.

The surface of the farmed land is mostly porous sand through which rainwater penetrates down to the water table although impervious layers exist in some small areas forming a suspended water table. Charging of the aquifers of the permanent water table occurs mainly outside these areas, along the edge of the swamp and from the permanent streams named above.

Present supplies of water

Smithton has a reticulated water supply derived from several miles outside the town. It is not of very high quality but is superior to bore water near the town and no advantage would be gained by using bores to supply Smithton.

The farmland outside the town on the drained portion of Mowbray Swamp has no reticulated supply. Almost all domestic supplies are drawn from rainfall storage tanks. Wells have been used but are suitable only for stock as some surface water is present and its constituents and dark colour make is unsuitable for other purposes. The Duck River is also used to augment supplies but again this water is generally too dirty for other than agricultural purposes. Many farmers are now using bores which give a reliable supply of water suitable for most purposes except washing and cooking.

The rainfall generally proves adequate for domestic purposes except in very dry summers but water is short for agricultural uses and supplies must be supplemented to maintain full production.

The artificial drainage channels remove surface water rapidly and in dry weather natural feed for stock dries up unless some irrigation is carried out. The drains are necessary during winter and periods of heavy rain, to remove the surface water as there is little natural run-off due to the level surface of the area.

Underground water

Bores have been sunk over most of the region (Fig. 12) and satisfactory quantities of underground water have been obtained.

The important aquifers in the district, excluding the western part of Mella, are the dolomite beds and the upper decomposed layer of the dolomite (Fig. 7). In the Mella section the aquifers are Cambrian tuffs and siltstones which yield a satisfactory supply of water. However the impurities suspended and dissolved in the underground water limit its uses. The presence of iron is sufficient to render it unsuitable for washing as staining results unless certain procedures are carried out to remove the iron. It is quite good for drinking purposes in an emergency. The water is used to flush milking apparatus but leaves a deposit, removable by scrubbing, in the pipes and containers. Other uses are for watering livestock and gardens, and in irrigation.

Examination of the chemical analyses of the bore water from this area as a whole shows that there is little variation in its composition. The water is classified as hard, with a moderate mineral content. It is suitable for use in septic tanks as it is not acidic.

The volume of water available from these bores ranges from 250 to 500 gallons per hour. They are generally sub-artesian, a rise of water in the bore occurring once water is struck. Bore number

Y49 overflows the casing which protrudes about one foot above the ground. This was tested at 500 gallons per hour which is about the highest rate that can be determined by the method used.

Seasonal fluctuations of the water table in this area have not been recorded and continued use in dry weather does not lower the water level of the bore hole permanently. The bores are several miles from the sea but the deeper ones have penetrated below sea level. The pressure of underground water is great enough to keep the sea water out and no evidence of alteration of levels due to tidal movements has been obtained.

Bores in close proximity to one another do not appear to have any effect on the volume of water available from individual bores. Continued pumping over a long period would reduce the volume available where the bores are close together. The present distribution of bores in this area excludes this possibility.

Contamination of bores could occur in those which do not reach the dolomite or which terminate in broken dolomite. Under these conditions continued pumping at a rate approaching the tested delivery of the bore, may cause collapsing of the less compact beds around the casing and would allow entry of surface water down the outside of the casing. Sand and mud may also be drawn into the borehole, contaminating the water and perhaps blocking the bore.

The tops of bores should be covered to prevent windblown materials contaminating the water. Contamination from domestic drainage appears to be absent probably because the effluents are diluted and removed rapidly by the local drainage system.

The springs in this area occur on the swamp plain. The fact that the water reaches the surface shows there is pressure operating from below. In some cases the water is tepid and in all cases it carries minerals in solution which are deposited to form mounds and layers round the openings. The water from those springs still flowing is not suitable for domestic use but livestock will drink it.

Drilling conditions

These vary in the dolomite and in several cases bores were abandoned when the drill struck cavities and boulders, but selection of a new site, sometimes only a few yards away, usually gives suitable ground for drilling. Casing of the sand beds is necessary to keep sand and surface water out of the bore.

From statistical and geological information prospects of obtaining wet bores are very good and a reliable and sufficient supply of ground water is almost certain. Examination of the drilling logs shows the deeepst bore in this area to be 90 feet, water being obtained in adequate quantities at 60 feet. Most of the holes are much shallower than this, the shallowest being 23 feet deep and the average depth of some twenty bore holes being 42 feet.

The Mella area on the western side of the plain extends over dolomite, siltstone and tuff. The only difference between this locality and those of Broadmeadows and Scotchtown is in the quality of the water. There is a slight improvement in quality from the siltstone aquifers.

Prospects here are similar to the rest of Mowbray Swamp and drilling conditions are perhaps better but holes must be fully cased, otherwise the siltstone walls may collapse.

(k) Scopus and North-west Mella (Fig. 8)

Agricultural development has extended from Muddy Creek, three miles west of Smithton, along an undulating strip for another four miles. This is known as Scopus. Because of forest reserves the development in the south of this locality is confined to the foothills of the low range which extends to Christmas Hills, and the area is limited to the north by the sea. To the west heathlands which are slowly being developed extend nearly to Montagu.

Cambrian siltstones, tuffs and conglomerates outcrop on the higher ground but the lower flats are covered by Recent sand which thickens towards the coast. The strike of the Cambrian rocks is nearly north and other data indicate the presence of a series of small open folds.

The inland hills rise to about 250 feet above sea level and run-off from these onto the coastal plain charges the aquifers which underlie the area. The catchment is slightly larger than the agricultural area and the rainfall is about fifty inches annually.

Rainwater is used for domestic supplies whilst water for dairying and agriculure is drawn from wells and in one case from a small permanent creek. Bores supply the needs of several farms in this locality. Supplementary supplies are necessary because the dairying industry demands a large quantity of water and bores are less expensive than large storage tanks. Surface water on the foothills is suitable for dairying purposes but is not permanent. On the lower levels the surface water is drained away as it is deeply stained and acidic.

The underground water is tapped by several bores all of which have Cambrian rocks as aquifers. Underground water accumulates and moves in joints and bedding planes in siltstones. The tuffs and conglomerate are more porous and should give slightly higher yields but they have not been struck in any bores.

Charging of the aquifers occurs in the hills and hillsides to the south and through sand covering the lower country.

The rate of drilling in the siltstones is not high but there have been no technical difficulties in boring this area. Sand and clay overlying the aquifers varies from 2 to 19 feet thick and must be cased. The depth to which wet bores have been sunk varies from 12 to 85 feet, water being struck between 8 and 72 feet. As the bore records are not very detailed it cannot be determined whether there is one particular bed which is the best aquifer but from the type of ground-water storage this would not appear to be so. Only in the deepest bore was the water struck below 40 feet. The local structures may affect the depth to which a bore must be drilled but lack of outcrops prevents accurate assessment of any structural control.

Bores in the area can be expected to produce from 200 to 500 gallons per hour of fairly pure water but the quality deteriorates in the lower level bores.

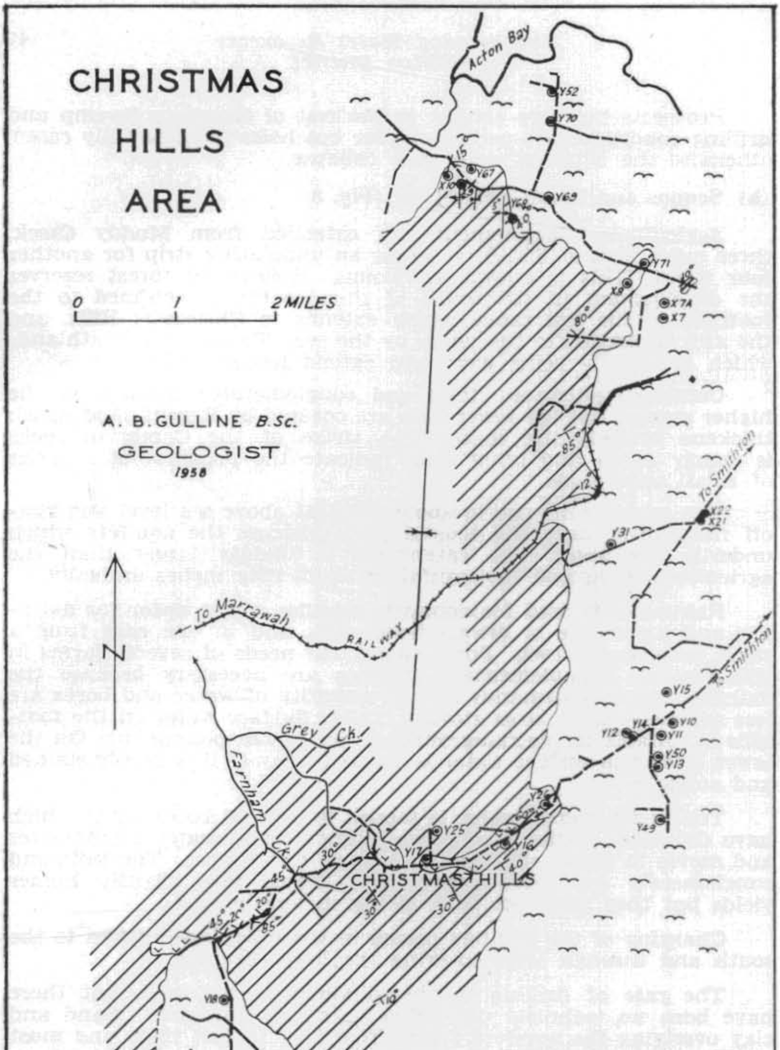

CHRISTMAS
HILLS
AREA
0 1 2 MILES
A. B. GULLINE B.Sc.
GEOLOGIST
1958
Acton Bay
To Smithton
To Smithton
To Marrawah
RAILWAY
Grey Ck.
Farnham Ck.
CHRISTMAS HILLS
Brittons
Swamp
To Marrawah
QUATERNARY...SANDS, GRAVELS ETC.
CAMBRIAN.....DUNDAS GROUP
TERTIARY........BASALT
DIP & STRIKE
BOREHOLES

Fig. 8.

