PART III
USE AND CONDITION OF THE LAND

7. PRESENT LAND-USE

Wool Growing and Beef Production

Wool growing is the most important primary industry for it occupies most of the farm land and is the main source of income for most of the landholders. Table 9 gives data relevant to the industry. The dominance of fine-wool sheep is clearly shown, particularly in the Shires of Arapiles and Ararat. In the Shires of Dundas and Wimmera, dual-purpose sheep are in significant numbers. In Dundas, the raising of fat lambs is more common than in the first two Shires. In Wimmera Shire, wheat growing is the dominant primary industry and sheep are used on many of the wheat farms to graze pastures in the cropping rotation and thereby to supplement the income. There are sheep properties producing fine wool in that part of the Shire to the south of the Western Highway. These differences between the Shires are further shown by a comparison of the yield of wool and numbers of sheep per rural holding (Table 9).

Table 9 - Sheep and cattle statistics for four shires

The Year Ending March 31st 1960

Shire	Rural Holdings	Wool Clipped	Sheep and Lambs shorn	Percentages of Total Sheep			Beef Cattle
				Fine-Wool	Dual-Purpose	Meat	
	No.	lb.					No.
Arapiles	343	4,216,141	450,959	96	4	Insig.	1,795
Ararat	768	12,850,292	1,386,726	93	6	1	11,153
Dundas	842	10,208,542	1,201,117	76	23	1	20,548
Wimmera	730	2,721,826	318,792	67	31	2	1,043
The Year Ending March 31st 1963							
Arapiles	368	3,486,997	448,204	89	10½	½	3,781
Ararat	776	12,340,167	1,495,918	89	10	1	19,649
Dundas	853	10,680,653	1,278,292	72	26	2	32,964
Wimmera	706	2,411,428	296,697	61	36	3	2,499

(The data in columns 2, 3, 4 and 8 were taken from the 1959-60 and 1962-63 volumes of Victorian Rural Statistics" published by the Commonwealth Bureau of Census and Statistics. The data in columns 5, 6 and 7 are for the years ending 31st March, 1959 and 1962 and were calculated from unpublished records of the Bureau. Fine-wool sheep are taken to be Merino and Merino comeback. Dual-purpose sheep are taken to be Corriedale, Polwarth and crossbreds. Meat sheep are taken to be British breeds such as Dorset Horn, Border Liecester and Romney Marsh. A rural holding is defined by the Bureau as a piece of land of one acre or more used for the production of agricultural products or for the raising of livestock and the production of livestock products. Shires are used because statistics for the exact area of the survey are unobtainable. The Shire of Arapiles is almost entirely within the area together with about half of each of the other Shires.)

Beef cattle are carried on many farms to provide a secondary source of income but because the cattle are a sideline, their numbers fluctuate over the years in response to prices and to the Australian and overseas demand for beef. Poll Hereford and Hereford are the popular breeds and Aberdeen Angus is also used. The greatest numbers, both in total and per rural holding, are in Dundas Shire and one reason for this may be the higher average rainfall and longer growing season that help to provide a greater bulk of green feed and meadow hay. The dominance of the wheat industry in the Shire of Wimmera is again illustrated by the very low numbers of cattle. Most of them are in the same part of the Shire as the fine-wool sheep, that is, outside the wheat area.

Pastures used by the Grazing Industries

The wool and beef industries are based on the maintenance of productive pastures. Pastures supply nearly the entire food ration required by the grazing stock, not only as feed in the paddocks but also as meadow hay.

In this report, pastures are considered to be of three kinds *unimproved native pastures,* where neither fertilizers nor pasture species of superior feed value have been added, *improved native pastures,* in which fertilizers have been applied and superior pasture species may or may not have entered the sward, and third, *introduced pastures,* where species of superior feed value are sown with a fertilizer, either by seed drill, chisel seeder, or light aircraft.

Most agricultural areas in the survey have an average annual rainfall of between 18 and 25 inches and the species used in the introduced pastures are the same in most places. The most widespread pasture mixture contains Mt. Barker variety of subterranean clover *(Trifolium subterraneum)* and perennial ryegrass *(Lolium perenne).* Bacchus Marsh subterranean clover is sometimes used as well. Phalaris *(Phalaris tuberosa)* is often sown in place of perennial ryegrass, and in the driest parts Wimmera ryegrass *(Lolium rigidum)* also replaces perennial ryegrass.

