# SOIL CONSERVATION AUTHORITY

# REPORT ON THE UPPER BARWON WATER SUPPLY CATCHMENT

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# REPORT ON THE UPPER BARWON CATCHMENT FOR THE GEELONG WATER SUPPLY

## 1. Introduction – Proclamation Of Catchment

The Upper Barwon Catchment was proclaimed a water supply catchment area under Section 22 of the Soil conservation & *Land Utilisation Act* (1953) on 4th November, 1953. On 7th December, 1953, the authority decided, with recommendation from the Land Utilisation Advisory Council, that "all Forest reserves and Crown Islands be retained for forest purposes, and that there be no further alienation of Crown Islands within the catchment". It was also agreed that "in regard to alienated lands within the catchment the best form of land use be determined in detail."

Considerable discussion was devoted to the future of the Barwon Valley in an enquiry by the Parliamentary Public Works committee, to which the them Chairman of the Authority, Mr. G. T. Thompson, gave evidence. The bulk of the evidence related to other parts of the Barwon River Catchment.

The present report deals with the survey which has been done in the catchment to provide detailed information for the determination of land-use, particularly on alienated land. The need for this determination has been accentuated by the commencement of construction work on a storage on the West Barwon River near Forrest. Formal request for the determination has been received by the Soil Conservation Authority from the Geelong Waterworks & Sewage Trust in a letter dated 3/5/60.

## 2. Location & Area.

This catchment is situated on the northern slopes of the Otway Ranges, about 15 miles south of Birregurra. The area consists mainly of steep, mountainous parts and lower foothills. The main streams draining the area are the West and East branches of the Barwon river, and several tributaries which join the Barwon River downstream from the catchment.

The proclaimed catchment covers most of the parish of Barwon downs, and parts of the parishes of Barramunga, Kaanglang, Lorne, Murroon, and Yaughter. The total area is 56 square miles. However, approximately 32 ½ square miles only are at present being tapped for the water supply. This includes the upper reaches of the East and West Barwon Rivers, and Dewings Creek at the north-eastern end of the catchment.

## 3. Importance of this Catchment in relation to other Water Sources for Geelong and the Bellarine Peninsula.

Geelong's water supply comes form the upper Barwon Catchment in the Otway Ranges and the East Moorabool Catchment on the south side of the Dividing range. Both sources are operated and administrated by the Geelong Waterworks & Sewage Trust. The total amount of water drawn from these two sources per annum is between 3,00 and 3,500 million gallons, of which about 2,00 million gallons is taken from the upper Barwon Catchment, the remainder coming from the East Moorabool Catchment. The latter is contributing its maximum amount, while the Upper Barwon Catchment has a much greater potential supply, as yet untapped. Apart from the new storage now being constructed on the West Barwon River, which will hold 18,00 acre feet or 5,00 millions gallons, the Trust may ultimately take water off from Callaghan;s King's and possibly Den Creek.

When the new storage is finished, there will be over twice the amount stored from the Upper Barwon Catchment as from the East Moorabool Catchment.

Water is carried from the catchment in open aquaducts to Wurdeeboluc Reservoir, south of Winchelsea; this storage holds 4,157 million gallons or approximately 15,300 acre feet. From there, the water is carried to service basins and fed into the Geelong supply, and to Queenscliff, Point Lonsdale, Ocean Grove, Barwon Heads, Anglesea and other towns on the Bellarine Peninsula.

## 4. Natural Environment

### *(i) Climate.*

#### (a) Rainfall.

As in most mountainous areas, rainfall stations are few. Only three are in the catchment and these are all on the western boundary. However, they do represent a section through the steepest part of the rainfall gradient.

Barwon Downs is at the northern end of the catchment at an elevation of about 450' and has a mean annual rainfall of 25.9".

Forrest is a third of the way along the western boundary from the northern end of the catchment at an elevation of about 650' and has a mean annual rainfall of 38.1".

Barramunga is about two-thirds of the waly along the western catchment boundary from the northern end at an elevation of about 1300' and has a mean annual rainfall of 53.3".

Mt. Sabine is the southernmost point of the catchment and has an elevation of 1911'. No records are available for this point but is gradually marked as within 60" isohyet. (Corangamite Regional Resources Survey, 1959).