5 cm

One bore, No. 52, drilled early in 1956 struck water at twenty-five feet but owing to the low output was deepened to 58 feet to give a yield of 200 gallons per hour. The water was tested and was potable. Towards the end of 1956 the cattle refused to drink this water and it was found to be salt, containing 10,142 parts per million (709.2 grains per gallon) of dissolved solids including 462.2 grains per gallon of sodium chloride (NaCl).

This bore is about 40 feet above sea level and half a mile from the coast. The bottom is a least 18 feet below sea level and the pressure of fresh water is apparently insufficient to exclude the salt water from the sea. Pumping does not approach the tested output so contamination from overpumping has not occurred. It may be that the pump intake is near the bottom of the bore in salt water, below relatively fresh water. If this is so, raising the intake to a few feet below the surface of the water should be tried and a test made to determine whether all the water in the bore is salt or only that in the lower part.

The bore water analysed from this area is generally of a quality slightly better than underground water from Broadmeadows. Most impurities were in the water from bores Nos. 52 and 15. Bore Number 15 (1947) contained 804.3 parts per million of dissolved solids, the main constituents being calcium sulphate, magnesium carbonate, and sodium chloride. These are not injurious but would cause scale deposits to form in pipes. Iron is present in sufficient amounts to cause staining. The water is therefore suitable for all purposes except washing. Because the Scopus area is near the sea, care must be taken in siting bores and pumping from them should be at a slow rate to reduce the risk of contamination. The distribution of bores excludes the possibility of interference reducing the output. Tidal movements can be expected to affect the level of water in bores on the lower lying areas.

(l) Montagu

The town of Montagu (Fig. 9) lies about 9 miles west of Smithton. There is a central area of basalt about 200 feet high which slopes down to the surrounding plains. Most of the development is on the basalt itself and on soil derived from it. To the south farming has been carried out on alluvial deposits from the Montagu River.

Present supplies of water are obtained from rainfall, wells and bores, the last becoming more popular as a supplementary supply because the groundwater is superior to well water.

Outcrops of dolomite occur to the west of Montagu and these beds have a general easterly dip of about 30°. To the north, at Stony Point, Cambrian rocks strike north and dip eastwards at about 25°. Tertiary basalt overlies the Cambrian rocks in the north and east. To the south there are no outcrops but drilling records show deep soil and sand covers overlying Tertiary limestone. In the Montagu River near the cheese factory this limestone unconformably overlies Precambrian dolomite.

5 cm

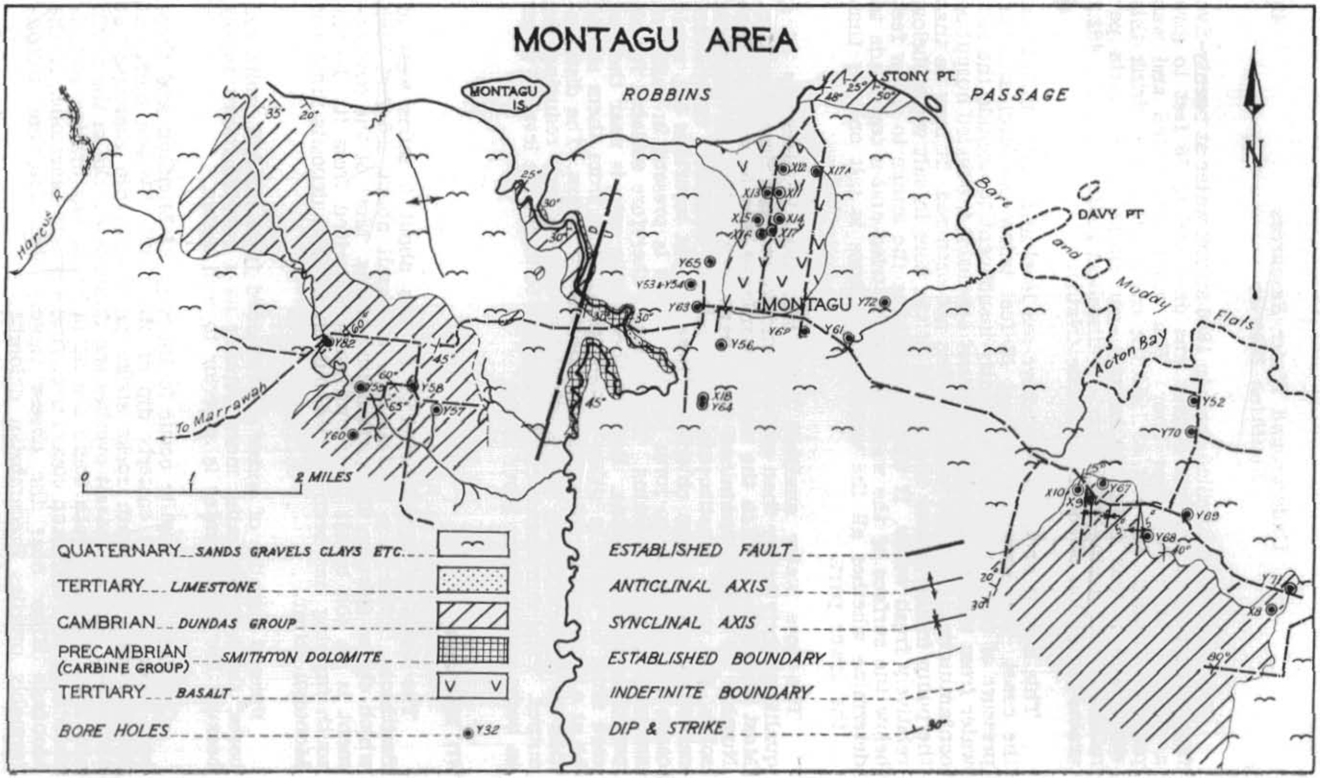

MONTAGU AREA
MONTAGU IS.
ROBBINS
PASSAGE
STONY PT.
DAVY PT
Bare
and
Muddy
Flats
Acton Bay
MONTAGU
Harcus R
To Marrawah
N
0
1
2 MILES
QUATERNARY _ SANDS GRAVELS CLAYS ETC.
TERTIARY _ LIMESTONE
CAMBRIAN _ DUNDAS GROUP
PRECAMBRIAN (CARBINE GROUP) _ SMITHTON DOLOMITE
TERTIARY _ BASALT
BORE HOLES
Y32
ESTABLISHED FAULT
ANTICLINAL AXIS
SYNCLINAL AXIS
ESTABLISHED BOUNDARY
INDEFINITE BOUNDARY
DIP & STRIKE
30°
X12
X17A
X13
X11
X15
X14
X16
X17
Y65
Y53 & Y54
Y63
Y72
Y62
Y61
Y56
X18
Y64
Y82
Y59
Y58
Y57
Y60
Y52
Y70
X10
X9
Y67
Y69
Y68
Y71
X8

Fig. 9.

Rainfall is about 50 inches per year with a winter maximum. The catchment zone is large and charging of the aquifers occurs over a wide area. Surface water is unsuitable except where it flows over the basalt. This water is used in some cases for all purposes, domestic and agricultural, but instances are known where the water has had a corrosive action on tanks. Analysis showed that acidity was the main cause of corrosion and this could be neutralised by the addition of the correct amount of lime.

Satisfactory supplies of underground water are obtained from several different aquifers. When the aquifers are intersected the water rises a short height in the bores indicating that it is of sub-artesian origin. The basalt area supplies the purest groundwater from an aquifer of broken and well jointed rock. One bore in the basalt one mile from the coast penetrates to a depth of 15 feet below sea level but no contamination has occurred. Drilling conditions on the basalt are little if any better than on other basalt country.

Analysis shows a maximum of 507 p.p. million of dissolved solids with sodium chloride having the highest concentration. Iron is present (1.6 p.p.m.) and causes staining but the water can be used for dairy purposes and irrigation. Two bores struck water in Tertiary limestone and supplies of between 300 and 400 gallons per hour were obtained. The limestone is permeable, showing bedding and joint plane solution weathering. Its porous nature is due to the fact that the shell fragments and sand grains of which it is composed have not been wholly cemented by calcium carbonate. Drilling is fast in the limestone but overlying boulders and gravels cause some trouble and must be cased. Chemical analysis shows that the water has a high mineral content, particularly of sodium chloride, but this is not sufficiently concentrated to be tasted and the water can be used for all purposes except washing fabrics.

Cambrian siltstones have been penetrated in several bores and as elsewhere these provide an aquifer which yields about 400 gallons per hour. Storage capacity is due to fractures and joint planes and enlargement of joints by continuous water movement. Drilling conditions in the siltstones are good but casing is necessary where overlying sands occur and where the siltstones are badly fractured and broken. The quality of the underground water is considerably better than that from the Tertiary limestone aquifer but again iron is present in quantities which cause staining.

Prospects are good in the Montagu area. Only in the basalt have any dry bores been sunk.

(m) West Montagu (Fig. 10)

This settlement is situated about 3 miles west of Montagu on the western side of the Montagu River. The elevation of the farmed area above the surrounding plains is due to the occurrence of resistant Cambrian rocks and remnants of Tertiary basalt most of which has now been eroded.

