GENERAL INFORMATION ABOUT THE AREA

Location

As the Locality Plan on page 6 shows, the area surveyed is in North-Eastern Victoria on the fringe of the Murray River Basin. It occupies the floor of two narrow valleys cut into the northern slopes of the Great Dividing Range, and extends onto the broad flood plain between outlying foothills.

Early History

Before European settlement in 1840 the life of the aboriginal people in the area, like that of the farmers today, was centred on the ramifying creeks and billabongs of the Ovens and King Rivers, and the grassy woodlands of the upper terraces. They made good use of what we today think of as the barren granite hills around Beechworth, and of the swampy areas of the lower King River. From the very start they resisted the European take-over of their watering places, the first settlers, the Faithfulls, losing men and stock in their first year, both at Oxley Plains and near Benalla. Later, Mackay abandoned Myrrhee on the King River and moved to Whorouly because of similar violent opposition. However, the pattern of aboriginal life was destroyed, and the last few aborigines of the district were removed to Coranderrk near Healesville in 1890.

The first European impact on the district was the exploring party under Hume and Hovell which crossed the Ovens River near Whorouly in 1824, seeking a route from Port Jackson to Port Phillip. In 1836 Sir Thomas Mitchell's party crossed at Wangaratta on its return from Portland to Sydney. Mitchell's reports brought the first squatters with a flood of cattle and sheep from across the Murray River. The Faithfulls selected their run at, Oxley Plains in February 1838, and were followed closely by Bowman, Reid, Chisholm, Mackay and Docker on the lower country, and a little later Forlonge was followed by Buckland on the higher country at Barwidgee.

Cropper, from the King River Valley, established "Dandongette" where the Rose meets the Buffalo River, but abandoned it before 1857.

Effects of Settlement on Soils

Agriculture.-All these and later squatters were interested only in water and grass, so that even as late as 1857 Surveyor Edward Barnett classified the whole of the country from Wangaratta to beyond Bright and Dandongadale into only five categories of grazing land, corresponding roughly to the main subdivisions of the present soil survey. Thus: "Scrubs in the bends" (of the Ovens River) corresponds to our Contemporary Sediments, apart from mining debris; "Fine open well-grassed box flats" (actually red gum) to the First Terrace at Oxley Flats, with "Narrow thinly grassed river flats" on the same terrace above Myrtleford. "Fine box forest at the back" describes the highest terrace at Everton and Tarrawingee, while all the country above the alluvium corresponding to our Hill Soils, he classed as “Barren Ranges", however heavily forested.

Under pastoral lease, burning and grazing must have had a profound effect on the vegetation and soils, as described by Curr (1883) for the Goulburn Valley in " Recollections of Squatting in Victoria ". The process was intensified when the discovery of the Ovens Valley goldfield in 1852 attracted a large mixed population, with an immense development and diversification of agriculture. There were 20,000 people at Beechworth in the first year, many being Chinese. Wheat, oats and barley, vines and tobacco, fruit, potatoes and vegetables, were soon growing in the Ovens Valley, and the first hop gardens in Australia were planted at Everton in 1860.

Repeated cutting of both forest and regrowth for fuel, and the cultivation of many hill slopes decreased the organic matter content and stability of the soils, and decreased the transpiration from plants. As a result leaching and all forms of erosion by water probably increased on most hill slopes, bringing increased sediments and soluble salts to the lower slopes and flats. When cultivated areas reverted to pasture and scrub, and as impoverished coppice growth took over former forested areas, the soils were probably thinner, less permeable and chemically poorer than before clearing.

Mining.-Mining operations themselves had even more obvious, direct effects on the soils of the area. Mining was by surface working at first, but from about 1860 shafts and tunnels exploited both the quartz reefs in bed-rock, and the great depth of alluvium, at levels more than 200 feet below the present surface.

Sluicing barges, introduced about 1870, greatly increased the pollution of streams with mining debris and spread deposits over parts of the flood plains of the Ovens River. Later on pollution was reduced by the operations of the Sludge Abatement Board, and by the substitution of bucket and suction dredges for the sluicing barges. The last of the big dredges ceased working at Harrietville in 1955, after moving more than 2 million cubic yards of material in its last year.

Reef mining was less important than in some other goldfields, so that, unlike Bendigo for instance, battery sand and mullock heaps have been a minor element in changing the landscape and soils.
Three other factors have influenced the landscape:

(1) Extraction of gravels from the lower reaches of the Ovens for road making, and the cutting of bends, have altered both the course and bed level of the stream.
(2) Flood-prevention levees, built largely by land owners, have limited the spread of overbank sediments from the Ovens River. These were started at Markwood and Wangaratta before 1880 and finally extended to form a continuous system.
(3) Forests of pines, first established in 1927, are replacing the native eucalypt forests in the middle reaches of the Ovens and Buffalo Rivers.

Transport, Water Supply and Government Centres
Roads, townships, industries and railways followed in that order the increase in population with mining, although some have since disappeared. A steam flour mill on the Ovens, and a foundry at Beechworth were started in 1856. Nowadays the most important industries, after agriculture, are timber getting and plantation forestry, and the spinning and weaving mills at Wangaratta. All the early development depended on road transport, with a punt over the Ovens at Wangaratta, until the first bridge was built in 1858. The railway to Wodonga was completed in 1873, the branch to Myrtleford in 1883 and the Bright extension in 1890. The Bright Road was declared a State Highway in 1947 and now carries the bulk of the traffic in the valley.

Until recently development of water resources was limited to the building of minor flood control levees, cutting bends, and the licensing of pumping from the river. In 1948 there were about 800 acres under irrigation in the Ovens and Buffalo River Valleys. A rapid increase to about 8000 acres in 1960 threatened Wangaratta's city water supply, which was safeguarded by the completion of the first stage of the Buffalo River Dam in 1965. Now a second stage is planned, as well as other dams above Bright and on the King River. These will effectively conserve the waters of the three rivers, which have a combined average annual flow at Wangaratta of 1.1 million acre-feet (maximum 4. 0, minimum 0. 1 million acre-feet) which is comparable with each of the Mitta Mitta and Murray rivers above Lake Hume.

The State Rivers and Water Supply Commission administers the area from its office in Wangaratta. The Department of Agriculture has three research stations in the area, the Tobacco Research Station at Myrtleford, and the Viticultural Research Station and Rutherglen Research Station at Rutherglen. There are offices at Wangaratta and Benalla.

Recent Trends in Primary Production
Although the surveyed area of 35,000 acres is two-thirds under pasture, and one-third cultivated, its agriculture and industry have always been closely linked with the neighboring timbered hill country of the five shires through which the area runs. Four of these five shires, Bright, Myrtleford, Beechworth and Oxley have 55 per cent. of their total area forested and less than 2 per cent. cultivated; whereas Wangaratta has 16 per cent. forested and 16 per cent. cultivated. In all five shires the balance is under native and improved pasture. Forested land here includes roads, farm buildings and township areas.

The grazing of the forest and alpine areas is integrated with pasture and fodder cropping of the river terraces, while much of the tobacco is grown on grazing properties by share farmers. Sheep, dairy cattle, and beef cattle are all important, the sheep being concentrated on the plains and lower hills in the west in association with wheat growing, dairy cattle in the valleys, and beef cattle in the valleys and on the high country.

During the 1930's superphosphate and subterranean clover doubled the carrying capacity of many farms, but had comparatively little impact in the higher parts of the valleys. Trends in farm production since then are illustrated by the short term averages quoted in Table 1.

While the total area of farms, including grazing leases, remained almost constant at 1.2 million acres for the five shires, the area of sown pasture more than doubled in fifteen years, to reach 362,000 acres average for the statistical years 1966 and 1967. Fertilizer used on all pastures increased from 215,000 to 302,000 hundredweights of superphosphate and from less than 2,000 to more than 24,000 hundredweights of other fertilizers, including mixed fertilizers. Number of beef cattle almost doubled to 81,400 head, the rate of increase accelerating in the last five years. The change in the dairying industry has been more complex; the number of dairy cows which rose from 25,000 to reach 28,000 in 1963-64 dropped to 22,000 in 1968-69, while the number of milkers per farm has doubled. By contrast, the state-wide trend I still one of steadily increasing number of dairy cows.