(See Table 1 for monthly and annual rainfall figures). These figures indicate a steep rainfall gradient, rising from north to south – an increase of some 34" mean annual rainfall over 11 miles.

Benwerrin (elevation 1400'), which is 4 miles north-east of the catchment on the same ridge which forms its southern boundary, has a mean annual rainfall of 44.4'. This indicates a decrease of about 16" from Mt. Sabine to Benwerrin, a distance of about 15 miles.

From a consideration of these figures it may be assumed that an increase in mean annual rainfall of about 25" would be found between Barwon Downs and the easternmost point of the catchment at the head of Dewings Creek.

**Table 1.**

| Station | Mean monthly Rainfall Points | | | | | | | | | | | | Mean Annual Rainfall (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | |
| Barwon Heads | 109 | 138 | 164 | 193 | 241 | 277 | 285 | 303 | 270 | 243 | 201 | 170 | 25.9 |
| Forrest | 145 | 183 | 255 | 284 | 354 | 427 | 419 | 451 | 408 | 375 | 287 | 219 | 38.1 |
| Barramunga | 210 | 196 | 336 | 405 | 554 | 639 | 636 | 610 | 590 | 474 | 349 | 326 | 53.3 |
| Benwer-rin | 194 | 220 | 291 | 366 | 486 | 557 | 460 | 486 | 504 | 383 | 269 | 226 | 44.4 |

The mean monthly rainfall figures in Table 1 show that over the whole area there is a winter maximum, January and February being the two driest months, and June, July and August being the wettest months.

In the study of the climate of the Western district by Hounam (1949) there are maps showing average seasonal rainfall. From these the following general statements my be made:-

Summer rainfall in the north averages about 4" rising to about 6" in the eastern corner and up to about 9" at the southern end.

Autumn rainfall in the north averages almost 6" rising to about 11" in the eastern corner and up to about 15" at the southern end.

Winter rainfall in the north averages about 7", rising to about 11" in the eastern corner and up to 15" at the southern end.

Spring rainfall in the north averages about 7", rising to about 11" in the eastern corner and up to 15" at the southern end.

Hounam's report also provides maps illustrating the chances of getting rainfall of specified amounts in each of the four seasons.

**(b) Temperature.**

There are no temperature recording stations within the catchment, or for that matter, nearby. The nearest are at Colac and Cape Otway, neither of which is representative of conditions in the catchment.

Colac has a mean annual maximum of 66.4˚F and a minimum of 45.4˚F and the corresponding figures for Cape Otway are 63.5˚F and 51.0˚F.

The northern part of the catchment may be compared with Colac: however, the higher elevations at the southern and eastern corners of the catchment would be expected to produce generally cooler temperatures throughout the year in these parts

## *(ii) Geology and Physiography.*

**(a) Geology**

The whole of the country of the catchment is Jurassic mudstones and shales; However,, in the north of the area some parts are overlain by a mantle of sand which is probably of Pleistocene or late Tertiary age.

The Jurassic rocks are readily weathered to yellowish brown soils with a fairly high clay content. Unweathered rock, when crushed, is a good road surfacing material.

The beds of Jurassic rock have slow dip to the east. This has resulted in numerous areas on the eastern slopes where slipping of the surface material has occurred: the sip of the rock beds apparently provides a suitably inclined slip plane. The most extensive area of slippage caused considerable interest some years ago when it moved down into the East Branch of the Barwon River and dammed back a large volume of water, now referred to as the Kaanglang Lake.

The sand mantle varies in depth from a thin deposit, which has largely become incorporated in the surface of the soils derived from Jurassic sediments, to deposits many feet thick.

**(b) Physiography.**

The catchment is rather unusual in that as well as the upper sections of the Barwon River it includes the upper sections only, of a tributary stream, which does not join the Barwon until some 4 miles to the north west of the northern boundary of the catchment.

All the stream in the catchment flow north-westerly from the dividing ridge of the Otway Range. This ridge has a north-eastern strike had has a fairly constant elevation of around 1900 – 200' above sea level. The boundary to the west is the spur which runs north-west from Mt. Sabine (1911') between the Barwon and Gellibrand rivers as far as Barramunga. From there the spur turns slightly east of north to continue down to meet the Barwon at Forrest at an elevation of about 550'.