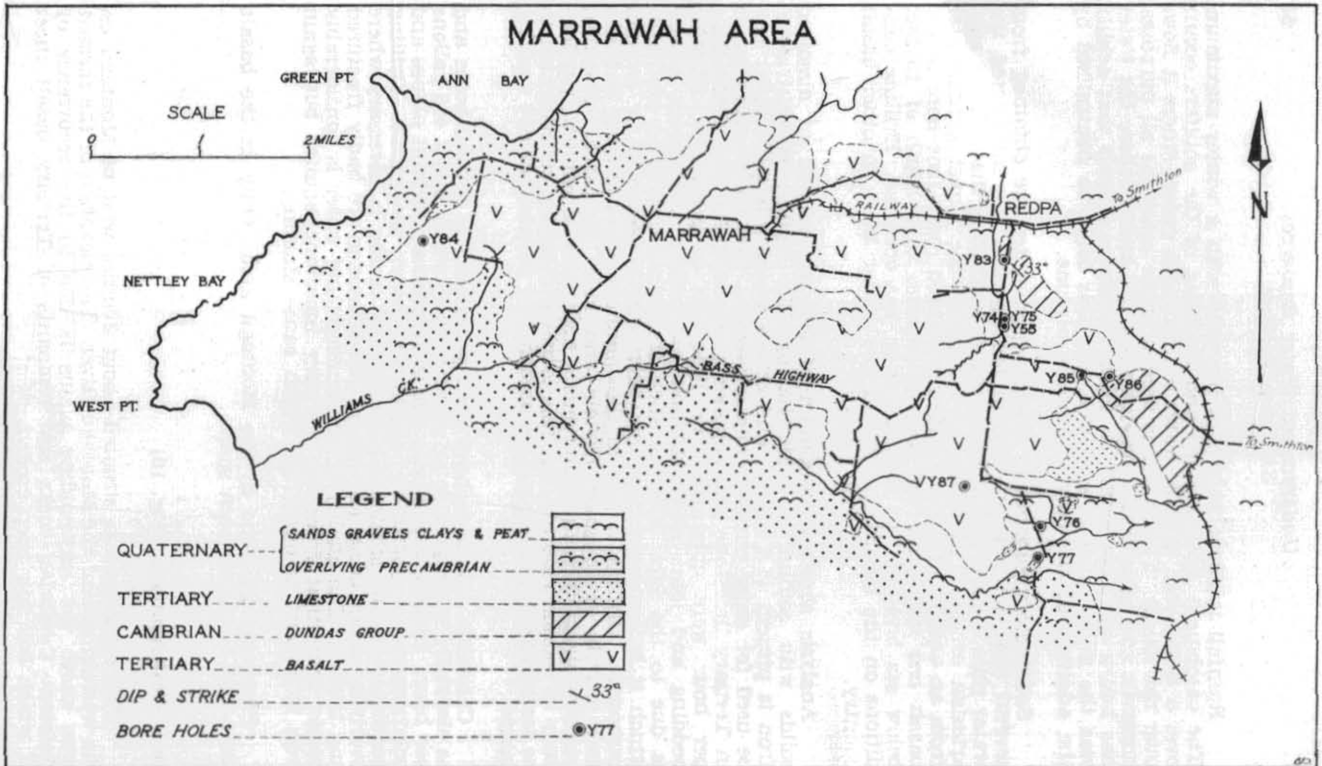

MARRAWAH AREA
SCALE
0
2 MILES
GREEN PT.
ANN BAY
NETTLEY BAY
WEST PT.
WILLIAMS CK.
MARRAWAH
REDPA
RAILWAY
BASS HIGHWAY
To Smithton
To Smithton
N
Y84
Y83
33°
Y74
Y75
Y58
Y85
Y86
Y87
Y76
Y77
LEGEND
QUATERNARY
SANDS GRAVELS CLAYS & PEAT
OVERLYING PRECAMBRIAN
TERTIARY
LIMESTONE
CAMBRIAN
DUNDAS GROUP
TERTIARY
BASALT
DIP & STRIKE
33°
BORE HOLES
Y77

Fig. 10.

5 cm

The outcropping rocks are of Cambrian Dundas Group comprising siltstones, tuffs, breccias and lavas. Outcrop is poor but on the coast several miles north the strike is north-west and the dip is about 25° to the south-west. Outcrops of volcanic rocks in two places at West Montagu give some confirmation of this strike in the area under discussion. Overlying the Cambrian rocks is a thick layer of clay and in one place boulders of Tertiary basalt occur.

The district, because of its hilly nature, cannot be expected to have large underground water resources as drainage would be rapid. The flatter parts have a considerable catchment and rainfall is about 50 inches annually so supplies should be reliable. Present supplies are from rainwater storage, and wells and dams which are easily constructed in the small, steep-sided valleys. Bores for extra supplies are becoming increasingly popular.

Surface and well water is suitable for watering stock but is unsatisfactory for other purposes, such as flushing milking machine pipes, where a large quantity of water is required.

Boring has met with considerable success and only one bore has proved unsatisfactory. This bore site was selected by a diviner, as were most of the sites in this area, and was a topographically unsuitable position. The bore is at the top of a steep hill, hence run-off is at a maximum and the catchment area is small. The drill log records 45 feet of clay and 30 feet of siltstone and water was struck at the base of the siltstone above lava. The bore was deepened to 86′, that is 11 feet into the volcanic rock, and the driller tested the yield at 200 g.p.h. When rigged with a pump the bore was found to be almost dry. This anomaly was probably due to water finding an escape route through the well-jointed lava, the elevation being such that the bore had not reached the permanent water table.

Other bores have struck water in siltstone and tuff beds which proved to be satisfactory aquifers, the yield approaching the maximum testable yield. Boring conditions vary but usually only in the rate of progress which depends on the hardness and character of the rock being bored.

From bore records it is seen that water can be expected at depths of 50 to 70′ and that the supply will be sufficient for agricultural and dairying requirements. The quality of the water analysed varies from good to poor, but it is suitable for most uses. These samples were taken from new bores and the quality may improve when they are in constant use The concentration of iron is high enough to stain material and containers but otherwise the water should be acceptable for domestic as well as agricultural uses. The water ranges from soft to hard, the dissolved solids content varying between 175 parts per million and 600 parts per million. In the lower levels the quality deteriorates probably because the decreasing rate of movement of water as the gradient decreases allows a longer period for minerals to be dissolved out of the rocks.

(n) Harcus

Because the Harcus district is isolated and there is only one farm, little geological investigation was done in the vicinity of the one bore-hole drilled.

The farm is located on and around a few small hills which rise about 100 feet above the sandy plain. The highest of these hills is capped with Tertiary basalt. At the drill site, the aquifer, a broken, partly silicified oolitic dolomite, is overlain by a poor china-clay which is covered by clay and soil.

Wells were used for extra water prior to the completion of the bore. Future bores should strike similar conditions and reasonable supplies of underground water can be expected.

(o) Woolnorth Estate (Van Diemens Land Company)

The property lies in the far north-west corner of the State and is mainly plains country with a range of coastal hills to the west. Rainfall is unrecorded but is estimated as about 40 inches per annum.

The developed area is underlain by Precambrian quartzite older than the Precambrian rocks seen elsewhere in the district. The quartzite strikes approximately north-east. Overlying the Precambrian rocks are beds of Tertiary limestone, unconsolidated sand and shells, and a cover of soil.

During the winter, excess surface water is a problem and deep drainage systems have been cut in the flat areas. The artificial drainage results in slight parching of the surface during dry summers. Bores have been drilled to remedy this situation and good water supplies were obtained in each case.

The aquifers vary but charging of them is considered to occur over the entire area and from the run-off of the western hills. This run-off percolates underground at the foot of the hills and as underground water it moves from west to east following the slope of the land. Two bores struck water in well jointed quartzite at three feet into the rock and this appears to be the water table 16 to 25 feet below the land surface. Other holes struck water in Tertiary limestone 32 feet below the surface in one case and in gravels and clay beds 30 feet below the surface in the other. These bores extend below sea level but the head of underground water from the hills is probably enough to keep sea water out especially in the deep bores into the gravel aquifer confined between clay beds. Prospects are good but the quality is unknown except that the water was not salty when tested.

(p) Christmas Hills (Fig. 8)

At the western edge of Mowbray Swamp the Marrawah road rises steeply to Christmas Hills which have an altitude of about 400 feet and extend several miles to Brittons Swamp. Much of the hill country is still forest-covered and strip farms have developed alongside the road. Rocks in the area comprise Cambrian siltstones, tuffs, breccia and conglomerate overlain in the highest part by a thin Tertiary basalt cap. About two miles south-east of the post office, fossils occur in a siltstone formation. The trilobite fauna in these beds is Upper Middle Cambrian in age.

The hills receive a higher rainfall than nearby Broadmeadows but their highly dissected nature leads to fairly rapid run-off. The catchment is restricted to a small strip slightly larger than the farmed areas. Local folding forms small basins where underground water may occur if confined by impermeable beds, otherwise groundwater may be obtained by tapping the permanent water table.

Present supplies are drawn from rainfall storage dams, wells and bores.

Drilling conditions are good in the Cambrian rocks but some difficulty may be experienced in the basalt area where boulders occur. Because of the high rainfall prospects are favourable and water can be expected at a depth of about 100 feet.

The water is of good quality and as the bore water tested contained 129.3 parts per million of dissolved solids and had a very low iron content, it is suitable for all purposes, domestic and agricultural.

(q) Brittons Swamp (Fig. 8)

This area is about 12 miles from Smithton on the Marrawah road and has been drained and developed as a dairying proposition. The swamp is cleared for about three miles in a northerly direction and averages a little over a mile in width. It is surrounded by low hills except in the south where there is undeveloped swampland. Lack of outcrops prevents detailed study of the local geology but from bore records and from the regional geology it appears that the swamp lies on the axis of an anticline.

Erosion removing the Cambrian siltstones and tuffs from the underlying Precambrian dolomite resulted in an elongated depression surrounded by hills of Cambrian rocks. The depression was slowly filled with Tertiary marine and freshwater deposits and Recent swamp deposits. At the northern end an isolated Tertiary basalt flow is present. Tertiary limestone probably underlies the northern end of the plain above the dolomite as the basalt contains blocks of limestone which it has picked up during its eruption.