Table 1 – Primary Production

Selected data for the Shires of Wangaratta, Oxley, Beechworth, Myrtleford[1] and Bright (total area 2.01 million acres), parts of which are included within the surveyed area.

Period	Sown Pasture	Fertilizer on Pasture			Beef Cattle	Dairy Cows	Maize for Grain	Hops		Tobacco		Timber		
5 years beginning July 1	1,000 acres	Area 1,000 acres	Super-phosphate tons	Other tons	1,000	1,000	Acres	Area acres	Dry Hops 1,000 lb	Area acres	Dry Leaf 1,000 lb	Hardwoods Logs[4] million super feet	Softwoods Area 1,000 acres	Softwoods Logs[4] million super feet
1951[2]	147	244	11,000	78	43.8	25.0	750	340	404	1,500	1,360	4.2	16.6	14.3[3]
1956	223	263	12,000	60	54.6	28.4	460	430	740	4,900	5,400	11.1	17.3	23.1[3]
1961	304	286	13,000	720	66.6	28.1	370	560	840	8,700	9,600	12.6	22.2	28.5
1966[2]	362	287	15,000	1,200	81.4	24.3	54	670	1,070	8,000	8,800	13.4	27.0	34.1

Native Pasture – Long term average 820,000 acres. Details no presented as total fluctuates widely from year to year with no definite trend, because a variable amount of native pasture is recorded as *Unproductive Area* when statistics are collected.

[1] Myrtleford excised from Bright, 17 May 1970
[2] Two years
[3] Two years beginning 1954, 1958
[4] Logs delivered to sawmills, in millions of super feet. The "Hoppus Log Volume" quoted averages 78 percent of the total volume of the log.

In cultivated crops the most drastic changes have been in flax, tobacco, and maize for grain. The wartime flax growing and manufacturing industry, still with 1,500 acres of crop in 1947-48, disappeared about 1958. Maize for grain has dropped from 750 to 54 acres, while tobacco growing has increased more than fivefold to about 8,000 acres. Of other specialized commercial crops, broom millet has almost disappeared, but hops, filberts and walnuts still account for most of the State production, even though occupying only small acreages. Vegetable growing has never been important commercially, except around Stanley near Beechworth, but with the expanding tobacco industry there was a great increase in farmer's subsistence crops, especially cucurbits of all sorts, tomatoes, and peppers; but also carrots, peas and beans. Tomatoes have been grown commercially for seed.

The history of tobacco growing is complicated. It was grown by the first settlers, as it was in all districts of Victoria, both for smoking and for making a dressing for the skin disease "scab" in sheep. It was grown at Dederang before the first township was there, supporting a factory in 1879. Smith (1905) reports "wheat, oats, hops and tobacco at Bright", while at Wangaratta "tobacco is now not such a thriving industry as formerly". In the late 1930's about 2,000 acres were grown, declining to 1,700 acres during the war, when 390 tons per year, or 97 per cent of the State total leaf was produced in the region, mostly within 10 miles of Myrtleford. In 1947-48 there were only 800 acres. Thereafter the expansion was rapid, in tune with a rise in the compulsory home grown content in Australian made cigarettes (and latterly in all tobacco) from 5 per cent in 1952 to 32 per cent in 1961. The peak acreage was 9,600 acres in 1963. While total Australian tobacco production was small, Australian cigarette manufacturers absorbed much of the poorer quality leaf being produced; but this became impossible with a greatly increased crop, so that in 1961 and 1962 most of the poorer quality leaf remained unsold. In Victoria, most of the high grade and much of the unacceptable leaf was grown in the Wangaratta and Myrtleford districts. By 1967-68 the 9,600 acres had dropped to 7,550, although the compulsory Australian content had risen to 50 per cent.

Timber cutting and milling has always been important in the area, including both mountain hardwoods and red gum from the river flats. Pine plantations, started about 1917 at Bright and later at Ovens and Stanley, totalled 29,000 acres at the end of 1969 and were increasing at approximately 1,000 acres per year, mainly on the ridge to the west of the Buffalo River.

Vegetation

Most of the surveyed area originally carried a eucalypt tree cover varying in density from open woodland to dense forest. The greater part of the original vegetation has been removed by clearing for agricultural purposes, but sufficient remnants are present to enable a reasonably accurate assessment to be made of the nature of the native vegetation. This assessment has been assisted by reference to various historical records relating to the district.

On the flood plains, and along the banks of rivers and streams, river red gum (*Eucalyptus camaldulensis*) was and still is the characteristic tree of the lower portion of the area. Originally, it formed a forest or dense woodland near Wangaratta, coarse tussock grasses being the main understorey, with dense scrub confined to the actual banks of the streams, and including Ovens wattle (*Acacia pravissima*), black wattle (*A. mearnsii*), burgan (*Leptospermum phylicoides*) and swamp bottle brush

(*Callistemon palludosis*), which have persisted to the present time. Burgan was more prevalent upstream from Wangaratta, and dogwood (*Cassinia aculeata*) was present on the stream banks at Myrtleford and further upstream.

Near Wangaratta, the upper terrace originally carried an open, grassy woodland with grey box (*E. microcarpa* formerly *E. hemiphloia*), yellow box (*E. melliodora*), white box (*E. albens*) and but but (*E. bridgesiana*) as the main tree species with river redgum (*E. camaldulensis*) present on some drainage lines. Kangaroo grass (*Themeda australis*) and wallaby grasses *(Danthonia spp.)* provided the ground cover. This vegetation association has persisted to the present time, although the grasses are now largely limited to road and railway reserves.

In the central and upper parts of the surveyed area the upper terraces originally carried a dry sclerophyll eucalypt forest with red box (*E. polyanthemos*), broad leaf peppermint (*E. dives*), narrow leaf peppermint (*E. radiata*), red stringybark (*E. macrorrhyncha*), but but (*E. bridgesiana*) and grey box (*E. microcarpa*) as the dominant species. There was an open understorey of leguminous and other shrubs, and only a sparse grass cover. On the granite soils at Nug Nug the trees were stunted and more twisted, and included manna gum (*E. viminalis*) and long leaf box (*E. elaeophora*). River red gum (*E. camaldulensis*) was confined to a narrow fringe along the actual stream banks and did not extend to the upper parts of the surveyed area.

In the more sheltered situations of the upper reaches of the surveyed area a wet sclerophyll forest was originally present, and this has persisted in degraded form to the present time. The larger trees included messmate (*E. obliqua*), broad leaf peppermint (*E. dives*), narrow leaf peppermint (*E. radiata*), manna gum (*E. viminalis*), blue gum (*E. bicostata*) and brittle gum (*E. mannifera*, syn. *E. maculosa*). A dense understorey included dogwood and silver wattle (*Acacia dealbata*) as dominant species, with grasses virtually absent.

Weeds.-Many introduced weeds are found in the area. The most aggressive of the larger weeds have been the blackberry (*Rubis fruticosis*), St. John's wort (*Hypericum perforatum*), cluster flowered vervain or square weed (*Verbena bonariensis*) and slender thistle (*Carduus tenuiflorus*), all on less-cultivated land; and thorn apple (*Datura stramonium*), fat hen *(Chenopodium alba),* hybrid amaranth *(Amaranthus hybridus)* and (*Paspalum dilatatum*) in tobacco crops.

The blackberry was the first weed to become established, and soon occupied stream courses, billabongs, stream banks and a large proportion of the annually flooded ground; but in recent years control by hormone sprays has become economically feasible.

St. John's wort seriously limited grazing on many thousands of acres of the district from 1890 until about 1946, when the introduced Chrysomela beetles and later the use of 2,4-D hormone spray enabled reasonable control to he obtained. Earlier, very heavy dressings of rock-salt were applied for control purposes. During the course of the soil survey it was observed that this weed was most prevalent on the higher ground and on gravel banks.

On the headlands of tobacco crops and on fallowed paddocks, square weed (*Verbena bonariensis*), flea bane (*Erigeron bonariensis*), cud weed (*Gnaphalium involucratum*) and prickly lettuce (*Lactuca seriola*) often form a dense cover; and in tobacco, maize and sorghum crops, only constant cultivation prevents thorn apple, fat hen and hybrid amaranth from taking over, and Paspalum dilatatum from preventing effective inter-row cultivation. On the sandier soils, capeweed (*Cryptostemma calendula*) frequently forms a dense cover in the winter following a tobacco crop; while winter grass (*Poa annua*), chick weed (*Stellaria media*), toad rush (*Juncus bufonius*) and sorrel (*Rumex acetosella*) commonly occur on all soils in similar circumstances.