The north-eastern boundary is the spur which runs north-westerly from the main ridge to the north-east of Dewings Creek. The remainder of the northern and western boundary is formed by the channel which conducts the water tapped from the Barwon and Dewings Creek to Geelong.

Dissection in the upper reaches of the streams is very deep and slopes are steep and long. The country along the main ridge and for some distance down the more prominent spurs is a relatively low relief, probably representing an ancient planated land surface into which the streams have cut following an uplift.

Grades of the spurs are generally not steep so that vehicular tracks traverse most of them.

In the north around Forrest and Barwon Downs the topography is more mature. Elevations are not as high and outlines of the kills are somewhat rounded, resulting in rolling (gentle) slopes on the tops and steep slopes on the sides of the hills which run into narrow valleys having narrow alluvial flats and streams with relatively straight courses (i.e. not meandering).

## *(iii) Soils*

Soils of the catchment have been classed into four main groups-

**Group 1** – Soils of the Jurassic sediments.

**Group 2** – Soils of the sand mantle.

**Group 3** – Soils on the Jurassic or fine grained parent material with sand influencing the upper horizons.

**Group 4** – Soils on the alluvium of the creek flats.

### 1. Soils of the Jurassic sediments.

The soils have a clay loam to loam surface and a gradual increase in clay content to a light clay subsoil. The colours generally are brown to very dark brown at the surface, becoming lighter to a yellowish brown or olive brown subsoil. The lower part of the profile may be weakly mottled. The soils from the higher rainfall parts of the catchment are usually slightly more strongly structured and friable than those from the drier areas and there is a greater accumulation of organic matter and thus darker A horizon colours are found.

Broken and advanced weathered parent material usually occurs at depths of about 4'–5', or shallower in drier areas.

These soils bear a strong resemblance to those on the Jurassic sediments of the Strezlecki Ranges described by Rowan and Sibley (1957). They may be similar to the brown earths of Costin (1954). Leeper (1952) comments that the Jurassic sediments of the Otways and South Gippsland Hills are remarkably rich for sedimentary rocks. The sand fractions contain felspars, both of potassium and calcium plus sodium, in abundance.

These soils are probably moderately acid and fertile. Their chief characteristic is their good structure which would make them suitable for intermittent cultivation on slopes up to 25%. The good structure results in these soils being permeable and resistant to erosion with normal use.

Turbidity of streams following heavy rains in this area may be due to a high proportion of very fine colloidal clay in the parent rocks and also in the soils. (Turbid water was observed coming from the upper parts of the catchment where the vegetation had not been disturbed for some 50 years or more and no erosion was obvious.)

### 2. Soils of the sand mantle.

The depth of the sand mantle varies considerably so that in some cases there are only just a few inches of sand overlying a soil on finer parent material and in others sand extends to a depth of many feet. Soils with only a shallow depth of sand are discussed later.

The typical soil on the sand mantle has a dark grey loamy sand for the surface 6"-8" and well leached grey loamy sand below and to about 14". There is a slight darkening in the next few inches before a zone of 2"-3" of black and dark-brown humus-stained sand or clayey sand is reached. This changes abruptly to a mottled yellowish brown and yellowish red gravelly clayey sand. The gravel is composed of iron and humus cemented sand. The boundaries of this zone of maximum accumulation of iron and humus are very irregular and contorted. Below this horizon the colour becomes mottled light grey and the texture gradually becomes heavier until it is a sandy light clay at 3'-4'.

The surface horizons have virtually no structure, being mostly single grained. The zone of iron and humus accumulation is massive and when dry is hard.

The soils are regarded as being good examples of the podzol of Stephens (1953). They would be included in the subgroups of hums-clay-podzols of Hallsworth, Costin and Gibbons 91953).

The surface foot of these soils is probably quite acid and impoverished.