Local differences of soil and drainage can lead to variations from the standard mixtures. Barrel medic is used in preference to subterranean clover on the grey calcareous clays of the wheat belt. On the podzols and podzolic deep sands, species like phalaris, perennial veldt grass *(Ehrharta calycina)* and evening primrose *(Oenothera biennis)* have shown most promise. Occasional use is made of Palestine strawberry clover *(Trifolium fragiferum)* and Yarloop subterranean clover in wet sites.

To grow vigorously, introduced pastures need fertilizers. Superphosphate is used on all the soils, and a few soils also require other fertilizers. Podzols and podzolic deep sands require a nitrogenous fertilizer and salts of copper, zinc and potassium, as well as lime on the very acid soils. Solodic soils that have formed on granitic rocks and Ordovician sedimentary rocks need molybdated superphosphate and also lime where the acidity is high. A potassium fertilizer is often needed in those solonetzic and solodic soils that have deep, sandy A horizons.

Pasture improvement is now widely practised within the area of the survey. By 1960, introduced pastures, including oats and lucerne sown for grazing, were actually of greater extent (55 per cent of pasture land) than improved and unimproved native pasture (45 per cent). In 1963 the figures were 62 per cent and 38 per cent respectively (Table 10). No figures are available for the areas of both unimproved native pasture and improved native pasture however during the course of the field work, many paddocks of sparse unimproved native pasture were seen. There is obviously still a great deal of work yet to be done on many properties before their full grazing potential is realised. Introduced pastures have raised the carrying capacity of farms three and four times above that provided by unimproved native pastures, from 1 dry sheep per acre to two dry sheep per acre in many cases.

Table 10 – Sown and native pastures in four shires.

The Year Ending March 31st 1960

Shire	Sown Pasture	Native Pasture	Total Pasture	Percentage of Total	
				Sown	Native
	Acres	Acres	Acres		
Arapiles	164,326	164,790	329,116	50	50
Ararat	405,313	233,375	638,688	63	37
Dundas	306,235	220,312	526,547	58	42
Wimmera	89,221	158,038	247,259	36	64
Total	964,095	776,55	1,741,610	55	45
The Year Ending March 31st 1963					
Arapiles	181,086	160,165	341,251	53	47
Ararat	466,406	157,194	623,600	75	25
Dundas	350,720	212,265	562,985	62	38
Wimmera	98,441	139,117	237,558	41	59
Total	1,096,653	668,741	1,765,394	62	38

(Sown pasture includes oats and lucerne sown for grazing. Data taken from "Victorian Rural Statistics" for 195-60 and 1962-63).

Table 11 – Wheat acreages and yields in four shires.

Shire	Year Ending March 31st 1960			Year Ending March31st 1963		
	Rural Holdings	Wheat for Grain	Wheat for Grain	Rural Holdings	Wheat for Grain	Wheat for Grain
	No.	Acres	Bushels	No.	Acres	Bushels
Arapiles	343	21,451	487,068	368	33,829	809,276
Ararat	768	21,138	532,175	776	32,678	979,134
Dundas	842	807	20,184	853	1,532	41,267
Wimmera	730	90,354	1,552,377	706	102,211	2,393,293

(Data taken from "Victorian Rural Statistics" for 1959-60 and 1962-63)

Water Supply Catchments

Victorian catchments receiving less than an average annual rainfall of 20 inches discharge a negligible run-off in years of average rainfall. Also, about half the rainfall in excess of 20 inches is discharged as stream flow, the most significant contribution to the run-off being delivered by the headwater catchments (Anon. 1960).

Catchments within the central Grampians receive an average annual rainfall of 34 to 36 inches so that the potential for stream flow is six or seven inches of run-off. However, the area is small, about 130 square miles, and some of the water available for stream flow is lost as seepage into the deep and porous sandy soils that surround each of the ranges and cover the floors of the flat valleys. Gloe (1947) suggested that Moora Valley could be an intake area for aquifers feeding the Murray Artesian Basin, and if so it would influence the volume of water in the Glenelg River.