In district pastures, common inferior species are brome fescue (*Vulpia bromoides*), silvery hair grass (*Aira caryophillea*), sweet vernal (*Anthoxanthum odoratum*) and hawk's beard (*Crepis setosa*); and the legumes small trefoil (*Trifolium dubium*) and birdsfoot fenugreek (*Trigonella ornithopodiodes*). These inferior pasture species are more prevalent in the upper reaches of the valleys. Slender thistle occurs throughout the district and is a major weed on a few grazing properties.

Climate

The surveyed area ranges in elevation only from 460 to 1,100 feet above sea level, but the climate varies greatly because of the influence of nearby hills and mountains, and the slope and aspect of particular sites. This is clearly demonstrated by the climatic data presented in Table 2.

At Wangaratta, elevation 485 feet, and extending to Milawa 8 miles further up the valley, the average annual rainfall is 25½ inches. The nearest hills are 6 miles away to the west, so site and aspect are unimportant.

Myrtleford, elevation 700 feet, near the middle of the surveyed area and close to the edge of the mountain front, has a much higher average annual rainfall of 34½ inches. The nearby hills, rising steeply on all sides to about 2,000 feet, have a marked effect on the local climate which can vary sharply from place to place. These effects include the influence of aspect and topographic shading on effective radiation, and on morning and evening ground, temperatures; the funnelling of the prevailing

north-westerly winds affecting evaporation and the severity of damage by hail; and the occurrence of frost hollows where the down-slope flow of cold air from the hills is interrupted or convergent.
At Bright, elevation 1,100 feet, the surveyed area is practically surrounded by mountains rising to a maximum of more than 5,000 feet. The average annual rainfall is 43 inches, but because the rainfall gradient between Bright and Mount Buffalo is 5 inches per mile, rainfall distribution in the valley is probably variable.

At all three centres February is the driest month and June the wettest, with a probable rainfall 3 to 31 times greater in June than in February. At all centres the expected precipitation rises steeply between May and June and drops sharply between October and November. In addition, at Myrtleford and Bright, but not at Wangaratta, there is an appreciable rise in March. The variation between the three driest months is least at Wangaratta and greatest at Bright, whereas the variation between the three wettest months is small at Wangaratta, and negligibly small at Myrtleford and Bright.

The above generalizations are based on the 50 percentile figures for each month given in Review of Australian Water Resources, 1968 Edition. These percentile figures give a somewhat better idea of rainfall expectancy than an average figure, which may be unduly influenced by occasional very high or very low figures. The rainfall in any period has a 50 per cent chance of being above or below the 50 percentile figure.

Temperatures over the surveyed area do not follow a simple pattern. Wangaratta and Myrtleford have almost the same average daily maxima of 87°F for January and 55°F for July, and the figures for Mitta Mitta, situated similarly to Bright for which no figures are available, are only slightly lower. However, minimum temperatures for the three centres are different, average daily minima for January and July being 59°F and 38°F at Wangaratta, 53°F and 36°F at Myrtleford, and 53°F and 34°F at Mitta Mitta.

The frequency of frosts is even more strikingly different. Wangaratta has an average of 16 severe frosts in 73 days between the average first and last dates of May 31 and August 11; Myrtleford averages 36 severe frosts in 164 days, the average first and last dates being May 2 and October 12; and the available records from Mitta Mitta show that frost incidence at that centre is much the same as Myrtleford. Light frosts have occurred at Wangaratta as early as March and as late as October, while at Myrtleford, Mitta Mitta and Bright light frosts can occur in almost any month of the year. The incidence of severe frosts determines the earliest date for planting out tobacco and the latest date for harvesting the leaf.

Actual figures for evaporation are not available from within or near the surveyed area, but calculations using Prescott's formula indicate that the average annual evaporation from an Australian standard tank would be approximately 35 inches at Bright, 41 inches at Myrtleford and 47 inches at Wangaratta. Monthly figures are given in Table 2 which brings out the inverse relationship between rainfall and evaporation. Calculations of influential rainfall show that at Wangaratta the growing season for pastures without irrigation is limited to about 7 months from April to October. At Myrtleford the growing season is about 10 months, with severe moisture limitations in January and February in most years. Low temperatures in June and July cause some restriction of growth at both centres. At Bright the growth period for pastures is 9 to 10 months, the only severe restriction to growth being low temperatures in June, July and August.

Similar moisture limitations apply to cultivated crops and, for any particular crop, Influence the length of the irrigation season and the frequency of irrigation, these being largest at Wangaratta and smallest at Bright.

Table 2 – Climatic Data

Period	Precipitation				Evaporation (1)	Average Daily Temperatures			Frosts (2)			
	Average	Percentiles				Max.	Min.	Mean	Severe	Average Extreme Dates	Light	Average Extreme Dates
		5o	10	90								
	in.	in.	in.	in.	in.	°F	°F	°F				
Wangaratta												
Years of record	30	87	87	87		39	39	39	23	23	23	23
January	1.51	1.00	0.09	3.58	8.0	87.3	58.5	72.9	0		0	
February	1.75	0.99	0.04	3.71	6.0	87.3	58.7	73.0	0		0	
March	1.61	1.29	0.19	4.80	4.8	80.8	53.6	67.2	0		0	
April	1.99	1.54	0-19	4.11	3.1	71.5	46.6	59.1	0		1	
May	2.09	1.85	0.53	4.48	2.0	63.6	41.5	52.6	2	May 31	6	May 6
June	3.12	2.87	0.87	4.72	1.2	56.3	39.0	47.7	5		6	
July	2.61	2.27	0.85	4.54	1.2	54.9	37.9	46.4	6		8	
August	2.68	2.28	0.89	4.31	1.7	58.1	39.3	48.7	3	Aug. 11	5	
September	2.24	2.00	0.98	4.05	2.6	63.5	42.4	52.9	0		4	Sept.25
October	2.44	2.39	0.75	4.45	4.0	70.0	46.3	58.1	0		1	
November	1.63	1.49	0.25	3.73	5.5	78.5	51.2	64.8	0		0	
December	1.90	1.18	0.27	3.78	7.2	84.1	55.8	69.9	0		0	
Year	25.6	24.1	16.8	35.5	47.3	71.3	47.6	59.4	16		31	
Myrtleford												
Years of record	39	62	62	62		21	25	8	35	21	25	21
January	1.82	1.49	0.11	3.75	7.5	87.4	52.9	69.5	0		0	

Period	Precipitation				Evapora-tion (1)	Average Daily Temperatures			Frosts (2)			
	Average	Percentiles				Max.	Min.	Mean	Severe	Average Extreme Dates	Light	Average Extreme Dates
		5o	10	90								
	in.	in.	in.	in.	in.	^{o}F	^{o}F	^{o}F				
February	1.69	1.36	0.10	4.36	5.5	85.2	52.7	70.5	0		0	
March	2.41	2.03	0.18	6.07	4.0	81.0	48.3	64.2	0		1	
April	2.25	1.98	0.45	5.49	2.9	71.0	42.4	56.6	1		4	Apr. 19
May	3.18	2.65	1.10	6.62	1.9	62.8	39.2	48.6	5	May 2	4	
June	4.58	4.03	1.38	6.91	0.9	56.2	36.3	43.4	8		5	
July	4.01	3.85	1.56	7.39	0.9	54.7	35.7	42.7	10		6	
August	3.87	3.90	1.51	6.34	1.3	58.5	37.2	45.1	7		6	
September	3.26	3.13	1.33	5.34	2.2	64.3	39.2	49.7	4		5	
October	3.03	3.18	0.94	6.20	3.5	69.3	42.9	54.8	1	Oct. 12	3	
November	2.04	1.90	0.47	4.96	4.5	76.0	46.6	59.3	0		1	Nov. 1
December	2.26	2.01	0.47	4.65	6.3	83.6	50.3	64.4	0		0	
Year	34.4	35.8	24.1	47.1	41.4	70.1	43.7	55.7	36		35	
Mitta Mitta and Bright*												
Years of record	30*	84*	84*	84*		7	7	7	16	12	16	12
January	1.98	1.64	0.29	5.47	7.0	86.6	52.5	69.5	0		0	
February	2.39	1.44	0.21	4.50	4.0	86.8	54.6	70.7	0		0	
March	2.48	2.25	0.42	6.08	4.0	79.8	49.4	64.6	0		1	
April	2.81	2.42	0.43	5.77	2.8	69.9	43.4	56.7	1		3	Apr. 13
May	3.93	3.20	1.08	8.40	1.9	59.0	37.6	48.3	5	May 6	5	
June	5.29	5.13	1.59	8.82	0.3	52.1	34.4	43.3	8		8	
July	4.84	4.97	1.98	8.48	0.4	52.0	34.0	43.0	11		7	
August	5.23	4.88	1.65	8.11	1.1	55.5	36.1	45.8	8		6	
September	4.20	4.17	1.87	6.40	1.9	62.7	37.3	50.0	6		6	
October	4.14	4.03	1.34	7.03	3.0	68.2	41.9	55.0	1	Oct. 9	3	
November	2.62	2.61	0.97	5.41	3.9	74.0	45.6	59.8	1		2	Nov. 6
December	2.96	2.30	0.70	5.17	5.0	79.7	48.3	64.0	0		0	
Year	42.9	42.3	31.5	55.7	35.3	68.8	42.9	55.8	41		41	