Because of the depth of leached sands, the establishment and maintenance of pastures would necessitate substantial topdressing with superphosphate, lime and copper, and probably potash. Experimental work has been some on similar soils in the Heytesbury Forest and is reported by Newman and Makeham (1960) and McLachlan (1953). These have shown the need for maintenance rates alone, of 2cwt/acre superphosphate per annum, ½ ton/acre of lime every 5 to 6 years, copper at the rate of 3½ lbs/acre applied every 3 to 4 years. Potash may also be necessary at a rate of 1cwt/acre every second year, depending on the depth of the subsoil and the intensity of pasture utilisation. There may, however, be some potassium available in the clays at depth, but this is probably beyond the reach of the roots of pasture species.

The development of these sandy podzols also presents problems of drainage. Most of the land is found on fairly broad flat-topped ridges and is not very steep, slopes varying between 5% and 20%.

The drainage problems arise from the proximity of the “coffee rock” pan to the surface in many places. This tends to hold up the water and make those areas rather wet. The vegetation in these parts is very poor and stunted, and large quantities of water drain from above the pan where it is exposed in road cuttings.

Both nutrient deficiencies and depth of hard-pan would need to be taken into consideration for establishment of pines on these areas. Skene and Poutsma (19580 in a survey of the Waaree Pine Plantation near Port Campbell described a similar soil which they called ""Waaree sandy loam". They reported that soils of this type carried some of the poorest pines and assumed that low fertility was at least a contributing factor with poor drainage being of equal or greater importance.

**3. <u>Soils on Jurassic or fine grained parent material with deposited sand influencing the upper horizons.</u>**

These soils are intermediate to those of groups (1) and (2) and occur in the transitional Zone between these groups or in the north where the depth of sand deposited was shallow, perhaps only a few inches. The top few inches of these soils is usually a dark grey sandy loam or loamy sand of single grain or crumb structure. Below this the colour becomes pale brown, sometimes mottled, the texture becomes more clayey and the structure is massive. At about 12” the texture becomes clay, the colour is brownish yellow and there is a moderate structural development and the influence of sand disappears. The clay continues down for several feet at least.

This soil probably fits into the top lepto-podsol groups of Hallworth, Costin and Gibbons (1953).

Where the sand is only a few inches deep or less, these soils may be of comparable fertility to those of the Jurassic sediment described earlier. However, the poorer structure and slightly podsolised nature indicates leaching of nutrients to a certain extent.

The poorer structure of these soils would make them a rather more hazardous soil to cultivate, particularly on steeper slopes. However, they could be expected to grow good perennial pastures with little or no fertiliser problems other than the need for dressings or superphosphate.

**4. <u>Soils on alluviam of creek flats.</u>**

These soils are of rather limited occurrence. Two sub-groups may be separated –
(a) dark soils of fine textures,
(b) light soils of medium to coarse textures.

(a) The soils which are formed on the alluvial deposits in the lower reaches of the streams are relatively uniform from stream to stream. This is probably because of the uniformity of the rock from which the soil material originated and apparently, the similarity in age of the alluvial deposits.

The typical soil is dark brown loam to very fine sandy loam – having a very strongly developed medium granular structure. Below about 6”-8” these smaller peds are aggregated into larger ones

which have a coarse sub -angular blocky structure. Mottling of the soil below the top few inches indicates some seasonal water-logging as would be expected with soils in this topographic position.

These soils would be very suitable for improved pastures, or summer fodder crops with supplementary spray irrigation.

(b) These soils are drier than those of sub-group (a) and often contain a quantity of water-worn stones. They may be cultivated when not too stony but are not so well favoured for agriculture because they dry out rapidly.

Soils of sub-group (b) were seen only in the West Barwon above the site for the new reservoir and would thus be flooded.

Soils of sub-group (a) occur along the lower reaches of the major streams.

### *(iv) Indigenous Vegetation.*

The vegetation is of two main types of which the sclerophyll forest is the more abundant, the other being heath with shrubby trees. The great variation in rainfall from north to south in the catchment results in variation in the species content of the shrub layer in the sclerophyll forest and also in its general appearance.

The dominant tree species are messmate (*E. Oliqua*) and mountain grey gum (*E. goniocalyx*) and these occur throughout the range of this vegetation from. Other tree species which occur are narrow-leaf peppermint (*E. radiata*), manna gun (*E. viminalis*) chiefly in the north, and mountain ash (*E. regnans*) in the south or in wetter situations.