Quantities of river discharge and sizes of catchment areas are given in Table 12. The four streams listed in the upper part of the table are the biggest that flow out of the Grampians and their headwaters are in the central area of comparatively high rainfall. The average annual discharge of the Glenelg River at Balmoral, from a catchment of 606 square miles, is 116,310 acre feet which is equivalent to an average annual discharge of 192 acre feet per square mile of catchment. The average annual discharge of the Wannon River at Dunkeld is 139 acre feet per square mile of catchment. For Mt. William. Creek at Lake Lonsdale the figure is 190 acre feet per square mile of catchment. Some idea of the variability of these streams is given by the ratios of the maximum yearly flow to the minimum yearly flow. Mt. William Creek and the Glenelg River have the very wide fluctuations in yearly discharge of 212 : 1 and 156 : 1 respectively. The figures for the Mackenzie River in columns five and six are unusually high for this part of Victoria and they approach the figures shown for two rivers in the eastern mountains of the State. Possibly the small area of the catchment, its position entirely within the area of higher rainfall, and its exaggerated saucer shape provided by the Mt. Difficult Range are contributing factors.

The data for the Goulburn and Macalister Rivers are given so that the potential of the Grampians to supply water can be compared with that of the eastern mountains of the State where the total precipitation as rain and snow and the volumes of water in the rivers are so much greater. The combined catchment area of the four Grampians streams approaches that of the Goulburn Catchment and yet the combined discharges, both total and per square mile of catchment, are only one fifth of the figures from the Goulburn River and its catchment.

The Grampians may appear to be a mediocre source of water but their value for this purpose is nevertheless real as shown in the following paragraphs.

In Chapter Three, reference was made to the unique role of these mountains as an isolated area of comparatively high and reliable rainfall in the far mid-west of the State. Their water resources have been developed to a high degree in efforts to supply domestic and stock water to cities, towns and farms throughout much of western and north-western Victoria, from Hamilton in the Western District to Walpeup and Underbool in the Malice.

The biggest scheme for using Grampians water is the Wimmera and Mallee Stock and Domestic Water Supply Scheme developed by the State Rivers and Water Supply Commission. The Wimmera and Mallee Regions lie inland to the north of the mountains and the average annual rainfall decreases from 18 inches in the south to 10 inches in the north. This rainfall is too low and the soils generally are too porous to support stream flow. Underground water throughout a large part of the area is unsuitable for humans and animals so that, apart from rainwater, the only water available is that which can be channelled from areas of higher rainfall elsewhere in the State. The plains slope from the Grampians to the Mallee and water is distributed by gravity rather than by pumping, which would be more expensive. About 10,000 miles of channels distribute water to 80,000 people, in towns and on farms over 11,000 square miles of western and north-western Victoria (East 1955). Without this assured water supply, the Wimmera and Mallee would have remained marginal agricultural areas. Now they support most of Victoria's wheat farms.

The Wimmera and Mallee scheme has twelve major reservoirs and their combined storage capacity is 588,000 acre feet. The headwaters of the Glenelg River flow into Rocklands Reservoir, the biggest storage with a capacity of 272,000 acre feet, and from there water is diverted inland to Toolondo Reservoir for distribution further north. There is also a small reservoir in Moora Valley into which some of the Glenelg waters are diverted for distribution. Other streams rising in the Grampians are regulated by reservoirs. Wartook Reservoir is on Mackenzie River, Lake Bellfield is on Fyans Creek, and Lake Lonsdale and

Table 12 – Discharge and catchment statistics for selected streams

River and site of gauge	Average annual precipitation over the headwaters	Average annual discharge	Area of catchment to the gauge	Average annual discharge per sq. mile of catchment	Ratio of maximum to minimum annual discharges
	Inches	Acre feet	Square miles	Acre feet	
Glenelg at Balmoral	34-36	116,310	606	192	156 : 1
Mackenzie at Wartook Reservoir	34-36	22,200	30	740	39 : 1
Mt William Crk at Lake Lonsdale	30	76,100	400	190	212 : 1
Wannon at Dunkeld	34-36	29,130	210	139	67 : 1
Total		243,740	1,246	196	
Goulburn at Eildon Reservoir	>60 (partly snow)	1,454,000	1,500	969	7 : 1
Macalister at Glenmaggie Reservoir	>50 (partly snow)	483,200	760	662	11 : 1

Lake Fyans store water from Mt. William Creek and Fyans Creek. Altogether ten of the twelve reservoirs are located within the survey area and their combined storage capacity is 525,000 acre feet. Nine reservoirs are shown on the land-system map accompanying this report. Lake Bellfield near Halls Gap is not shown.