The annual rainfall is over 40 inches and the farms are drained by deep artificial drains to keep surface water to a minimum. Present water supplies are drawn from rainfall storage and bores have been sunk to give an added supply. The catchment area is confined to the surrounding hills and the surface of the plain. Charging of the aquifers occurs on the hills and perhaps by some surface percolation from the swamp. Five bores have been drilled, two being abandoned on instruction from the farmer as they were deep and becoming too expensive. These two were in clays and gravels and apparently there are some dry areas caused by clay sealing the water out. Future boring should be carried out well away from these areas if possible. Drilling conditions through the unconsolidated materials are good. The Cambrian siltstones can be penetrated at a faster rate than the dolomite but neither is difficult to drill.

Prospects on the swamp are fair provided the underlying dolomite is reached. Bores of over 100 feet in depth may be necessary. The holes in Cambrian rocks should strike water at similar depths but dry areas may result from the filling of joints and fractures with clay.

The quality of the water is fair and it does not have any noticeably adverse effects. The water from one bore which supplies a timber mill is used for drinking and can be used for washing as the iron concentration is lower than the limiting value of 0.3 parts per million.

Between Brittons Swamp and Montagu Swamp the road rises on low hills of Cambrian siltstones and a farm about 1 mile along this road has a productive bore. Two holes were drilled here, one wet and one dry, both in the same type of rock. Water was struck in one at 140 feet and the other bore was still dry at 145 feet. About a quarter of a mile further on bores were put down in the same sediments and one was dry owing to clay filling the joints. This was probably the reason for the other dry bore.

Montagu Swamp is low lying and has been recently drained and cleared preparatory to agricultural development. The rainfall is high, the recorded precipitation for the year 1956 being 76.50 inches but this was a record wet year and less rain is expected in normal years. Although this rainfall may be adequate an evaluation of the underground water resources is necessary if extra supplies are required.

The swamp is bounded on the east and west by hills of Cambrian siltstone occurring above Precambrian dolomite which underlies the drained area and outcrops in the Montagu River. A layer of 10 to 20 feet of sand and peaty material covers the dolomite.

The Montagu River flows through the cleared area and this, together with water moving down from the surface of the catchment area, should charge any aquifers. The situation appears to be similar to Broadmeadows and the prospects of underground water are good. The quality of the water may be poor but it should be suitable for agricultural purposes. Drilling conditions are expected to be favourable and for adequate supplies the bore holes should average about 40 feet in depth. Surface water is deeply stained and unsuitable for most purposes.

(r) Redpa

The Redpa district (Fig. 10) lies about 25 miles from Smithton and four miles from Marrawah and has been the site of extensive agricultural development.

The geological structure is not clear but by comparison with other districts there is a gently folded basement of Cambrian siltstones resting on Precambrian dolomite which in places is overlain by Tertiary limestone and basalt. Outcrops are rare owing to deep weathering and an extensive soil cover.

The town of Redpa is on a flat area of unconsolidated Tertiary and Quaternary gravels and clay. Cambrian siltstones and tuffs outcrop as hills in the plain and occur more extensively to the east.

The catchment for the lower levels is large and the rainfall average of 49.93 inches per annum is such that underground water supplies are not subject to great seasonal fluctuations. The higher levels—basalt capped hills—vary in area, gradient and drainage so no general statement is applicable.

Present supplies are derived from rainfall storage and wells containing surface and ground water. Extra water required in summer for dairying has called for the drilling of several bores. At the school and Nursing Centre bores have also been drilled to supply water for drinking and toilet purposes.

In one area about 3 miles south of Redpa post office three bores have been drilled. This locality extends to the Welcome River and Swamp in the south and east and is bounded to the north by the Bass Highway. The basement rock is Precambrian dolomite. In places only a thin covering of Quaternary material overlies the dolomite but it is generally overlain unconformably by Tertiary limestone and more recent gravels and clay. Tertiary basalt caps most of the hills in the lower part of this district and overlies Tertiary limestone. Near the highway there are no outcrops but the soil and clay indicate that Cambrian sediments underlie the basalt.

The extensive basalt hills lie mainly to the west of this area and drainage is eastwards.

Wells and dams have been used for extra water supplies, the wells in one case being unreliable. Replenishment of the aquifers depends on the downward migration of rainwater through the surface layers of basalt and limestone on the hills and around the edge of the flatter area where clay beds are not continuous. Some underground water may originate from the Welcome River.

Bore No. 76 revealed an aquifer of silicified dolomite covered with 30 feet of clay and gravel and bore No. 77 has a Tertiary limestone reservoir underlying 33 feet of clay and gravel.

Drilling conditions were good although the reservoir rocks were hard and drilling slow. The depth at which water should be struck in this region is between 30 and 40 feet and a satisfactory yield can be expected all the year round.

On the higher land basalt boulders may present difficulties and although the depth to the water table may be considerably greater the possibility of wet bores is still good. The quality of the water analysed shows that it is suitable for all purposes, including septic tanks but iron is present in sufficient concentration to cause staining.

Redpa School is built on a thick deposit of Tertiary and Quaternary clay and gravels filling a deeply eroded valley. The presence of water in this basin depends on the surrounding rocks being permeable as the downward penetration of rain is prevented by the clay layers. The only way water can enter the porous gravel beds is by movement down the boundary of the Recent sediments with older permeable rocks or through these rocks into the gravels. Apparently this does occur because water was struck in the gravels fairly close to the bottom of the deposit, this position being indicated by the angularity of the gravels.

The bore was about 90 feet deep and had to be cased most of the way so this area should be avoided if cost is important to the farmer. Close by to the west lower portions of valleys in basalt hills could be expected to yield supplies of ground water at shallower depths. To the east an area of Cambrian siltstone and tuff occurs and similar rocks form residual hills which protrude from the flat. A bore into these Cambrian rocks indicates that underground water can be obtained at a shallower depth than in the gravels. Boring in these rocks is less complicated than in the gravels.

The remaining areas are mainly basalt hills and plateaux. Factors controlling water supply may vary slightly from other basalt areas because some flows are intensely jointed, fractured and weathered. This allows the free movement of water which may form a water table at a considerable depth below the surface and make deep bores necessary. Otherwise the basalt should provide a supply of underground water at relatively shallow depths if the topographic position of the bore is selected correctly. No advantages are gained by selecting the top of a basalt hill for a bore site as has been done by some farmers. What is gained by the additional height enabling gravity distribution of water, is often lost in the cost of a deep bore. A shallower bore in a natural topographic depression or basin would be less costly. The same pump which would be necessary on a deep bore to bring the water to the surface could be used on a shallower hole to pump water to a higher point for distribution by gravity to various paddocks.

(s) Marrawah (Fig. 10)

Marrawah is mainly a basalt area, the basalt overlying Tertiary limestone in some parts and Precambrian quartzites in others but almost all development has been on the basalt. Underground water prospects are fair as surface drainage is not extensive or well developed, indicating that rainwater migrates down to an underground aquifer instead of running off the surface.

Quaternary swamps on the basalt may be underlain directly by Tertiary deposits and such formations could be expected to contain underground water. Prospects are not good on the higher basalt areas but may improve on the lower hills in the south of the Marrawah district.

(t) Trowutta

A short reconnaissance of the geology of the Trowutta area revealed Precambrian rocks overlain by Cambrian rocks of the Dundas Group. Remnants of Tertiary basalt cap isolated hills and other prominent hills are composed of Cambrian volcanic rocks. The factors influencing the occurrence of underground water are considered to be favourable in this area. Boring should not be difficult in the Cambrian sediments but bores should be fully cased to prevent the walls of the holes collapsing. Bores between 50 and 100 feet deep should give adequate supplies in this district.

5. SUMMARY AND CONCLUSIONS

The investigation has shown that underground water prospects in the district are generally favourable. The geological structure of the Cambrian and Precambrian rocks does not have any great effect on the occurrence of underground basins because jointing in these rocks allows free movement of water. A few localised basins do occur in the Cambrian sediments, where impervious surface and underground layers retain the water.

The post-Tertiary geological structure and Tertiary or later sedimentary deposits have a marked influence on the presence of underground water, because the deposits, elevation and topography resulting directly and indirectly from Tertiary faulting are favourable. The physiography is therefore an important factor in determining the prospects of striking water in a bore. The general low relief and elevation above sea level, the high rainfall with little run-off and the presence of numerous aquifers result in almost ideal conditions for productive bores. Only on the higher hills and basalt capped hills do the prospects of striking water become less favourable.

Underground water is usually sub-artesian but an occasional artesian supply has been tapped. Artesian water is restricted to small areas, neighbouring bores within a quarter of a mile being sub-artesian.

Use of the water is determined by the proportion of dissolved salts and the acidity or alkalinity (pH) of the water. It has been found that all bores except one yield water suitable for stock, irrigation and flushing dairies and milking machinery. However, use of the water for domestic purposes is limited in most cases because iron in solution causes staining. The pH values of underground water tested are within the required limits for safe usage (pH5.5-8.6).

Water with a pH in this range is also suitable for use in septic tanks.

As the cost of bores is relatively low there is little need for any farm to be short of water during a dry spell.