The understorey of the drier form of the sclerophyll forest consists of braken (*P. esculentum*) banksia (*B. spp*.) In the wetter areas the shrub species form a much more dense understory with such species as blanketleaf (*Bedfordia salcina*), hazel (*Pamaderris apetala*), blackwood (*Acacia melanoxylon*), dogwood (*Casuarina aculeata*) and wiregrass (*Tetrarrhena juncea*).

The gradual increase in annual rainfall is accompanied by a gradual change in these species and the appearance of the vegetation so that the formation is not readily sub-divided.

The second form of vegetation, although of less extent, is of importance because it indicates the occurrence of the sandy podsols. It takes the form of a continuous heath stratum consisting of manuka (*L. scoparium*), burgan *(L. ercoides*), common heath (*Epacris impressa*) with a scattering of shrub-like trees of peppermint (*E. vitrea*).

## 5. Land Allienation in the Catchment

As has already been mentioned the total area of the proclaimed catchment is 56 square miles, and in total, approximately 32 ½ square miles are being tapped for water supply. So far this has been tapped by means of weir off-take only, but the supply will be increased greatly by the construction of the reservoir on the West Barwon River. The catchment of this storage will be approximately 19½ square miles.

The remaining proclaimed area of some 23½ square miles includes the valleys of three main tributaries to the Barwon River – Den, Callaghan's and King's Creeks.

The total amount of alienated land is at present approximately 4900 acres, or approximately 7¾ square miles. Of this, approximately 1700 acres is within the untapped catchment area. Within the catchment to the reservoir, there is at present an area of 1700 acres privately owned. However, the Forests Commission is contemplating purchase of up to 1055 acres in this part of the catchment because of the high forest potential both under indigenous hardwood timber or conifers.

Thus, about 87 per cent of the catchment area is under Reserved Forest and Crown Lands, largely with dense forest cover.

## 6. Present Land-Use.

The main forms of land-use are forestry and grazing either with dairy and beef cattle, or with sheep.

### (a) Agriculture & Pasture.

The alienated and developed land is largely along the alluvial flats and on sloping land on the sides of the valleys. In the northern or lower parts of the catchment, some ridges with the soils of the Jurassic sediments have been cleared and developed for pasture and fodder cropping. Most of these areas are reasonably well developed, thought there appears to be a real need for top-dressing and pasture renovation on many blocks. Understocking in some developed areas the ground cover is good, and no serious occurrences or erosion were seen.

The condition of the alienated land on the western fringe is generally poorer, commonly showing signs of neglect, and reversion to scrub or braken. The higher rainfall, cooler exposed conditions, management is aimed at intensive usage, particularly during spring and autumn.

The best conditions for pastures and cultivation for cropping are found on the alluvial soils and on the lower hilly areas derived from the Jurassic sediments. The steepest slopes which appear to be successfully maintained under pasture are 25 to 30 per cent.

### (b) Forestry.

Most of the forests in the central and southern parts of the catchment consists of mature and overmature timber, with patchy regeneration in many places. Early utilisation appears to have been very erratic and intermittent, with little regard for the future and maintenance of the stands. Fires in 1919 appear to have done considerable damage in some parts.

In recent years, utilisation is being directed and controlled along silviculture lines by the Forest Commisiion. This includes thinning, improvement fellings and regeneration fellings, together with the extraction of mature timber. The policy of the Commission within the catchment is that of the general policy of management of the State Forests in the Otway ranges, but special prescriptions are being formulated for the protection of the catchment areas.

Topography is the main factor limiting full utilisation of the forests. The forests Commisiion has not yet decided on a maximum slope on which logging will be permitted, but accessibility is also important in limiting utilisation in more remote parts. Safe operations, creating a minimum of disturbance and erosion, depend on the construction of feeder tracks from the ridges into the valleys. Several of the tracks along the ridges are at present only trafficable by Land Rover, and in many places conditions do not favour construction of such side tracks.

At present the maximum slope being considered by the Forest commission is 40˚ (1 in 1.2) based on recommendations by the Senior Forester at Forrest. These include the departmental logging of areas where slopes are between 30˚ and 40˚ (1 in 1.7 to 1 in 1.2), or where soil conditions require special care in logging, or the imposition of specific conditions on licences granted to logging licensees. The reason for recommending these slopes are stated as follows:

"1. Slopes up to 30˚ are normally logged by tractor without serious difficulty; in fact, a jeep 4-wheel drive will climb a 30˚ slope.