Waters of the Grampians are further used for town water supply in the cities and towns immediately surrounding the mountains. Urban centres such as Horsham, Hamilton, Stawell, Ararat, Willaura and Dunkeld receive their domestic and industrial water through pipelines coming from small reservoirs in the mountains. In most cases a local water supply trust administers each scheme. Also, 7,500 acres of irrigated land near Horsham and Murtoa are supplied with water.

Plate 20 – Rocklands dam and reservoir on the Glenelg River upstream from Balmoral.
This is the biggest storage in the scheme to distribute Grampians water northwards to the Wimmera and Mallee

Proclaimed Catchments

The Act of Parliament under which the Soil Conservation Authority operates has a section dealing with the proclamation of defined water supply catchments by the Governor in Council. The proclamations follow recommendations by the Land Utilisation Advisory Council after consultation with the Soil Conservation Authority. The purpose of the proclamations is to control the use of those catchments that supply water to water authorities or to individual users. The function of the Soil Conservation Authority in this regard is to make a land-use determination for each proclaimed catchment. The determination defines areas within the catchment where various declared forms of land-use may be practised without detriment to the quality, quantity and regularity of the water supply. Contemplated changes in the use of any part of the catchment should be referred to the categories of land-use defined in the determination.

The catchment to Rocklands Reservoir has been proclaimed and wholly lies within the area of the survey as does more than half of the proclaimed section of the Wimmera Catchment (see Figure 32). Most of the Rocklands Catchment is Reserved Forest under the control of the Forests Commission, and most of the Wimmera Catchment is farming land on the plains and lower hills. A discussion of the types of land within both catchments is given in Chapter 28 of the report.

Wheat Growing

Wheat growing as the main form of land-use is restricted to the most northerly part of the survey, that is, to the east and west of Horsham, where the average annual rainfall is 17 to 18 inches. Most wheat farms are 640 acres to 800 acres in area. The most popular wheat variety is Pinnacle, although Olympic introduced in 1957 is gaining acceptance and has been recommended as a main variety for the "black" soils where it has given higher yields than other varieties in yield trials (Anon. 1961b).

The soils are mainly gilgaied grey soils of heavy texture that are calcareous and self-mulching and are commonly referred to as the black or "Wimmera black" soils. These soils have given the Wimmera its reputation as one of the most productive sections of the Australian wheat lands, and within the survey area their boundary is also the boundary of the wheat belt.

Because of their fertility and self-mulching property, the grey clays are more favoured for wheat growing than the red-brown earth soils which are not as widespread. The red-brown earths are locally called red soils. They are not self-mulching but tend to set hard when dry, and they generally give lower yields. For these reasons, the red-brown earths can be a handicap to cultivation wherever the two soil group closely intermingled.

For the ten years during the 1950's, the average yield throughout the Wimmera was 24 bushels per acre although individual farms in favourable years often gave yields higher than 50 bushels per acre. Both two and three-year rotations are used although there is now an increasing emphasis on the longer rotation. The two-year rotation of wheat-fallow gives yields that are usually between 25 and 35 bushels per acre. The three-year rotation, with a year of barrel medic pasture, usually yields between 45 and 60 bushels per acre, and this is associated with increased levels of nitrogen in the soil and of protein in the grain. Some of the problems of wheat growing on these soils are discussed in the Horsham land-system in Chapter Ten.

Plate 21 – There are limited areas of millable tress in the Grampians. This forest has been thinned to produce as many straight trees as possible.

The inclusion of a legume pasture in the rotation has enabled the wheat growers to diversify their farming by adding wool growing or fat lamb raising as a profitable sideline. Sheep are no longer used as scavengers for cleaning up fallows and crop stubbles. Comeback and crossbred ewes are commonly kept for their wool.

Plate 22 – Areas of young red gum, as illustrated here, are of limited extent and this adds to their value as future sources of hardwood in western Victoria.

To a lesser extent, wheat is grown also as a cash crop on other soil types in other areas. On solonetzic soils in the north-western parishes, cropping is used every few years to renovate old subterranean clover pastures and to use the accompanying build-up of nitrogen. This practice is sometimes called a modified clover-ley system. Cash crops of wheat are grown in solodic soils on the basalt plain around Willaura. Here a clover-ley system has been adopted in which wheat and wool growing are of about equal importance in the farm economy.