(1) Evaporation from an Australian standard tank. Interpolated from the map published by the Commonwealth Bureau of Meteorology, in "Review of Australian Water Resources, Part 2."
(2) Severe frost Screen temperature 32.0^{o}F or lower.
Light frost Screen temperature 36.0 to 32.1 ^{O}F.
* Precipitation records refer to Bright.

Physiography and Geology

The surveyed area is a representative section of the floor of the Ovens and Buffalo River valleys. The soils of the flood plain, the four terraces and the colluvial cones described in this report have been formed on sediments which are directly related to the rocks and erosion processes of the drainage basins from which the sediments are derived. The soils of the colluvial cones derive from the hill slopes immediately above them, The main features of the Ovens, Buffalo and King River basins are summarized in Figure 2 " Geology and Topography of the River Catchments ".

For reasons given below it appears that these and neighboring basins are being carved out of one great high plain, and that apart from a reduction in the area of high plain the main basins have been altered very little during the deposition of the four terraces. This means that age and climate rather than parent material account for the differences between the major soil groups.

As Figure 2 shows, the Ovens and Buffalo River basins, above their confluence, are very similar in size and shape, topography and stream trace, and in geology. The one is almost a mirror image of the other. The climatic pattern is probably similar also, as confirmed by the native vegetation. However, there are important differences in some of the subcatchments which account for local variations in soil within the surveyed area. Differences in the proportions of different rock types affect grain size of soils, drainage and accumulation of organic matter.

Differences in climate affect the leaching, and hence the salinity of shallow ground water. The King River basin shows some sharp contrasts with the Ovens and Buffalo River basins, in structure and rock type, and also in stream pattern.

The basins will be described in two sections: upstream where most of the erosion takes place, and streams form a simple tributary system; and downstream, largely depositional, where streams with a lower gradient meander more widely, and branch and rejoin.

Upstream Section

The upstream part of the. Ovens River basin, above its confluence with the Buffalo River, is 38 miles long and 18 miles wide at its widest point, about 60 per cent of the area being below 2,000 feet elevation. The rim rises steeply to 2,000 feet within 5 to 7 miles of the confluence, and then very gradually to 4,500 feet in the south, with local peaks to about 6,000 feet. The watershed is a sharp ridge, with slopes on each side of the order of 2,000 feet per mile, except for areas of relatively gentle slope on the top of Mount Buffalo, and small areas of high plain around Mount Cobbler and Mount Hotham. It is worth noting that these three flatter areas have quite different rock types, and their elevations accord with the Dargo High Plains and the Bogong High Plains to the south and east, suggesting that they were all once part of the ane plain surface. The 2,000-ft contour line dictates the general form and rugged terrain in the valleys, and shows that steep average slopes continue down to the trunk streams.

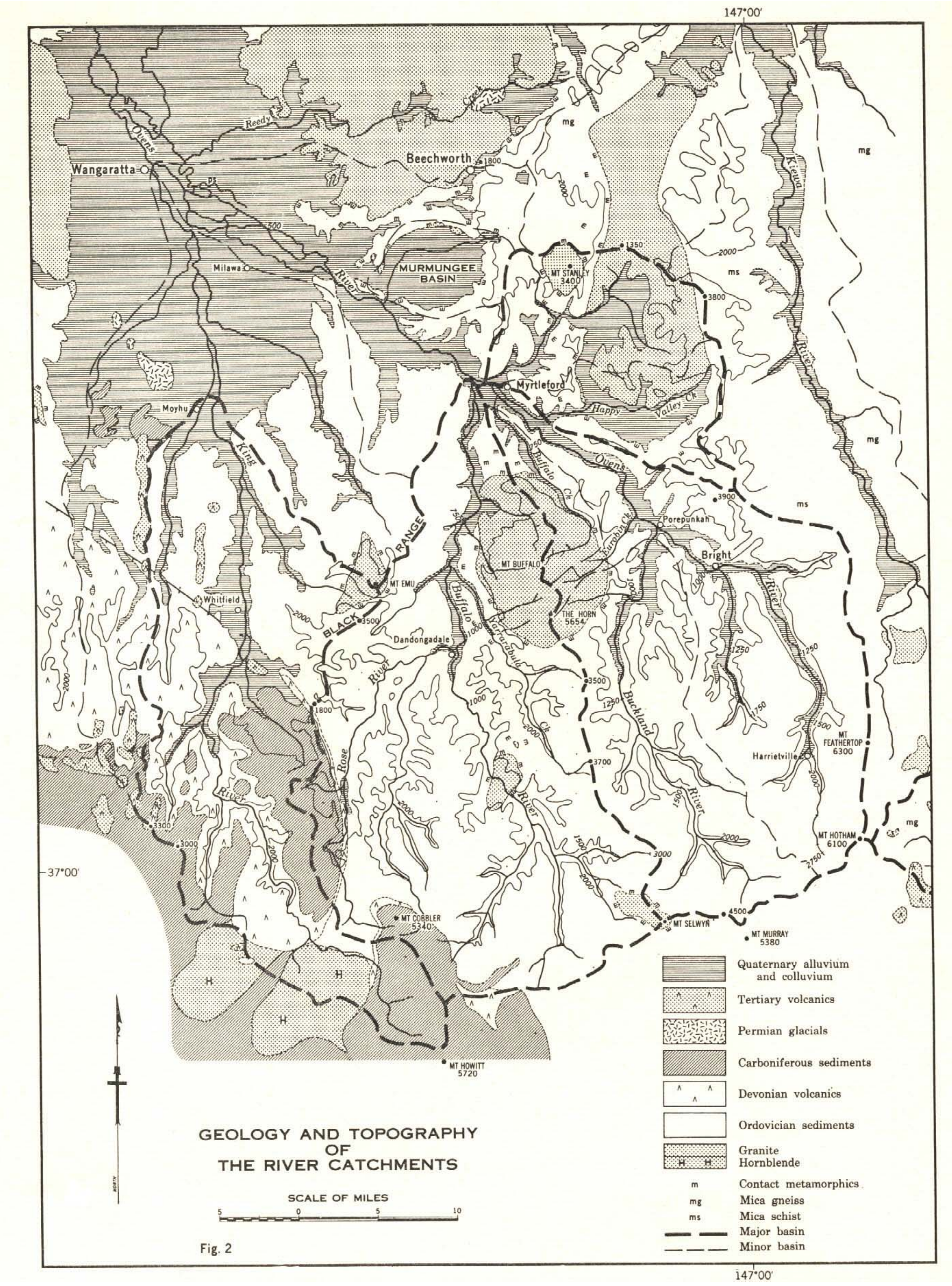
Most of the basin is formed on folded, medium to fine grained Ordovician marine sedimentary rocks. Granites are exposed on Mount Buffalo and Mount Selwyn, and the usual zone of metamorphic rocks occurs between granite and sedimentary rock. Quaternary sediments form only a few per cent. of the area, and are mainly cones of colluvium with quite narrow alluvial terraces, as detailed in the W maps between Bright and Myrtleford. There are also important but small areas of terrace along the Buckland River, the upper Ovens, and along Buffalo Creek.