"2. Slopes from 30˚ to 40˚ are normally logged by winch without serious difficulty.

"3. Slopes over 40˚ pose definite problems in felling and extraction; logs tend to slip when felled, and increased difficulty is experienced in the prevention of scour of snig tracks, etc……"

Additional comments are made about the occurrence of much highly productive forest in areas where slopes between 30˚ and 40˚. Exclusion of these areas from forestry operations would thus mean the loss of valuable sources of timber supply.

The conditions of the climate and soils in the catchment appear to create no objection to logging on slopes up to 30˚. If logging is to be considered in the State Forest areas between 30˚ and 40˚, there will need to be strict control on the number and location of snig tracks, and the erosion prevention measures applied to these tracks following completion of operations. The timing of operations should also be restricted to absolutely safe seasonal conditions.

Forest operations on alienated land should be limited to areas with slopes up to 30˚, where the soil is derived from the Jurassic sediments.

On the sandy areas, the timber stand is very poor and of no commercial value. These areas are mostly Reserved Forest, and because of poor fertility and considerable variations in depth of sand, present considerable barriers to intensive usage.

## 7. Erosion Hazard and Incidence.

The erosion hazard in the catchment is generally low. The soils on Jurassic sediments, which are the most common, have good structure and depth in the profile, and absorb moisture readily. This explains the absence of any significant occurrences of sheet erosion, even where the pasture or timber cover is poor. On sandy podzols, the hazard is greater; sheet and rill erosion occurs mainly along tracks where the surface has been compacted. In we periods, seepage from above the coffee-rock layer can amount to considerable flows feeding to the tracks on sloping ground, and washing sand along the table drains and track surfaces. However, the amount of this sand actually reaching streams is insignificant.

The main erosion hazard consists of landslides in the higher, steeper sided valleys. The effect of the sip of the Jurassic rock on this for of erosion has been mentioned in the section on geology. Clearing of timber would be expected to favour landslides, but they appear to happen even without clearing, as exemplified by the large landslide which dammed the East Barwon River south-east of Forrest. Other minor landslides have occurred in recent years in steep forested land near the southern end of the catchment. However, it is sufficient to realise that the retention of forest cover on vulnerable areas will reduce the hazard, and therefore it is important that the upper reaches of the catchment should be permanently devoted to forestry. Where the alienated land in these parts is not being used productively, it should remain unchanged or be returned to forestry.

Minor stream bank erosion has occurred along parts of the developed land in the northern part of the catchment, i.e., along Dewing's Den, Callaghan's and king's Creeks. However, these instance are isolated and little consequence. It should be possible to stabilise such banks by vegetative means.

The apparently low erosion hazard on the sols on Jurassic sediments is demonstrated by recent cases of development for pastures in the Dewing's Creek area at the north of the catchment. Areas which had previously been under a dense cover of bracken, had been ploughed down slops of between 30 and 40 per cent, though in one instance the ploughing had been extended to a slope of 55 per cent. At the time if inspection, tis steep ground was in rough condition, while some of the lesser slopes had already been cultivated to fine tilth. Ploughing was done to within one chain of the creek in some places, but no erosion was apparent on the steep ground, and no sign of washed silt could be seen along the creek.

These areas demonstrated in extreme fashion the stability of such land, even when the development involves cultivation. However, erosion is likely to occur on the steeper slopes if heavy rain is to fall on a finely prepared seed-bed. Continued cultivation would destroy structure and make such areas more vulnerable.

## 8. Potential Land-Use.

Little further clearing for development will be possible, or advisable. The alluvial flats, potentially the most productive areas, are fully alienated and cleared. These alienated areas which are under bracken or forest are usually too steep for farming. In the catchment to the proposed reservoir, the alluvial flats and some adjoining slopes between the West Barwon river and the Apollo Bay road will be submerged by the stored water. This will leave insufficient buffer areas along these slopes to permit further development. Though there is little risk of endangering the amount of water supply, further clearing or cultivation could cause some deterioration in quality.