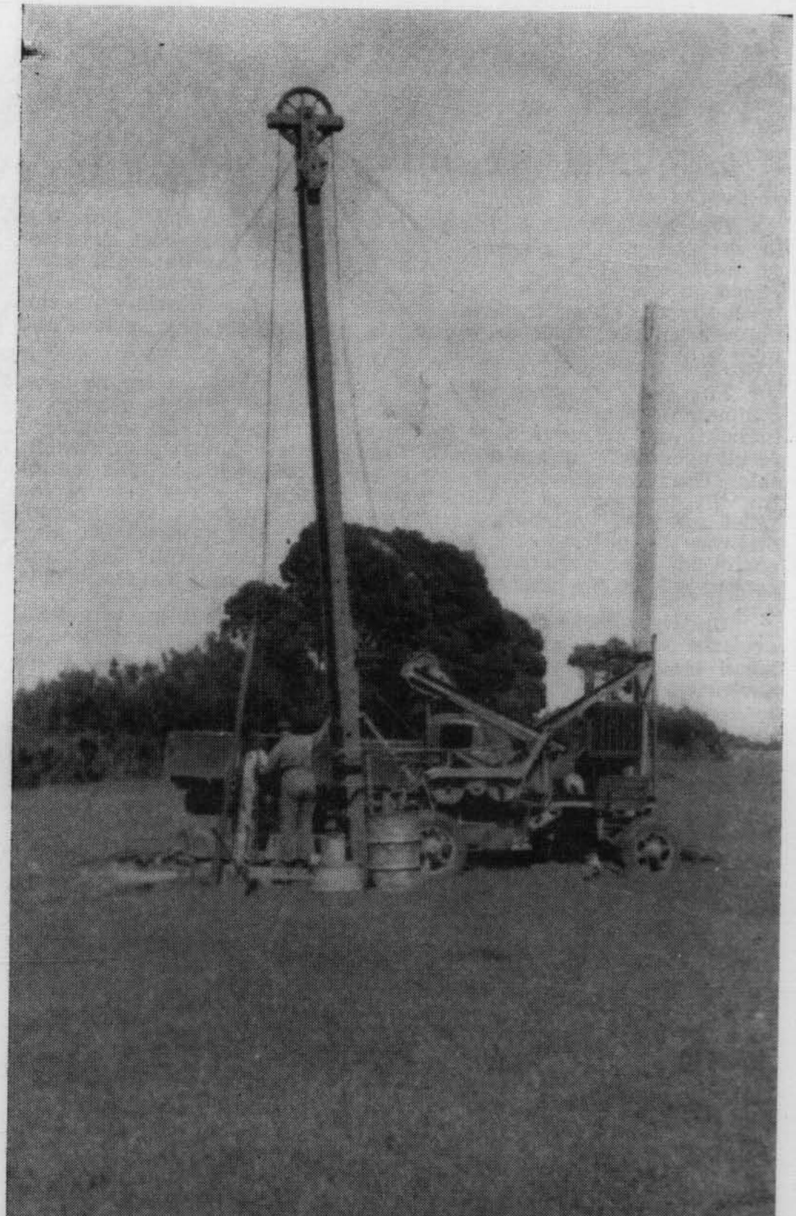


Fig. 11.—G33 percussion drill in operation.

6. RECOMMENDATIONS

Several problems have arisen in the district concerning the bores. These difficulties may be overcome by proper investigation to find the most suitable type of pump and by using sufficient casing in bores rather than trusting the bore walls to stand unsupported.

In one instance a bore yielded fresh water when it was tested on completion, but after several months was found to contain a large proportion of salt water. This bore was near the sea and the bottom was below sea level. Similar situations have arisen elsewhere in Tasmania and the reason and remedy have been found. In the bore in question yield was low compared with most bores. Pumping should be slow to ensure that the supply of fresh water is not exhausted and to prevent salt water rising into the bore to contaminate the supply.

The following points are important in such a case:—

1. The rate of withdrawal should not exceed the rate of flow of fresh water into the bore.
2. The intake for the pump must be placed so that it is only a few feet below the surface of the water in the bore. If this is done the pump cannot draw enough water to permit the entry of salt water.
3. Use of the correct capacity pump is essential. Over-pumping is best avoided by using a large storage tank and an automatically operated pump to keep it full. The capacity of the pump should not be greater than the tested yield of the bore. A bore with a reservoir of 50 gallons and a yield of 500 gallons per hour can only be pumped for about 5 minutes with a 1,000 gallon per hour pump before over-pumping occurs and the bore would be dry for a few minutes. Pumping at such a rate could only be repeated at six minute intervals indicating the disadvantage of a pump with too large a capacity.

When a bore is over-pumped collapse of the walls may occur, overlying sand and surface water may be drawn down the outside of the casing so causing pollution. Collapse may be prevented by casing the bore hole with pipe which is slotted to allow the inflow of underground water. Holes drilled in Cambrian siltstone tend to be unstable and should be cased as deep as possible.

All bores and wells should be covered to prevent contamination by windblown impurities and foreign material. It is also recommended that whenever possible a geologist should visit proposed drill sites and give advice where required. This is necessary because the farmer is often influenced in his choice of site by its elevation and its proximity to electric power supply. This may lead to the sinking of a bore in an unfavourable position with disappointing results.

The sites must also be accessible. The percussion drilling plant (Fig. 11) is heavy and unwieldy and cannot be taken over very rough terrain.

Bores should be continued well below the depth at which underground water is encountered to provide a reservoir within the hole where silt, rock fragments and other debris can settle instead of blocking the pump intake.

7. TABULATION OF RESULTS

(i) BORE LOGS

Bore No. (X Series)	Date Completed	Depth at which water struck	Total Depth	Output in Gals./hr.	Analysis No.	Geological Record	Owner and Locality
		ft.	*ft.*				
1	18.3.46	63	..	400	..	0–26′ sand and clay, 26′–50′ sand, gravel and dolomite, 50′ onwards dolomite	Dr. G. Packham, Smithton
2	24.4.46	*	51	*	1,196	0—8′ 6″ sand and clay, 8′ 6″–51′ dolomite	A. Nicol, Smithton
3	2.5.46	..	29	..	..	0–5′ 6″ sand, 5′ 6″–29′ gravel and boulders	C. Popowski, Smithton
3A	5.6.46	47½	47½	420	..	0–5′ 6″ sand, 5′ 6″–29′ 6″ gravel, 20′ 6″–47′ 6″ dolomite	C. Popowski, Smithton
4	13.6.46	..	60½	*	..	No record, finished in dolomite	S. E. Jones, Smithton
5	5.7.46	..	18	..	..	Sand overlying dolomite	R. E. Anthony, Smithton
5A	17.10.46	70	74	300	..	0–6′ sand, 6–74′ dolomite	R. E. Anthony, Smithton
6	31.10.46	25	28½	200	..	0–15′ 6″ sand, 15′ 6″—20′ 6″ boulders, 20′ 6″–28′ 6″ dolomite	W. Innes, Smithton
7	3.12.46	..	100½	..	..	0–7′ clay, 7′–100′ 6″ siltstone to slate (Cambrian)	Ward Bros., Smithton
7A	5.12.46	..	11	..	..	0–6′ soil and clay, 7′–11′ siltstone	Ward Bros., Smithton
8	13.12.46	26	34	300	333	0–3′ 6″ clay, 3′ 6″–18′ weathered rock, 18′–34′ siltstone	D. H. Johnston, Scopus, Smithton
9	19.12.46	10	12	100	..	0–2′ clay, 2′–12′ loose boulders	D. Timms, Scopus, Smithton
10	13.1.47	28	30	200	..	0–12′ clay and boulders, 12′–30′ sandy siltstone	D. Timms, Scopus, Smithton
11	17.1.47	..	28	*	..	Basalt	D. B. Quilliam Jnr., Montagu
12	28.1.47	35	40½	200	..	0–13′ clay, 13′–40′ 6″ hard mudstone	D. B. Quilliam Jnr., Montagu
13	14.2.47	26	30	180	..	0–7′ clay, 7′–30′ basalt	D. B. Quilliam Jnr., Montagu
14	24.2.47	40	52½	500	..	0–37′ 6″ clay and basalt boulders, 37′ 6″–52′ 6″ siltstone	C. J. Ennis, Montagu
15	5.3.47	..	31	..	..	0–18′ clay, 18′–28′ 6″ mudstone, 28′ 6″–31′ basalt	C. H. Ennis, Montagu
16	17.3.47	..	60	..	..	clay and mudstone—no further records	F. Grey, Montagu
17	1.4.47	54	60	400	334	0–47′ clay and boulders, 47′–60′ mudstone (Cambrian?)	F. Grey, Montagu
17A	4.7.47	60	67	200	..	0–12′ clay and pebbles, 12′–67′ basalt (Tertiary)	C. J. Ennis. Montagu
18	5.9.47	67	69½	400	..	0–59′ clay, sand and boulders, 59′–69½′ dolomite	C. Wilson, Montagu
19	6.10.47	15	17½	240	..	0–8′ sand, 8′–10′ 6″ sand and shells, 10′ 6″–17′ 6″ dolomite	R. D. Brown, Broadmeadows, Smithton
20	21.10.47	28	34	500	..	0–3′ 6″ sand, 3′ 6″–7′ sand and shells, 7′–34′ dolomite	G. F. Acheson, Broadmeadows, Smithton
21	3.12.47	..	50	..	..	0–36′ clay, sand and boulders, 36′–50′ dolomite	T. Edwards, Mella
22	12.12.47	63	67	500	1,198	0–8′ 6″ sand, 8′ 6″–50′ clay and gravel, 50′–67′ dolomite	T. Edwards, Mella

* Not recorded.