The streams themselves form a symmetrical dendritic network in the Ordovician sediments, but on Mount Buffalo a rectangular pattern picks out the main joints in the granite. Buffalo creek drains the granite and metamorphic rocks long the zone of contact, as does Eurobin Creek.

The high ratio of rainfall to evaporation throughout the basin results in streams being very low in dissolved salts, even in summertime. The soils of the terraces contain less than 5 parts per 100,000 of sodium chloride, and usually less than 3 parts; but seepage areas on lower hill slopes have up to 10 parts per 100,000. One exception is a small area in Myrtleford itself where the deep subsoil chloride rises to 45 parts per 100,000.

The Buffalo River basin differs from the Ovens mainly in having a remnant of Carboniferous sandstones on the southern and western rim, overlying the so-called older volcanics, in this case Upper Devonian rhyolites. The rim is everywhere actively eroding, and these rocks certainly make some difference to the sediments in the tributary streams, but not in the surveyed area. There is a knob of granite exposed at Mount Emu, its accompanying zone of metamorphic rocks forming the rim of the basin. Erosion of another knob of granite at Abbeyard has caused the widening of the valley there, although the course of the Buffalo River is barely affected by it. Deep weathering of the sort responsible for this erosion is obvious in the gravel quarry at Nug Nug.

Fig. 2 – Geology and Topography of the River Catchments



Overall, the sediments of the Buffalo River are slightly coarser than those of the Ovens, reflected in the much greater proportion of light profile variant in Group 1 soils, and a lesser proportion of unnamed series 1_4 relative to the area of the 1_3 or Ovens series. This parallels the greater area of both granites and metamorphics in the Buffalo catchment, which have increased the content of primary minerals in the sediments. These effects are most marked in the sediments of Buffalo Creek, where dark, gritty profiles occur in contemporary sediments, Yarrarabula Creek and Eurobin Creek. Nug Nug Creek basin is wholly granite, and contains the only appreciable area of series 1_2 and the gravelly variant of the Eurobin series. The soluble salt content of streams, shallow ground water and soils is very low, as in the Ovens River basin, and is distributed similarly.

In the King River basin the stream network is dendritic to parallel, controlled in part by two valley flows of Tertiary basalt, though basically by a fault which probably extends at least as far as the Murray River near Corowa. Another intersecting fault south of Whitfield divides the basin into two distinct rock areas. To the north are Ordovician and Quaternary sediments; to the south Devonian volcanics overlain by sediments of Carboniferous age. These latter groups of rocks, which hardly occur in the Buffalo Valley, make up most of the upper catchment of the King River. The Carboniferous sediments belong to the same general group as the red mudstones and sandstones which colour younger terraces and soils as far away as Mansfield and Maffra.

Downstream Section

The Ovens and Buffalo Rivers share the same downstream section, and their flood plain and terraces merge with those of *the King River* between Milawa and Wangaratta. The watershed is formed by low rounded hills of Ordovician sandstones in the south, and of Devonian granites in the north, and later follows barely perceptible rises on the third terrace.

The stream network is one of roughly parallel, meandering streams, branching and rejoining. The sediments are of late Pleistocene and Recent age. Strongly meandering prior stream courses with subdued levees are evident on the highest terrace. One of these, marked p.s., is shown in Figure 2.

A precipitation to evaporation ratio of 0.53, moderately permeable soils, and shallow sandy aquifers, ensure a constant seepage and some flowing springs of saline water from the scarp of the higher terrace. Some of these give rise to local high concentrations of salt in the soils between Everton and Wangaratta. In contrast, the aquifers of the lower terraces at Markwood and Oxley Flats are recharged annually from the Ovens River and its anabranches, especially Tea Garden Creek, and contain very little salt. At Whorouly and Gapstead the position is more complex. There is no lateral stream of any size to separate the lower terrace from the hill, slopes and upper terraces, which are variably leached. The lower terrace therefore receives appreciable seepage, which is reflected in the variable salinity of waters in farm waterholes excavated into the gravel beds.

In addition to the three main basins, three small basins to the north also contribute to the combined downstream section of the surveyed area, and differ from the main basins in several ways. The average rainfall is probably only about half as great, so that the contribution of water is small. There is relatively little unaltered Ordovician rock, but in the case of Happy Valley Creek and Barwidgee Creek there are relatively big areas of Quaternary colluvium where the streams have eroded the granite. In the Murmungee Basin, unaltered Ordovician rocks barely exist at all, and the granite surface has been eroded away almost completely, leaving an infilling of Pleistocene and Contemporary sediments. The flat surface, lower rainfall and a low ratio of rainfall to evaporation ensure that the shallow ground water is relatively saline, which shows in the very high salt concentration in Burgoigee Creek in summertime.

The Flood Plain and the Terraces

The quaternary alluvium consists of the flood plain and four terraces. The flood plain carries Group 0 soils, and the terraces carry soils of Groups 1, 2, 3 and 3f, in order of increasing age and increasing elevation.

Group 0 soils occur in all parts of the survey, but not continuously throughout. The pattern of sediments is very detailed, characteristic of the meander belt of fast, variable streams. The characteristic materials are sands and gravels of stream beds, point bars and sand splays, covered by variable depths of levee material, usually fine sandy loam and less often fine sandy clay loam. Along the lower reaches where more extensive and finer flood plain deposits would be expected, artificial levees have limited their development.

The first terrace, with Group 1 soils, is a continuous body of sediment throughout the surveyed area, only slightly modified by soil forming processes. The general level is slightly above the flood plain in the upper reaches, but may be slightly lower downstream from Markwood. Group 2, 3 and 3f soils are on parts of earlier terraces at higher levels than Group 1 soils.

The stream traces associated with Groups 0, 1 and 2 show that above Myrtleford, the whole area of each terrace has been worked over by similar meandering streams, so that it is normal for soils of groups 0, 1 and 2 to have the same range and pattern of sediments in their deep sub-soils. The upper layers may be the very fine sandy to sandy material of levees, or the clay and silt of flood plain or swamp. Group sediments lack the uppermost layer of very sandy clay loam which is usual on terrace 1.

Below Whorouly, and more particularly below Markwood, the valley is wide enough for the river to switch from one side to the other without re-working the middle portion. This means that here the valley fill consists of several meander belts similar to those described above, separated by a flood plain common to courses of the stream, and built up of layer after layer of clay and silt, without intervening gravel and sand beds, apart from occasional small breakaways from the main streams.

The clearest example of such a shared flood, plain is between Oxley Flats and Wangaratta where successive courses of the Ovens River have been:

1. Tea Garden Creek and the lower end of Reedy Creek at one time part of the same river.
2. The upper part of Maloney's Creek.
3. The present Ovens River.

All of these have, or had, a common floodplain where grey, heavy, poorly drained soils occur, and where major floods scour out rather straight narrow channels across the clay plain.

On the third terrace, some of the detail of the sedimentary pattern has been obliterated by weathering and soil formation, but there is evidence that the stream course had a much greater meander wave length than the present day stream. This terrace marks the maximum infilling of the valley, before down-cutting began again to produce terraces 2 and 1, and. the contemporary deposits.

On the fourth terrace with Group 3f soils, weathering and soil formation have removed all details of sedimentary pattern to at least 61 feet below the present surface. The gravels have a much steeper gradient downstream than any of the later terraces, which means that the river valley was being deepened rapidly at the time this highest terrace was deposited.

Terrace heights and depths of sediment.-- The highest terrace with Group 3f soils on it, mapped at Buffalo River Dam on Map 18, is 70 feet above contemporary deposits Other approximate heights are: first terrace 6 feet and second terrace 14 feet. There is no third terrace and the present stream is downcutting. At Wangaratta, contemporary sediments overlap the lower parts of the first terrace and are approximately 15 feet below the third terrace. There is no second terrace here and the flood plain is building up generally.