At the same time the quality of the water from the catchment appears to be lower than that yielded by high mountain areas in the north-east of the State, or area such as the Macedon Range. This appears to be due to the nature of the Jurassic rock and the soils thereon, which causes a cloudiness in the water following heavy rain. This cloudiness is already present in the upper parts of the catchment where no clearing or forestry operations have been carried out.

The development of the sandy podsols for pastures is probably uneconomic. The only alternative to leaving these areas under their present poor cover is to attempt establishment of pine plantations. The varying depths of sand occurrence of retentive coffee-rock layers would require s detailed soil survey to assess the likelihood of success in such a venture, but on basis of the findings of Poutsma & Skene in the Waarre Pine Plantation Survey, these soils are probably not suitable for pines.

## 9. Land-Use Determination.

The most important aspects to be considered in this catchment appear to be –

(a) The determination of safe forestry operations in Reserved Forest and Crown Lands, as well as in alienated lands, based on guidance by the Forests Commission regarding the maximum slope on which forestry operations should be permitted in those lands within the catchment under direct control of the Commission.

(b) Safeguarding and improvement of stream banks and water supply by –

(i) Control of cultivation practices on land sloping directly to streams, and within a certain minimum distance of the stream bank;

(ii) Restriction of forestry practices within a certain minimum distance of the stream bank.

(c) Protection of the reservoir now under construction by imposition of wide buffer strips along the high water level and above the intake area.

The question of maximum slope for departmental forestry operations in this area being considered by the Forests commission. The choice of an upper limit may be based on the use of a winch for logging. 40˚ (84 per cent) has been suggested, but unless operations are conducted by departmental personnel, it is considered that the maximum slope on privately-owned land and all other land over which the commission had no direct control, should be 30˚ (57 per cent). This would permit logging by tractor. It would be desirable to have logging on freehold land under the supervision and control of the Forests Commission.

The following categories of land-use could be considered:-

1. “Land which should be permanently used for forest purposes where forestry operations cannot be practised with mechanical means because of excessive slopes and inaccessibility.”

This could apply to land with slopes in excess of 40˚ or such upper limits as determined by the Forests commission and acceptable to the Soil Conservation Authority. Much of the southern part of the catchment would be in this category.

2. “Land which should be permanently used for forest purposes, where logging can only be carried out by winch, and where the forestry operations should be conducted by the Forests Commission.”

This could apply to those areas under direct control of the Forests Commission, where the slopes are between 30˚ and 40˚ or between such upper limits as determined by the Forests commission and acceptable to the Soil conservation Authority.

3. “Land which should be permanently used for forest purposes where forestry operations should be carried out under the supervision and control of the Forests Commission acting as agent for the Authority.”

This should apply to forested land with slopes below 30˚, under the direct control of the Forests commission, or in private and practically all the forested land in the northern parts of the catchment.

4. "Land which carries non-productive timber, scrub, bracken or other protective vegetative cover on which there shall be no change in land-use except with the approval of and land under conditions imposed by the Authority/"

This would apply to all areas carrying bracken, low scrub or noxious weeds. Although such areas are mostly steep or very steep, for example, near Barramunga, this category would also apply to rolling to hilly areas on the sandy soils, where poor soil and drainage conditions appear to be the limiting factors to growth.

5. "Cleared land suitable for pasture or for agriculture subject to conditions imposed by the Authority for particular circumstances."

This is to apply to all cleared land at present being used for grazing or agriculture, without detriment to the catchment.

6. "Land within one half-chain, or such greater distance as the Authority may specify from streams and offtakes on which land-use shall be subject to conditions imposed by the Authority, and where removal of trees will not be permitted except if considered necessary because of interference to the stream flow, but no cultivation or erection of buildings will be permitted under any circumstances."

This is to apply to all cleared and uncleared land adjoining the streams in the catchment.

7. "Land within 5 chains of the highwater level of the West Barwon Reservoir and within 5 chains of the West Barwon River for 10 chains upstream of the top end of the full reservoir, where no forestry or agricultural operations shall be permitted, and where there shall be no change in land-use except with the approval of and under conditions imposed by the Authority."

SIGNED

W.R. ROTHOLS,
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# APPENDIX.