(i) BORE LOGS—continued

Bore No. (Y Series)	Date Completed	Depth at which water struck	Total Depth	Output in Gals./hr.	Analysis No.	Geological Record	Owner and Locality
		ft.	ft.				
1	16.6.54	40	75	300	..	0–2′ 6″ soil and pebbles, 2′ 6″–75′ slate (Cambrian?)	R. V. Rockliffe, Wiltshire
2	12.7.54	dry	200	..	..	basalt (Tertiary)	C. J. Medwin, Green Hills, Stanley
3	6.9.54	45	48	200	915	0–40′ basalt soil, 40′–48′ basalt boulders	E. J. Anthony, Green Hills, Stanley
4	9.9.54	25	40	300	1,031	0–40′ basalt clay and decomposed basalt	H. T. Hill, West Forest
5	16.9.54	dry	38	..	..	0–10′ clay, 10′–32′ sand, 32′–36′ basalt boulders, 36′–38′ water-worn boulders	A. F. Bonney, Lileah
6	7.10.54 (unrigged)	45	60	200	1,197	0–40′ soil and clay, 40′–60′ (Cambrian) siltstone	A. F. Bonney, Lileah
7	14.10.54	35	42	300	..	0–3′ 6″ clay, 3′ 6″–40′ mudstone (Tertiary), 40′–42′ basalt (Tertiary)	P. J. Young, Lileah
8	25.10.54	..	27½	..	..	0–1′ 6″ clay, 1′ 6″–27′ 6″ basalt boulders	V. W. Medwin, Lileah
9	28.10.54	12	25½	300	..	0–6′ clay, 6′–17′ basalt boulders, 17′–25′ 6″ basalt (Tertiary)	V. W. Medwin, Lileah
10	11.11.54	28	40	400	1,027	0–1′ 6″ soil, 1′ 6″–21′ sand, 21′–33′ broken dolomite, 33′–40′ soft dolomite	F. H. C. Fenton, Broadmeadows, Smithton
11	16.11.54	20	41	500	1,026	0–2′ soil, 2′–8′ 6″ clay, 8′ 6″–15′ 6″ sand, 15′ 6″–41′ broken dolomite (Precambrian)	L. C. Thomas, Broadmeadows, Smithton
12	23.11.54	30	37½	450	..	0–2′ soil, 2′–5′ clay, 5′–15′ sand, 15′–28′ clay, 28′–37′ 6″ dolomite	W. V. Murphy, Broadmeadows, Smithton
13	23.12.54	43	88	300	..	0–2′ soil, 2′–4′ 6″ clay, 4′ 6″–8′ peat?, 8′–9′ 6″ sand, 9′ 6″–88′ dolomite	L. F. Blazely, Broadmeadows, Smithton
14	7.1.55	21	27	500	330	0–2′ soil, 2′–6′ clay, 6′–14′ sand, 14′–20′ pug, 20′–27′ wash?	W. V. Murphy, Broadmeadows, Smithton
15	7.2.55	60	90	300	..	0–1′ 6″ soil, 1′ 6″–3′ 6″ clay, 3′ 6″–11′ 6″ sand, 11′ 6″–13′ shells and sand, 13′–90′ dolomite	E. J. Anthony, Broadmeadows, Smithton
16	15.2.55	65	83½	300	..	0–1′ 6″ soil, 1′ 6″–4′ sand, 4′–30′ weathered basalt, 30′–37′ basalt (Tertiary), 37′–83′ 6″ Cambrian siltstone	S. Rowe, Christmas Hills
17	23.2.55	80	101½	300	..	0–2′ soil, 2′–10′ clay, 10′–48′ weathered decomposed basalt, 48′–101′ 6″ Cambrian siltstone	R. A. Eastley, Christmas Hills
18	3.3.55	60	76	300	..	0–2′ soil, 2′–12′ clay, 12′–60′ pug and pebbles, 60′–76′ dolomite (Precambrian)	F. L. Britton, Britton's Swamp
19	21.3.55	..	120	..	..	0–120′ clay and gravels	Britton Bros., Britton's Swamp
20	6.4.55	25	90	150	..	0–20′ soil and clay, 20′–90′ Cambrian siltstones	Britton Bros., Britton's Swamp
21	14.4.55	..	65	..	..	0–65′ pug and gravel	Britton Bros., Britton's Swamp
22	5.5.55	80	100	300	1,025	0–75′ clay, 75′–78′ broken dolomite, 78′–100′ dolomite	Britton Bros., Britton's Swamp

(i) BORE LOGS—continued

Bore No. (Y Series)	Date Completed	Depth at which water struck	Total Depth	Output in Gals./hr.	Analysis No.	Geological Record	Owner and Locality
		ft.	ft.				
23	23.5.55	..	145	dry	..	0–58′ decomposed rock, 58′–145′ Cambrian siltstone	W. G. Mercer, Britton's Swamp
24	3.6.55	140	166	200	1,024	0–1′ 6″ soil, 1′ 6″–22′ clay and decomposed rock, 22′–166′ Cambrian siltstones	W. G. Mercer, Britton's Swamp
25	15.6.55	65	100	300	335	0–2′ soil, 2′–17′ clay and stones, 17′–100′ Cambrian siltstones	L. W. Dunn, Christmas Hills
26	28.6.55	35	110	100	..	0–2′ soil, 2′–5′ sand, 5′–18′ clay, 18′–110′ Cambrian siltstone	S. R. Reeves, Christmas Hills
27	5.7.55	15	35	400	..	0–2′ soil, 2′–10′ sand, 10′–12′ sand and shells, 12′–35′ dolomite	R. T. Collins, Broadmeadows, Smithton
28	27.7.55	..	16	†	..	0–1′ soil, 1′–7′ sand, 7′–9′ shells and sand, 9′–16′ dolomite	U. J. Kay, Broadmeadows, Smithton
29	12.8.55	..	21½	†	..	0–1′ 6″ sand, 1′ 6″–8′ 6″ sand, 8′ 6″–10′ shells, 10′–21′ 6″ dolomite	U. J. Kay, Broadmeadows, Smithton
30	6.9.55	16	41	250	1,199	0—1′ 6″ soil, 1′ 6″–7′ sand, 7′–12′ sand and shells, 12′–38′ dolomite, 38′–41′ cavitied dolomite	U. J. Kay, Broadmeadows, Smithton
31	13.9.55	24	55	400	1,200	0–1′ 6″ soil, 1′ 6″—4′ 6″ white sand, 4′ 6″–19′ 6″ peat and sand, 19′ 6″–22′ sand and shells, 22′–55′ siltstone	F. D. and R. W. Kay, Mella
32	28.9.55	17	60	300	..	0–1′ 6″ soil, 1′ 6″–6′ 6″ sand, 6′ 6″–11′ pug, 11′–60′ dolomite	E. A. Popowski, Scotchtown, Smithton District
33	25.10.55	50	70	300	..	0–2′ soil, 2′–5′ clay, 5′–9′ river gravel, 9′–26′ broken dolomite, 26′–35′ dolomite boulders, 35′–62′ cemented dolomite boulders, 62′–70′ dolomite	R. E. Anthony, Scotchtown
34	31.10.55	..	18	..	..	0–7′ sand, 7′–18′ dolomite with cavities	S. N. Burgis, Scotchtown
35	2.11.55	..	14	..	..	0–8′ 6″ sand ,8′ 6″–10′ 6″ dolomite, 10′ 6″–14′ cavity—some mud	S. N. Burgis, Scotchtown
36	4.11.55	21	27	500	..	0–1′ 6″ soil, 1′ 6″–12′ sand, 12′–18′ peat, 18′–27′ dolomite	S. N. Burgis, Scotchtown
37	17.11.55	30	85	300	1,029	0–4′ soil and clay, 4′–22′ decomposed slate, 22′–85′ black slate (Precambrian)	F. Bellinger, South Forest
38	29.11.55	15	50	300	1,030	0–6′ soil and clay, 6′–12′ soft slate, 12′–50′ black slate	E. B. Haywood, South Forest
39	5.12.55	40	90	300	..	0–2′ soil, 2′–35′ soft mudstone, 35′–90′ slate	T. J. House, South Forest
40	7.12.55	25	47	400	1,028	0–2′ soil, 2′–10′ clay and weathered siltstone, 10′–45′ siltstone, 45′–47′ siliceous slate	M. G. Kay, Forest
41	14.12.55	..	25	†	..	0–8′ 6″ clay, 8′ 6″–25′ basalt boulders	T. F. Medwin, Forest
42	19.12.55	..	27	..	..	0–27′ basalt clay and boulders	C. J. Medwin, "Green Hills." Black River

* Not recorded. † Abandoned.