Not all changes in terrace level are marked by changes in soil. Some scarps where there is no appreciable change are shown on the detailed soil maps; for example on Map 2 near Tarrawingee, with Group 3 soils; and at Wabonga Bridge and Four Creeks, on both sides of the river, with Group 1 soils (Maps 12 and 13).

Some records of the total depth of unconsolidated sediment are as follows: Harrietville, 130 feet; Bright, 220 feet; Nug Nug, 180 feet; Gapstead, 225 feet; Murmungee basin, 260 feet; Wangaratta, 390 feet.

A line of bores across Morse's Creek at Wandiligong, near Bright, showed 125 feet of sediment, and was interpreted by Kenny (1925) as showing two bedrock terraces with different soils at about 20 feet and 50 feet below the present surface, representing pauses in the down-cutting of the valley. There are two layers of dark soils at 55 feet and 100 feet below the present surface, indicating two pauses in the later infilling of the valley. The terraces of the present bulletin are cut into this mass of infilled sediment, indicating a period of renewed down-cutting.

The Colluvial Cones

Although colluvium forms the main part of the quaternary sediment in the main basins, cones of this sort of material are relatively unimportant in the surveyed area. They have been formed by two main processes, and are arranged in age sequences revealed by a range of soils comparable with those on the terraces. The processes of formation are firstly, the slumping and sliding of masses of unsorted soil and rock from hill slopes, and secondly, the dumping of similar material, only roughly sorted, by ephemeral torrents in steeply sloping gullies. Successive cones from the one source may be side by side, or overlapping wit a common apex. In many cases the younger cone beside an older one, has been initiated by the river cutting down to a lower level, so increasing the grade of the lateral valley. At Bright (Map 14) there are three cones side by side, with soils of Groups 2, 1 and 0, (0 being just off the map). At Wabonga Bridge on Map 12 there are cones with four soil groups. Groups 3, 1 and 0 are on cones which lie side by side, but the cone with soils of Group 2 just fails to cover the earlier one with Group 3 soils on it.

In the Buffalo River Valley, major earth movements on hill slopes have blocked the valley or diverted the river on several occasions; at the Dam Site on Map 18 by the cone which carries Group 3f soils; at Johnston's Bridge on Map 17 with Group 3 soils; and on Map 16 with Group 2 soils. This latter is a very unstable area of deep weathering at the contact of metamorphics and granite, and has produced the only very recent cone of any size, marked by Group 1 soils. The high level area of Group 1 soils around site 59 is classified as alluvium, but is probably due to the continued slow accretion of fine-grained hill wash over swamp deposits.

Further details of the features which distinguish the main groups of soils, and of the relationship between soil types and sedimentary processes are given in the section, " Description of Soil Types ".

Relationship of Soil Types to Agriculture

This section summarizes the characteristics of the soils which determine their potential for agriculture, and then discusses each main mapping unit in these terms in relationship to pastures, tobacco, summer and winter cultivation, orchards and pine plantations.

It is understood that climatic factors such as frost, and the limits of the growing season, are just as important as soil characteristics in assessing the potential of any area. Furthermore the importance placed on the chance of flooding, for instance, or a shallow water table, will depend not only on the crop being considered but its profitability, in that the same risk may be worth taking at one time and not at another.

Soil Characteristics and Land Use

The characteristics discussed are:

1. *Drainage position.*-This ranges from depressions which fill with water several times a year, or liability to almost annual flooding as with most Group 0 soils, to locally high spots on terraces 2, 3 and 3f which are never inundated.
2. *Through profile* drainage.-This depends on texture which ranges from coarse sands and gravels, to heavy clay, although most of the area is in the range fine sandy loam to silty clay loam, with or without a light deep subsoil.
3. *Surface topography.* This includes factors such as the very irregular natural surface of Group 0 soils, closely spaced watercourses, and the generally sloping nature of colluvial cones.
4. *Surface texture and depth.*-The full range present is from large gravel to clay, but in fact more than 80 per cent. of the area has fine sandy loam to very fine sandy clay loam surface soils of 7 to 12 inches depth.
5. *Variability*.-This includes the range of profiles within the various soil types, the complexity of mapping units, and the range and fluctuations in watertables.
6. *Salinity and nutrient status*.-Salinity is only slightly determined by soil type, but increases downstream, especially in the vicinity of seepage areas. Nutrient status is dependent on texture profile, age, parent material and management history.

Soils of Group 0

Except for some small areas of recent dredge tailings, Group 0 soils are below the level of frequent floods. Being mostly deep, light textured, and intersected by many watercourses and depressions, they have good lateral drainage when watertables are low. The watertables rise to the surface at high river, even when the area is protected by levee banks. Sludge areas near Wangaratta do not have this underdrainage. Group 0 soils are therefore unsuited to some perennial crops, and to winter and early spring cultivation. Perennial pastures cannot be grazed when watertables are high. Hops and walnuts are grown successfully on series O_3, and Pinus radiata thrives on dredge tailings, though some of the latest workings, outside the surveyed area, are reported to be infertile, either because of low watertables or exceptionally low contents of fine material.

The through profile drainage is excessively fast in the 0_1 and 0_2 series, moderate in 0_3, moderate to slow in 0_4 and slow in the shallow phase of O_4. A light deep subsoil increases the through profile drainage in each series. The available moisture and resistance to flow of water are both dependent on horizons of fine texture (fine sandy to silty clay loam) and on the content of fine organic matter. Organic matter does not appear in the definition of the soil types and phases, but in general, in these Group 0 soils, it increases with clay and silt content. However there are exceptions, so the colour of surface and subsoil horizons should always be checked for an indication of unusually high or low organic matter content.

The surface topography of Group 0 soils was originally extremely uneven, except for areas of sludge which were very even. Most have now been graded flat. This was facilitated by light textures and the absence of a B horizon, but the very coarse dredge tailings required heavy equipment. In these coarsest soils grading has also tended to even out surface textures over an area. In the Myrtleford and Wangaratta series levelling has often meant filling watercourses with many feet of highly organic surface soil, and sometimes exposing gravel or sand beds. These infilled areas have abnormal drainage and nutrient characteristics for many years after. In the case of tobacco growing this may necessitate different fertilization, and possibly exhaustive cropping of the filled-in area with barley or oats.

Areas of 0_1 and 0_2 soils are wholly dependent on surface horizons for the nutrition of shallow rooted plants, and require frequent fertilization if irrigated. For tobacco and other annual crops, a gravel surface makes seedling establishment and inter-row cultivation difficult, so that any other surface is to be preferred. For pine trees the surface texture is unimportant, growth being dependent on the total silt and clay in the profile and a reasonably high watertable. Fine sandy loam and fine sandy clay loam surfaces predominate in the Myrtleford and Wangaratta, series. In this range the most important differences are in the infiltration rate of frequently cultivated soils, a slightly coarser or grittier texture giving the higher infiltration rate. This controls both the total water that can be absorbed per irrigation, and the length of time when the roots tend to be waterlogged.

Group 0 soils in general are the most variable group of the survey as regards texture profile, because the sediments lack the uppermost layer of finer material which blankets the levees and flood plains of the terraces. They also lack the unifying effect of soil development. Sludge areas on the contrary are exceptionally uniform. Watertables rise and fall in unison with the river levels, in contrast to Group 2 and Group 3 soils which are above this influence. Group 1 areas are intermediate in this respect.

As regards salinity and nutrient status, Group 0 soils are almost uniformly very low in chlorides, the only notable exception being the seepage area of sludge on Map 1 near Wangaratta. Significant areas of Group 0 soils, mostly of the Wangaratta series, on Maps 2, 3, 4 and 15 have appreciable but still low chloride contents, probably also related to local seepage. It is of interest that downstream from Myrtleford, Group 0 soils are usually significantly lower in chloride than neighbouring Group 1 soils, but above Myrtleford Group 1 tends to be slightly lower. The Myrtleford and Wangaratta series, have a high average content of organic matter through the profile. This contributes to a generally high nutrient status, which may mean undesirably high nitrogen levels for tobacco growing. Management can readily overcome these differences in respect of surface horizons. Dredge tailings and series 0_1 and 0_2 generally, have very low nutrient status.