Forestry

The forests are centred in the Grampians and western Black Range and on parts of the plains between these two mountainous areas. Very few of the forests are under private ownership. Most of them are either Reserved Forest or unoccupied Crown land under the control of the Forests Commission and the Department of Lands and Survey.

Forest management is more than the removal of timber from a forest and the provision of a future supply. Forests have other uses and these should be in operation at the same time. Native plants and animals should be protected and their habitats preserved as far as possible, soil erosion should be prevented, and stream flow should be unimpaired in its quality, quantity, and regularity. Some forests have little or no timber of commercial value and they are therefore managed in the interests of soil and water conservation, natural history, and recreation. Forests such as these are called protection forests.

Most of the forests in the Grampians and western Black Range are protection forests. They cover the sandstone ranges and the outwash slopes beneath, and they are mostly short dry sclerophyll forests and heath woodlands of brown stringybark, messmate, long leaf box and apple box. These forests are of no value for timber production because many sites are inaccessible and the trees have an inferior form and shape. However, as protection forests, they are located where the need for protection is greatest, that is, throughout the catchments supplying water to the system of reservoirs. Within the Grampians there are a few limited stands of productive brown stringybark and messmate used for scantling timber and transmission-line poles. These aspects are considered again in Chapter 27 when discussing land-use in the Grampians Ranges land system.

Most of the forests of value for timber production are located on the plains near the ranges, particularly in the vicinity of Rocklands Reservoir where valuable woodland stands of red gum, grey box, yellow box and yellow gum are maintained as Reserved Forests. Timber cutting is carried out under licence by private contractors and the timber is used for scantling, poles, fence posts, firewood, and railway sleepers. Forest grazing is permitted under licence or agistment in suitable areas provided that other interests are not adversely affected.

Another form of timber production is softwood plantations of *Pinus radiata.* There is only one mature plantation within the survey area, at the foot of Mt. Difficult Range in the Grampians. For an assessment of the potential of the survey area for the extensive development of pine plantations, the general requirements of these plantations must be considered.

Plantations of P. radiata will grow in a number of soils and climates but their growth rates vary and depend on the capacity of each site to meet the requirements of the species. The requirements for vigorous plantation growth can be summarized as being a high annual rainfall (about 28 inches and higher) with a uniform seasonal distribution, and a deep, well-drained soil with moderate to high levels of plant nutrients. If sites under consideration have a low rainfall, a markedly dry summer, a poorly-drained soil or an infertile soil, it cannot be expected that plantations of pines will have high growth-rates.

There is little published Victorian information about the environmental limitations imposed on the growth of *P. radiata. A* paper by Hall (1961) records the significant field and pot responses to phosphorus and nitrogen and pot responses to copper measured in P. *radiata* seedlings growing in nomopodzols in East Gippsland. A paper by Poutsma and Simpfendorfer (1962) describes pine failure caused by waterlogging in solodic soils near Port Campbell in the Western District. Across the border in the lower south-east of South Australia, the climate and some of the soils are similar to the climate and nomopodzols in the Grampians survey. Thomas (1957) and Lewis and Harding (1963) have described climatic and soil limitations to *P. radiata* growth in this part of South Australia. The long, dry summer period places a severe water stress on pines growing in the podzols. Also, many of these soils are deep, white or grey dune sands with organic horizons in the subsoil, and their infertility makes them poor sites. They require the addition of superphosphate and nitrogen fertilizers before their site quality rating is good enough to warrant their use for plantations.

To be successful, a softwood industry must be supported by a large area of vigorous, healthy plantations. However, when growing in plantations, pines require better sites than do individual trees because the competition for water and nutrients is more severe. Therefore, to establish a softwood industry, large areas of land of good site quality, as described, are required.

Most of the land available for pine plantations in the survey area is the unoccupied Crown land in and around the Grampians, which has been mapped as the Grampians Plains land-system. This land comprises the outwash slopes of deep, siliceous sand located around the sandstone ranges, and its environmental features are summarized as follows. The average annual rainfall is 22 inches to 30 inches and there is a seasonal variation from a maximum in winter to a minimum in summer. The soils are generally deep, light grey to white nomopodzols although there are small areas of leptopodzols and deep phases of solonetzic soils. These soils are well-drained but their storage capacity for water is low which is a disadvantage for plant growth in an area with a low and intermittent summer rainfall. Also, the soils have very low amounts of plant nutrients, and deficiencies of at least nitrogen, phosphorus and zinc must be overcome before healthy Pine plantations can be established.