(i) BORE LOGS—continued

Bore No. (Y Series)	Date Completed	Depth at which water struck	Total Depth	Output in Gals./hr.	Analysis No.	Geological Record	Owner and Locality
		ft.	ft.				
43	22.12.55	..	38	..	..	0–38′ basalt clay and boulders	C. J. Medwin, "Green Hills," Black River
44	31.1.56	..	17½	†	..	0–17′ 6″ basalt clay and boulders	R. E. Cotton, Forest
45	2.2.56	35	63	200	..	0–60′ clay and decomposed basalt, 60′–63′ basalt	G. Ferguson, Forest
46	8.2.56	22	27	400	..	0–12′ 6″ soil and sand, 12′ 6″–19′ 6″ clay, 19′ 6″–27′ dolomite	S. E. Jones, Scotchtown
47	13.2.56	..	23	†	..	0–8′ soil and sand, 8′–13′ clay, 13′–23′ broken dolomite	C. Popowski, Scotchtown
47A	23.2.56	*	23	..	..	0–6′ sand, 6′–23′ broken dolomite and boulders	C. Popowski, Scotchtown
48	14.3.56	25	40	200	..	0–2′ soil, 2′–7′ sand, 7′–12′ 6″ gravel and boulders, 12′ 6″–40′ dolomite	C. Popowski, Scotchtown
49	26.3.56	24	37	500 (Flows)	..	0–2′ soil, 2′–7′ mud and sand, 7′–14′ clay, 14′–20′ sand, 20′–36′ dolomite, 36′–37′ water-worn stones and pug in a cavity	B. A. Bryan, Broadmeadows, Smithton
50	10.4.56	43	50	400	..	0–2′ soil, 2′–3′ 6″ clay, 3′ 6″–13′ sand, 13′–32′ sandy peat, 32′–43′ broken dolomite, 43′–50′ dolomite	C. E. Tedman, Broadmeadows, Smithton
51	30.4.56	18	35	250	960	0–1′ 6″ soil, 1′ 6″–5′ sand, 5′–11′ peaty sand, 11′–35′ dolomite	G. N. Guest, Broadmeadows, Smithton
52	11.5.56	25	58	200	958	0–9′ 6″ soil and sand, 9′ 6″–12′ 6″ sand and shells, 12′ 6″–16′ slate boulders, 16′–19′ sand and shells, 19′–58′ slate and siltstone	J. Poke, Scopus, Smithton
53	5.6.56	..	63	†	..	0–19′ soil and decomposed rock, 19′–35′ soft mudstone, 35′–60′ cemented sand, 60′–63′ dolomite	E. J. Gourlay, Montagu
54	3.7.56	45	61	400	959	0–2′ soil, 2′–33′ clay and basalt pebbles, 33′–52′ Tertiary limestone, 52′–61′ hard siltstone	E. J. Gourlay, Montagu
55	11.7.56	..	115	..	..	0–38′ yellow clay, 38′–50′ blue clay, 50′–105′ yellow clay, 105′–115′ clay and gravel	Redpa State School, Redpa
56	18.7.56	50	83	300	..	0–9′ 6″ soil and sand, 9′ 6″–30′ clay, 30′–50′ clay and mudstone, 50′–83′ Tertiary limestone	T. H. Wilson, Montagu
57	23.7.56	35	60	300	..	0–1′ 6″ soil, 1′ 6″–28′ clay and gravel, 28′–60′ Cambrian siltstone	J. H. Buckby, West Montagu
58	6.8.56	36	56½	200	762	0–9′ 6″ soil and clay, 9′ 6″–20′ siltstone, 20′–54′ basalt (Cambrian), 54′–56′ 6″ Cambrian siltstone	J. H. Buckby, West Montagu
59	9.8.56	40	65	300	763	0–20′ soil and clay, 20′–65′ Cambrian siltstone and tuff	V. R. North, West Montagu
60	20.8.56	75	86	200	916	0–45′ 6″ soil and clay, 45′ 6″–75′ Cambrian siltstone, 75′–86′ Cambrian lava	E. H. Quilliam, West Montagu
61	22.8.56	33	51½	400	917	0–13′ soil and sand, 13′–16′ shells, 16′–51′ 6″ siltstone	E. H. Quilliam, West Montagu

* Not recorded. † Abandoned.

(i) BORE LOGS—continued

Bore No. (Y Series)	Date Completed	Depth at which water struck	Total Depth	Output in Gals./hr.	Analysis No.	Geological Record	Owner and Locality
		ft.	*ft.*				
62	17.9.56	45	68	300	918	0–9′ soil and sand, 9′–18′ peaty sand, 18′–22′ blue clay, 22′–25′ basalt boulders, 25′–43′ shale, 43′–48′ Tertiary limestone, 48′–68′ siltstone and slate	E. A. Williams, Montagu
63	26.9.56	70	72	300	961	0–8′ soil and clay, 8′–20′ peat, 20′–70′ siltstone	E. A. Williams, Montagu
64	8.10.56	72	87½	300	962	0–2′ soil, 2′–18′ basalt boulders, 18′–38′ sand, clay and shells, 38′–60′ pug and sand, 60′–87′ 6″ siltstone	C. Wilson, Montagu
65	17.10.56	70	100	300	..	0–40′ soil amd clay, 40′–100′ buckshot gravel, and cemented pebbles	H. H. Quilliam, Montagu
66	24.10.56	45	71½	300	..	0–2′ soil, 2′–45′ clay, 45′–71′ 6″ broken quartzite and silicified oolitic dolomite	C. E. Williams, "Harcus," West Montagu
67	8.11.56	40	65	200	..	0–10′ soil and sand, 10′–65′ Cambrian siltstone	L. G. Kilby, Scopus, Smithton
68	14.11.56	8	21	400	..	0–2′ 6″ clay, 2′ 6″–21′ Cambrian siltstone	R. Smith, Scopus, Smithton
69	26.11.56	72	85	300	..	0–25′ soil, sand, shells and gravels, 25′–72′ broken slate and cemented gravel, 72′–85′ slaty siltstone	L. R. Boote, Scopus, Smithton
70	5.12.56	16	43½	200	..	0′–1′6″ soil, 1′ 6″–9′ sand and peat, 9′–43′ slaty siltstone	L. R. Boote, Scopus, Smithton
71	17.12.56	15	60	500	..	0–1′ soil, 1′–6′ gravel, 6′–60′ Cambrian siltstone	F. M. Cure, Scopus, Smithton
72	14.2.57	56	58	150	..	0–10′ sand, 10′–58′ Cambrian siltstone	B. J. Williams, Montagu
73	21.2.57	28	46	200	..	0–5′ sand, 5′–46′ basalt?	M. J. Gourlay, Montagu
74	11.3.57	81	87	†	..	0–81′ clay, 81′–87′ gravel and sand	Redpa State School, Redpa
75	1.4.57	81	89	300	332	0–81′ clay, 81′–89′ gravel and sand	Redpa State School, Redpa
76	5.4.57	29	36	300	331	0–30′ clay, 30′–32′ silicified dolomite pebbles, 32′–36′ silicified dolomite	J. F. Bell, Redpa
77	15.4.57	34	40	400	..	0–22′ clay, 22′–33′ gravel, 33′–40′ Tertiary limestone	F. I. Nicholls, Redpa
78	2.5.57	25	60	400	..	0–4′ sand, 4′–6′ clay, 6′–22′ peat, 22′–60′ quartzite	V. D. L. Company, Woolnorth
79	8.5.57	32	65	400	..	0–25′ sand, 25′–31′ sand and shells, 31′–65′ limestone	V. D. L. Company, Woolnorth
80	15.5.57	16	45	450	..	0–6′ sand, 6′–13′ hard pan, 13′–45′ quartzite	V. D. L. Company, Woolnorth
81	24.5.57	30	85	450	..	0–28′ sand, 28′–60′ gravel and clay, 60′–85′ blue pug	V. D. L. Company, Woolnorth
82	30.5.57	30	48	400	..	0–1′ soil, 1′–24′ weathered rock, 24′–28′ siltstone	M. and D. Saward, West Montagu
83	13.6.57	50	80	300	..	0–30′ soil and clay, 30′–80′ Cambrian siltstone	Redpa Health Centre, Redpa
84	..	..	165½	†	..	0–16′ 5″ basalt rubble	A. E. Saward, Marrawah
85	3.9.57	65	135	200	..	0–48′ clay and pebbles, 48′–85′ limestone, 85′–135′ Cambrian siltstone	A. E. Saward, Redpa
86	6.9.57	20	50	400	..	0–17′ clay and pebbles, 17′–50′ Cambrian siltstone	N. D. Hay, Redpa
87	11.9.57	40	98	200	..	0–98′ clay and basalt pebbles	E. Nicholls, Redpa
88	23.9.57	..	130	†	..	0–50′ clay, 50′–110′ clay and mudstone, 110′–130′ slaty siltstone	Closer Settlement Board, Montagu Swamp, Lot 79
89	4.10.57	70	100	300	..	0–18′ clay, 18′–100′ black siltstone probably Precambrian	Closer Settlement Board, Montagu Swamp, Lot 79

* Not recorded. † Abandoned.

(ii) WATER ANALYSES

(Parts per Million)

Reg. No.	Total dissolved solids	$Fe_2O_3 + Al_2O_3$	Ca	Mg	Na	Cl	SO_4	CO_3	SiO_2	Temp. hardness	Perm. hardness	pH	Zn from tanks, pipes, &c.
330	463.1	0.8	99.2	30.3	34.6	52.7	4.3	223.0	15.8	368.0	5.0	8.0	2.6
331	295.0	1.2	27.4	14.2	47.0	63.2	18.1	88.4	17.2	148.0	6.0	7.9	..
332	331.9	1.4	50.2	21.7	42.4	63.2	11.9	121.2	19.7	202.0	13.0	8.2	..
333	804.3	1.4	46.6	79.0	116.6	229.9	107.3	155.3	24.8	259.0	182.0	7.8	Trace
334	507.3	1.6	28.6	21.4	107.9	108.8	82.3	100.7	35.4	155.0	5.0	7.7	8.5
335	129.3	0.6	3.4	7.8	27.4	42.2	7.6	21.2	16.9	32.0	8.0	7.7	2.2
762	175.7	1.8	5.3	10.7	30.5	61.8	11.1	14.9	13.3	..	..	5.9	..
763	603.7	6.2	5.0	9.7	167.6	70.6	270.6	21.6	35.5	..	..	6.4	..
915	400	1.1	9.5	9.1	102.0	114.7	57.6	36.8	27.7	61.3	Nil	7.1	..
916	195.7	0.9	0.5	1.2	53.9	31.8	29.7	29.1	19.7	6.1	Nil	7.1	..
917	840.0	3.1	76.8	11.2	226.9	303.6	24.1	166.8	15.4	237.7	Nil	7.5	..
918	616.0	1.1	76.5	38.1	94.7	174.7	9.9	178.1	19.4	297.0	50.6	7.6	..
958	10,142.0	12.0	455.0	305.0	2,600.0	4,744.0	968.0	217.0	20.0	361.0	2,045.0	8.2	7.4
959	752.8	1.6	42.5	26.2	194.2	233.6	71.0	140.8	27.4	216.0	Nil	8.4	1.3
960	464.6	2.0	76.6	36.9	49.0	63.7	Trace	215.7	15.9	343.0	Nil	8.2	..
961	309.1	3.6	27.8	12.4	63.8	83.2	1.0	84.3	29.3	120.3	Nil	8.2	..
962	498.6	1.4	79.5	14.4	78.0	51.3	74.9	166.1	17.8	259.0	Nil	7.6	..
1,024	199.5	0.8	0.7	5.1	41.5	69.9	6.0	33.9	8.9	56.5	14.5	7.1	32.2
1,025	223.8	0.8	48.5	4.6	26.5	37.2	5.4	85.6	9.6	142.6	Nil	8.1	1.9
1,026	483.2	1.0	99.4	29.7	41.3	63.7	22.4	208.2	16.6	547.0	23.2	7.6	..
1,027	530.0	1.0	108.3	34.0	40.0	51.3	2.1	263.0	16.8	426.0	Nil	7.6	10.3
1,028	80.5	0.6	0.3	2.9	21.0	26.6	6.6	7.5	15.4	12.5	Nil	7.7	..
1,029	105.0	0.6	0.7	3.6	29.1	38.9	8.2	9.9	13.0	16.5	Nil	7.7	..
1,030	199.2	0.8	1.3	6.6	24.0	30.1	8.0	57.3	16.5	95.5	Nil	7.1	42.6
1,031	162.2	1.6	7.1	2.1	38.8	29.2	18.9	34.4	23.4	57.3	Nil	7.5	4.8
1,196	443.2	10.0	41.7	16.2	65.8	109.7	1.1	117.4	12.6	195.7	13.4	7.3	25.1
1,197	90.0	1.0	2.6	2.8	20.7	31.9	4.9	10.6	12.2	17.7	5.0	7.1	3.1
1,198	475.0	0.4	90.1	33.3	40.8	51.3	5.1	223.7	25.4	362.0	Nil	7.8	..
1,199	532.2	0.4	112.0	33.7	40.4	51.3	21.2	249.1	18.0	415.0	6.7	8.1	2.4
1,200	680.1	2.4	25.8	7.7	217.5	63.7	3.5	285.2	33.9	16.0	Nil	8.1	..