To sum up, soils of the 0_1 and 0_2 series are very suitable for some forestry purposes, and, after costly preparation, for tobacco growing, with limitations of low nutrient status and excessively rapid through profile drainage. They are inferior for pastures, and in most cases suffer from flooding and high watertables at times. 0_3 and 0_4 series have probably the highest inherent productivity of all series in the survey, especially for a relatively deep rooted crop such as tobacco which can exploit the favourable moisture characteristics to a depth of several feet. The major limitations lie in flooding, high and fluctuating watertables, local variability, and low water retention near the surface particularly in Myrtleford fine sandy loam. The areas most suitable for growing cigarette tobacco, are the 0_1 and 0_2 series, and the Myrtleford or 0_3 series, except for the shallow phase and areas excessively broken by water courses.

Soils of Group 1

Group 1 soils are, by definition, either above the level of frequent flooding, or have been long protected from flooding by artificial levee banks. However extensive low-lying areas of grey and yellow-grey soils are subject to frequent waterlogging. These are the Oxley Flats series and grey phases generally. In all such areas surface drains of some sort are needed.

The through profile drainage is excessively fast in the 1_1 and 1_2 series, as it is in the 0_1 and 0_2 series. It is moderate in the Ovens or 1_3 series, although slow in the shallow phase. It is slow to very slow in the series 1_4, 1_5 and 1_6. The gleyed deep subsoil phases of the Ovens series must be treated as suspect as to through profile drainage. In some cases the evidence of deep subsoil waterlogging is due to conditions no longer operating, but in others it reflects either a shallow profile or a high watertable.

The surface topography of Group 1 soils was originally rather uneven, except that most areas of point bars had a very wavy surface with parallel depressions 2 to 4 feet deep, and 60 to 90 feet apart. These are mostly the areas of the light profile phase of the 1_3, series, or belong to the 1_2, series. At Wangaratta North and Milawa Bridge there are areas of 1_3, and 1_6 series excessively broken by deep watercourses and scour lines.

Surface texture and depth is a very uniform 7 to 10 inches of very fine sandy clay loam over large areas, except for the point bars, and heavily graded areas of the 1_4 series. For spray irrigation of cultivated crops, sandy loam, fine sandy loam, gravelly loam, and the slightly gritty textures common on the reddish variant and the light profile phases of Ovens fine sandy clay loam, are preferred to the normal fine sandy clay loam. Under pasture these slightly coarser textures are of little if any advantage.

Although areas of Group 1 soil types and phases are more uniform in all respects than areas of Group 0 soils, there are several large areas of soil complexes shown on the maps. In most cases the components of the complex are quite distinct, as shown by the pattern in the photographic background of the map, and can be managed differently if necessary. An example is the complex of 1, and 1, types on Map 12. On the other hand there are several important areas where one type or series grades imperceptibly into another. Both are present but the majority of the area is an intergrade between the two, and the whole area is best treated agriculturally as an intergrade, not as a complex of contrasting types. Three different examples of this sort are on Maps 2, 12 and 17.

The salinity of Group 1 soils is extremely low in the upper reaches of the valleys, 0.002 and 0. 003 per cent sodium chloride from 1 to 4 feet being usual upstream from Map 9. Downstream from Map 7 there are appreciable areas above 0.005 per cent, and downstream from Map 4 above 0. 009 per cent with local concentrations above 0.100 per cent. Since the surface foot is usually slightly higher in chloride than the average to 4 feet, salinity alone severely restricts the area suitable for tobacco on Maps 1, 2 and 3. In nutrient status, Group 1 soils are generally lower in organic matter than Group 0, particularly in the subsoil and deep subsoil. Regional differences in the balance of nutrients are related to differences in leaching, but are readily overcome by agricultural practice.

Overall, the soils of Group 1 are highly suitable for annual or perennial pastures, with minor limitations due to broken surface topography and poor water relationships, and low nutrient status in the 1, and 1, series. For tobacco, hops and walnuts the Ovens series is preferred, particularly the light phase, the reddish variant, the light deep subsoil phase, and fine sandy or sandy loam surfaces. Shallow profiles are unsuitable. Gleyed subsoils are suspect, and downstream from Markwood chloride is sometimes detrimental. The 1, series is suitable for tobacco, though water penetration and root development may be restricted, and chloride is more likely to accumulate than in the Ovens series. Where there is the added drawback of a clay loam surface or gleyed deep subsoil, areas of the 1, series should be avoided for tobacco. The Oxley Flats series, and grey phases of all types are unsuitable for light cigarette tobacco and probably for hops, but are excellent for irrigated and dry pastures, for vegetables and for maize. Surface drainage is necessary when these soils are irrigated, and the rate of water penetration may limit the productivity of crops with a high demand for water.

Soils of Group 2

In drainage position, soils of Group 2 fall into two categories. The island remnants on Maps 3 and 15, and extensive terraces on Maps 7, 8 and 13, and on the Buffalo River are practically never flooded or inundated. Colluvial cones and smaller terrace remnants are subject to occasional inundation by runoff from the hills unless protected by lagoons or gravel banks.

Through profile drainage is generally moderate, with some faster profiles in areas of light deep subsoil. The generally shallower surface and slightly heavier subsoil of the Eurobin series as compared with the Ovens series of Group 1, make for a slower water intake, partly compensated for by a coarser sand fraction and better subsoil structure. Seepage and shallow profiles impede the drainage in local spots on both colluvium and terrace.

Surface topography is very even, with former stream courses reduced to shallow depressions. Colluvial cones at Porepunkah have gentle uniform slopes, and there is an area of rolling topography at Nug Nug.

Surface texture and depth are very uniform over large areas. Six inches of fine sandy clay loam is usual, with fine sandy loam or gritty clay loams at Whorouly and in the Buffalo River Valley, and sandy and gravelly textures up to 20 inches deep on granitic sediments. The shallower surfaces are on gravel banks, and the deepest are on granitic colluvium. The shallow profiles on gravel would have to be avoided in flood irrigation layout. They produce only very light growth of dry pastures.

In salinity and nutrient status Group 2 soils are close to the corresponding textures amongst the reddish variants of Group 1 soils, any slight differences being due to a greater age. Thus downstream from Whorouly the salinity tends to be very slightly higher in Group 2 soils, particularly in the deep subsoils, while above Myrtleford, the Group 2 soils have negligibly low salinity. The balance of nutrients also reflects this leaching pattern.

Overall, Group 2 soils are the most uniform group of the survey. They are of similar potential to the reddish variants of Group 1 soils, but with generally shallower surfaces, somewhat lower nutrient status, and in the wetter parts of the valley they are more strongly leached. The terrace remnants at Milawa Bridge have profiles nearer to Group 3 soils. In every case there appears to be considerable scope for pasture improvement. For irrigation purposes, the main disadvantage of Group 2 soils is their distance from the rivers.

Soils of Group 3

This group has not been investigated as closely as the other groups, but in general, Group 3 soils are not subject to flooding or inundation, apart from some local depressions.

Through profile drainage, and therefore root development, is restricted by the clayey B horizon in some places, and by surface crusts, but generally infiltration is fairly fast under pasture.

The range of surface depths and textures is similar to that of Group 2 soils, but drainage conditions have produced stronger local contrasts. Depressions are marked by strongly developed grey soils, usually strongly bleached, often with clay loam surfaces and slight accumulations of salt.

Salinity is generally low, though slightly higher in deep subsoils in the drier parts of the valley. It is extremely low upstream from Myrtleford.

There is a potential for flood irrigation between Wangaratta and Everton, including deeper rooting crops such as tobacco, lucerne, orchard trees and vines, but sites should be investigated for surface depth and surface crusting, and for salinity in the deep subsoil and the water table.

Soils of Group 3f

The comparatively small total area of this group appears to be very uniform in all respects, except that the area of colluvial terrace on Map 18 is dissected to an undulating topography with rather shallow profiles.

Infiltration rate is comparable with Group 2 soils and field capacity is higher.

Salinity is extremely low throughout the profiles which are markedly more leached than any others, with metal ion saturations of 10 to 0 per cent against 30 to 60 per cent for most other soils.

The group is mostly under pasture, but appears particularly well adapted to growing deep-rooted summer crops under irrigation, the high lift from the river being the only disadvantage

Drainage and Cultivation Categories

The drainage relationships and suitability for cultivation of all the soils can be summarized any defining seven land use categories as follows:

Category 1. Very well drained soils of Group 0, not excessively broken by watercourses, namely Series 0_1, 0_2 and 0_3 excluding their shallow phases and areas of series 0_3 excessively broken by watercourses.