**Detailed descriptions of typical soil profiles.**

## (1) Soils of the Jurassic Sediments.

This example is a soil on the southern boundary ridge where the rainfall is about 15" – 50" per annum. The vegetation is a wet sclerophyll forest of messmate (*E. obliqua*) and mountain grey gum (*E. gonicalyx*) with a dense understory of such shrubs as lanker leaf (*Bedfordia salicina*), hazel (*Pomaderris apetala*), digwood (*Cassinia acueata*) and blackwood (*Acacia melanoxylon*).

0" – 9" (10YR 2/2) very dark brown; clay loams; strong fine subangular blocky structure; moist to friable; gradually changing to

9" – 21" (10YR 3/3) dark brown; clay loam to light clay; strong, fine and medium subangular blocky structure; moist and friable, small pebbles of P.M. frequent; diffuse boundary.

31" – 48" (10YR 4/3) dark brown to brown; clay loam to light clay; strong, fine and medium subangular blocky structure; moist and friable, fragments of P.M. more common; boundary clear and rather wavy –

30" – 48" (2.5YR 5-4) olive brown; blay loam to light clay; moderate, fine 4 and medium subangular blocky structure; moist and friable; abundant decomposing P.M.; boundary abrupt and wavy.

48" + decomposing P.M. (Jurassic mudstones).

## (2) Soils of the Sand Mantle.

The following profile description is of a typical soil on the sand mantle. It occurs on the flat ridge top to the east of the Barwon river at Yuagher (Thompson's Track) where the rainfall is about 38" per annum. The vegetation is heath of manuka (*L. scoparium*), gurgan (*L. ericoides,U Syn. Ukunzea peduncularis*), comon heath (*Epacris impressa*), and grasstree (*Xanthorrhea minor*), with a discontinuous shrub stratum of peppermint (*E. vitrea).*

0" – 8" (2.5Y 3/1) very dark grey; loamy sand; single grain structure; moist and loose; gradually changing to

8" – 14" (10YR to 2.5YR, 5/1) grey to greyish brown; loamy sand; single grain structure; moist and loose; abruptly over

14" – 16" (10YR 6/2) light brownish grey; loamy sand; single grain structure; moist and loose; boundary abrupt and wavy –

16" – 18" (10YR 2/1 + 7.5YR 3/2) black and dark brown; clayey sand; massive; moist and slightly firm; boundary, abrupt and wavy-

18" – 25" (10YR 5/4 + 5YR 5/8) Yellowish brown and yellowish red; gravelly, clayey sand with abundant concretions of humus and iron cemented sand – boundary clear and wavy –

25" – 30" (10YR 7/2 + 10YR 6/8) light grey with brownish yellow mottles; clayey sand; massive; wet and sticky gradually changing to -

30" – 36" (10YR 7/2 + 10YR 6/8 + 5YR 5/8) light grey with brownish yellow and yellowish red mottles; sandy light clay, massive; wet and sticky.

**(3) <u>Soils on Jurrasic or other fine grained parent material with deposited sand influencing the upper horizon.</u>**

An example of a group 93) soil from a broad flat-topped ridge in the north of the catchment is given below. The vegetation is a "moist" sclerophyll forest of messmate (*E. obliqua*), narrow leaf peppermint (*E. radiata*) and occasional mountain grey gum and bracken fern (*Pteridium esculentum*).

| | |
|---|---|
| 0" - 1½ | (10YR 4/1) dark grey, loamy sand; single grain structure; moist and loose; boundary is abrupt and smooth – |
| 1½ - 3" | (10YR 5/1) grey; loamy sand; single grain structure, moist and loose; boundary abrupt and wavy – |
| 3" - 7½" | (10YR 5/1 + 10YR 5/4) grey with yellowish brown mottles; sandy loam to sandy clay loam; massive; moist and firm; boundary clear and wavy – |
| 7½" - 11½" | (10YR 6/3 + 10YR 5/1) pale brown with grey mottles; sandy clay loam; massive; moist and firm; boundary gradual and wavy – |
| 11½" - 22" | (10YR 6/6 + 10YR 5/1) brownish yellow with grey mottles; heavy clay; moderate coarse subangular blocky structure, wet and plastic. |

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