(iii) ASSUMED COMPOSITION OF SALTS

(Parts per Million)

Reg. No. of Analysis	$CaSO_4$	$CaCO_3$	$MgCO_3$	$MgCl_2$	$ZnCO_3$ from Tanks, &c.	Na_2CO_3	Na_2SO_4	NaCl
330	6.1	243.1	105.0	..	5.0	..	..	86.9
331	7.9	62.6	49.2	..	..	..	18.5	104.2
332	16.9	112.8	75.2	..	..	..	..	104.2
333	152.0	4.7	214.3	67.3	..	..	..	296.4
334	6.2	66.9	74.2	..	16.3	..	115.2	179.4
335	10.8	..	27.0	..	4.2	..	..	69.6
915	..	23.8	31.6	..	..	..	85.2	189.1
916	..	1.2	4.2	..	..	44.5	43.9	52.4
917	..	191.8	38.8	..	..	42.8	35.6	500.4
918	14.0	180.8	98.0	38.4	..	..	..	240.8
958	1,372.0	128.3	..	987.0	14.2	..	..	6,609.0
959	..	106.1	90.9	..	2.5	20.0	105.0	385.1
960	..	191.3	127.9	..	..	17.7	..	105.0
961	..	69.4	43.0	..	..	21.4	1.5	137.2
962	..	198.6	49.9	..	..	20.3	110.8	84.6
1,024	2.4	..	6.9	7.9	61.3	..	..	105.5
1,025	..	121.1	15.9	..	3.6	..	7.4	61.3
1,026	31.7	225.0	103.0	..	..	..	..	105.0
1,027	..	270.5	117.9	..	19.8	13.1	3.1	84.6
1,028	..	0.7	10.0	..	..	..	9.8	43.8
1,029	..	1.7	12.5	..	..	..	12.1	64.1
1,030	..	3.2	22.9	..	88.4	..	11.8	49.6
1,031	..	17.7	7.3	..	9.2	25.1	27.9	48.1
1,196	1.7	102.7	46.1	11.3	48.1	..	..	167.1
1,197	6.9	1.5	9.7	..	5.9	..	..	52.6
1,198	..	225.0	115.5	..	..	11.7	7.5	84.6
1,199	9.1	273.0	116.9	..	4.6	..	21.9	84.6
1,200	..	64.4	26.7	..	..	402.1	5.2	105.0

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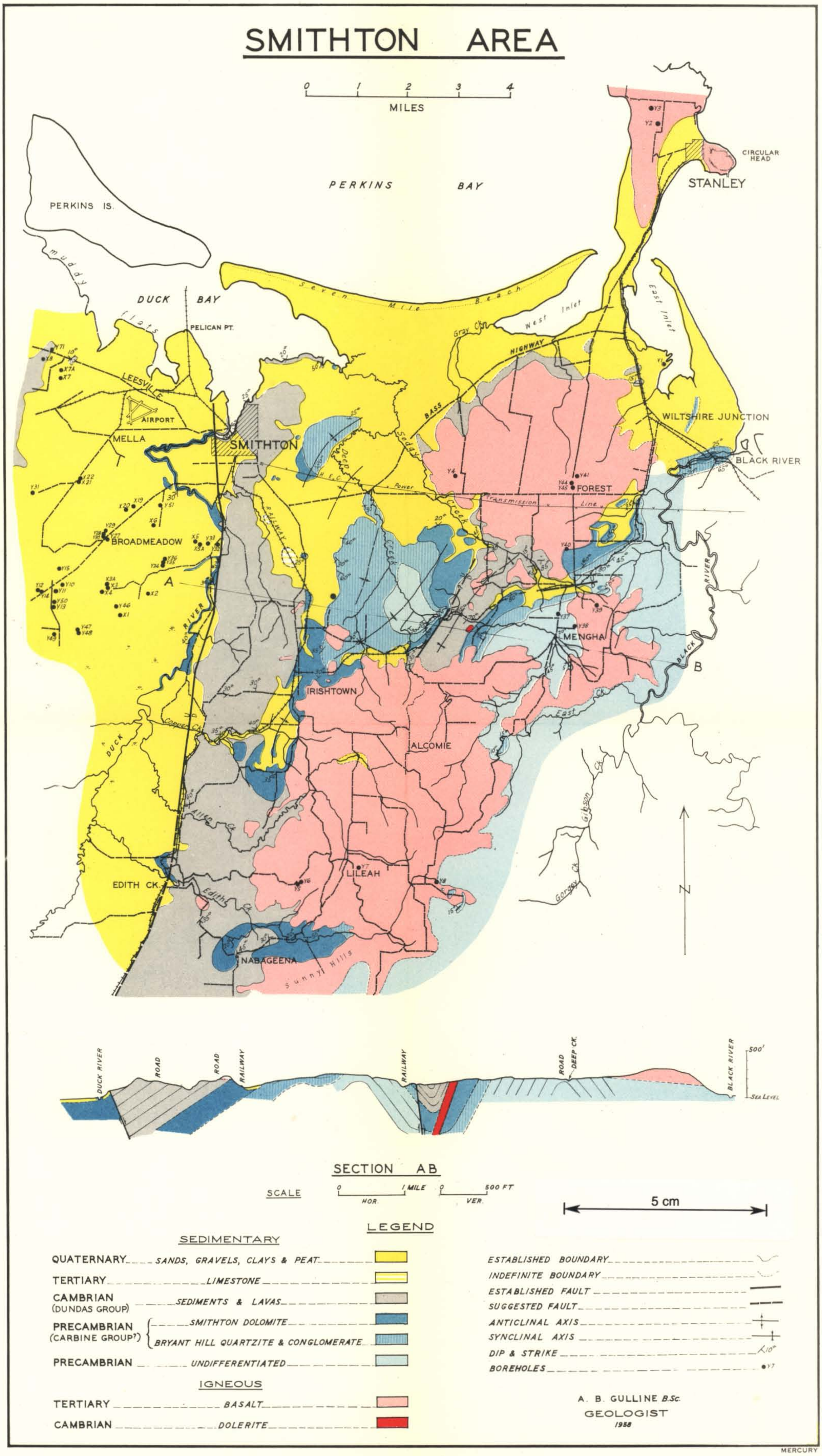
SMITHTON AREA
0 1 2 3 4
MILES
PERKINS BAY
PERKINS IS.
muddy flats
DUCK BAY
PELICAN PT.
Seven Mile Beach
West Inlet
East Inlet
CIRCULAR HEAD
STANLEY
Gray Ck.
BASS HIGHWAY
LEESVILLE
AIRPORT
MELLA
SMITHTON
WILTSHIRE JUNCTION
BLACK RIVER
H.E.C. Power Transmission Line
FOREST
BROADMEADOW
A
DUCK RIVER
RAILWAY
Deep Ck.
Sedgy Creek
MENGHA
B
BLACK RIVER
IRISHTOWN
ALCOMIE
East Ck.
Copper Ck.
Allen Ck.
Gibson Ck.
Gorge Ck.
EDITH CK.
Edith Ck.
LILEAH
NABAGEENA
Sunny Hills
N
DUCK RIVER
ROAD
ROAD
RAILWAY
RAILWAY
ROAD
DEEP CK.
BLACK RIVER
500'
SEA LEVEL
SECTION AB
SCALE
0 1 MILE HOR.
0 500 FT VER.
5 cm
LEGEND
SEDIMENTARY
QUATERNARY SANDS, GRAVELS, CLAYS & PEAT
TERTIARY LIMESTONE
CAMBRIAN (DUNDAS GROUP) SEDIMENTS & LAVAS
PRECAMBRIAN (CARBINE GROUP?) SMITHTON DOLOMITE
BRYANT HILL QUARTZITE & CONGLOMERATE
PRECAMBRIAN UNDIFFERENTIATED
IGNEOUS
TERTIARY BASALT
CAMBRIAN DOLERITE
ESTABLISHED BOUNDARY
INDEFINITE BOUNDARY
ESTABLISHED FAULT
SUGGESTED FAULT
ANTICLINAL AXIS
SYNCLINAL AXIS
DIP & STRIKE
BOREHOLES
A. B. GULLINE B.Sc.
GEOLOGIST
1958
MERCURY

Fig. 12.