Category 2. Less well drained soils of Group 0, namely series 0_4 and all shallow phases of Group 0 soils. Excessively broken or variable areas of series 0_3 are included in this category.

Category 3. Well drained soils of Group 1, not excessively broken by depressions or watercourses, and not in complex with poorly drained soils of Group 1. Series 1_1, 1_2 and 1_3, excluding shallow phases, grey and heavy profile variants, and broken areas. Series 1_4 excluding 1_4 clay loam and the gleyed deep subsoil phases.

Category 4. Poorly drained soils of Groups 1, 2 and 3, and areas of these groups broken by depressions and watercourses. That is, series 1_5, 1_6, 2_6 and 3_6, and all shallow phases and grey or heavy profile variants of Groups 1, 2 and 3. Type 1_4 clay loam and the gleyed deep subsoil phases of the 1_4 series.

Category 5. Group 2 soils excluding grey profile variants and series 2_6.

Category 6. Group 3 soils excluding grey profile variants and series 3_6.

Category 7. Group 3f soils.

Crop Suitability

Broadly speaking the suitability of the various categories for different crops is as follows:

Tobacco.-Categories 1, 3 and 7 are most suitable for growing tobacco to 1970 standards, categories 5 and 6 are of variable suitability, and categories 2 and 4 are unsuitable; but chloride content overrides these drainage criteria in many cases.

Maize, sorghum and millet.-All soils in categories 5, 6 and 7, and categories 1, 2, 3 and 4 excluding series O_1, O_2, 1_1, 1_2, and excessively broken areas.

Pastures, oats.-Categories 3, 4, 5, 6 and 7, and parts of category 2 not subject to flooding.

Lucerne.-Categories 3 and 5, and category 6 excluding surfaces shallower than 6 inches, with climatic limitations above Myrtleford in all cases.

Hops and Walnuts.-The better-drained parts of series O_1 and 0_4 in categories 1 and 26 also categories 3, 5 and 7.

Summer vegetables.-All soils in categories 5 and 7, and categories 1, 2, 3, 4 and 6 excluding series O_1 O_2, 1_1 and 1_2, excessively broken areas, and soils in category 6 having surfaces less than 6 inches deep.

Winter vegetables.-Categories 3, 4, 5 and 6, and parts of category 2 not subject to flooding.

Vines.-Categories 3, 5 and 6 below Myrtleford.

In all the categories there are small areas of seepage or higher salinity which make them unsuitable for any of the above uses. There may be circumstances in which by special attention to management practices, crops can be grown economically on areas not recommended above.

Areas of Drainage and Cultivation Categories

The areas of soils in each of these categories in different parts of the valleys are tabulated in Table 3. The Buffalo River Valley is considered as one locality, tabulated as occurring on Maps 15 to 18, the Ovens River Valley above Myrtleford as another locality, on Maps 10 to 14 while the Ovens Valley below Myrtleford is subdivided into three further localities, Myrtleford to Whorouly on Maps 7 to 9, Whorouly North almost to Milawa Bridge on Maps 4 to 6, and Milawa Bridge to Wangaratta North on Maps 1 to 3. The area of each category in each locality is shown both in acres and as a percentage of the area of the locality. The percentage figures emphasize the progression from coarser, better drained soils in the higher reaches, to finer, and more poorly drained soils downstream. This is particularly well shown by Category 4. Categories 1 and 2 show the same trend, but in addition show the concentration of well drained soils on Maps 7 to 9.

Additional figures are given for areas of light deep subsoil, irrespective of the above categories. These are the areas of gravel and sand profiles, and all areas mapped as light deep subsoil or light profile, except shallow phases; that is to say all areas with gravel, sand or sandy loam textures from at least 30 inches to 48 inches in the profile. Areas of Group 3 soils where fine sandy clay loam at 30 inches becomes sandy loam or coarser before 48 inches are also included.

Table 3. - Areas of Land Use Categories.

Category	Soil Groups	Area	Maps 1-3	Maps 4-6	Maps 7-9	Maps 10-14	Maps 15-18	Total
1	Group 0	acres	358	360	921	1,080	700	3,419
	well drained	%	3.3	5.2	17.8	17.5	12.2	9.8
2	Group 0	acres	1,230	1,640	337	503	233	3,943
	less well drained	%	11.4	23.9	6.5	8.2	4.1	11.4
3	Group 1	acres	2,300	1,630	2,630	2,400	2,120	11,080
	well drained	%	21.2	23.7	50.7	38.9	37.1	31.9
4	Groups 1, 2, 3	acres	4,300	1,920	830	940	565	8,555
	poorly drained	%	39.6	28.0	16.0	15.2	9.9	24.5
5	Group 2	acres	63	85	460	1,230	1,380	3,218
	well drained	%	0.6	1.2	8.9	20.0	24.2	9-3
6	Group 3	acres	2,590	1,240	4	6	497	4,337
	well drained	%	23.9	18.0	0.1	0.1	8.7	12.5
7	Group 3f	acres				8	215	223
		%				0.1	3.8	0.6 --
	Total all soils	acres	10,841	6,875	5,182	6,167	5,710	34,775
	Total sands and Total gravels	acres	1,090	15390	1,830	1 0 54	-2,070	7,92
	in deep sub-soils	%	10.0	20.2	35.3	25.0	36.2	22.8

Distribution and Significance of Soil Chlorides

The chloride content of the soils and the total soluble salts as measured by electrical conductivity are very low throughout the surveyed area, apart from a few small seepage areas. Only one of these, on Map 1, shows visible signs of salinity, in bare ground, salt tolerant plants, and soil dispersion. The chloride ion, expressed as sodium chloride or common salt, is so important in determining smoking quality of tobacco that its distribution has been studied in detail. Very low concentrations of chloride are concerned, much below the levels associated with adverse effects on growth of tobacco and other plants.

The chloride content of the top foot of soil was measured, as well as the average content from 1 to 4 feet. In about 200 profiles the chloride content of each foot to 4 feet and sometimes 7 feet was measured. In all cases chloride contents have been expressed as sodium chloride or common salt. The Salt Distribution Map summarizes the salt contents of the 1 to 4 foot layer. It is seen that the figure is strongly dependent on the distance downstream from Bright and Dandongadale, and the proximity to higher terraces. An additional fact not shown is that the variability within each mapped salinity class also increases downstream. For instance, on Map 12 in the green area (less than 5 parts per 100,000), the modal value from 90 determinations is 2.7 parts per 100,000 and there are no figures above 5 parts per 100,000. On Map 4, the modal value for the green area is just over 4 parts per 100,000, and there are isolated values as high as 32 parts per 100,000.

There is a weak correlation with soil type and with land use on any one map. Above Ovens, the contemporary soils have a modal value of slightly over 4 parts per 100,000, and first and higher terrace soils have a value below 3 parts per 100,000. Below Gapstead, the slightly higher figures are on first terrace soils and especially on the heavier Oxley Flats series.

Land regularly irrigated has salt contents averaging about 10 per cent. higher than neighbouring, non-irrigated land of the same type, except the extremely permeable sands and gravels which are lower in salt when irrigated.

With regard to salt distribution within the profile, the soils of the Oxley Flats series and most shallow phases of other types show a steady increase in chloride with depth and especially where tobacco is grown regularly. In other types, about 60 per cent of profiles show a slight decrease in the second foot, usually between 2 and 6 parts per 100,000, and an increase with depth below 2 feet; 25 to 30 per cent show no change or a steady increase with depth; and 10 to 15 per cent of profiles show a steady decrease in salt content down to 4 feet.

Tobacco quality is itself subject to changing fashions and it is difficult to set a permissible upper limit for the chloride content of a soil for tobacco growing. However on the Salt Distribution Map, the upper limit of the second category, 9 parts per 100,000 sodium chloride, is close to the permissible limit adopted by the Tobacco Branch of the Department of Agriculture.

The salt content of the soils from 1 to 4 feet is very rarely above 40 parts per 100,000 in the surveyed area, or above 80 parts per 100,000 in any one foot. These concentrations are too low to adversely affect pastures or crops other than tobacco.