Therefore, the overall potential for pine plantations of the Crown land in the survey area is low. If plantations were established by the usual techniques of plantation management and tree spacing, there may be some millable logs but the main produce within the usual length of crop rotation would be poles and posts. If millable logs were required, heavy applications of phosphorus and nitrogen fertilizers would be needed and the life of the crop extended by a number of years. The problem of deterioration of site quality and its effect on the productivity of the second crop of trees must also be considered. Thomas (1957) and Lewis and Harding (1963) express concern at the signs of lower yields in the second rotation crops growing in the best sites. This problem would be even more serious in marginal sites like the Grampians Crown lands where the soils would have to be heavily fertilized to support even the first planting of trees. Furthermore, because the average rainfall is lower than desirable, there is a risk of total failure in the early life of a plantation, should there be a dry year, because the deep, sandy soils have a low water storage capacity. In the Crown lands, some small areas with comparatively fertile soils have been planted to pines in recent years, but these areas are not typical of the Crown lands as a whole,

8. SOIL EROSION

Soil erosion is an accelerated loss of soil initiated by man's misuse of land. In this way it differs from geological erosion which is one of the processes that shape the earth's surface. It occurs when two conditions are present. They are, first, that the soil is bare and without its protective plant cover, and second, that sufficient energy is thrust upon the soil to move it. Bare soil is not a normal feature of undisturbed environments in a region of temperate climate like western Victoria. However, white man has totally or partly uncovered the soil through his techniques of land-use such as clearing, burning, overstocking, ploughing and fallowing, and by the introduction of the rabbit. Then the energy in wind, in running water and in gravity has led to the erosion of the soil.

Erosion Hazard

Four important features of the environment help to determine the likelihood of erosion and the rate of its development. These are the topography (the gradient and length of the slope) the physical properties of the soil (its texture, structure, coherence and permeability) the nature of the plant cover, or the lack of it and the elements of the climate, particularly the strength and turbulence of the wind and the annual amount, seasonal incidence and intensity of the rainfall. Within the area of the survey, topography exerts the greatest influence on the hazard and occurrence of erosion. Provided the land is flat there is little chance of serious erosion irrespective of the climate, soil or nature of the plant cover.

The highest hazard of **water erosion** occurs in the eastern part around Ararat, Moyston and Great Western. Here the average annual rainfall varies from 21 inches to 24 inches, and wet winters are followed by dry summers with occasional storms of high intensity (see Figure 6). The topography is rolling to hilly, the soils are gravelly solodic soils, and the plant cover is mostly shallow-rooted pastures of native and introduced species. Originally the area was covered with eucalypt woodlands. Although the topography has the strongest influence, the nature of the climate, soils and plant cover in the area add to the severity of both the hazard and the extent of water erosion.

The hazard of water erosion and also of catchment salting is high in valleys on the dissected tableland in the south-west. Here, again, the four environmental features enumerated above are all important in creating the hazard although topography has the greatest influence. The hazard is also high over the sandstone ranges of the Grampians because the topography is very steep, the soils are shallow and sandy, and there is a strong possibility of high intensity rain during the summer and early autumn when bushfires expose the soil.

Undulating plains in the north and in the south have a moderate hazard because of the gently sloping topography and the sandy loam topsoils of the solonetzic and solodic soils. The flat, depositional plains with gilgaied clays in the north, and the flat, undissected parts of the tablelands with solodic soils in the south-west, all have a low hazard of water erosion.

The hazard of **wind erosion** is negligible throughout most of the survey area. The isolated places where the hazard is moderate to high have combinations of the environmental features that are uncommon to the area. For example, the hazard is high on the sand dunes and sandy lunettes because the deep, loose sand of these land-forms is fashioned into a sharp ridge and is thereby exposed to the wind. In their undisturbed state, only the native vegetation prevents the dunes and lunettes from eroding. Another type of site with a definite hazard is the fallows on the wheat farms around Horsham. The bare soil breaks down to fine aggregates by self-mulching and cultivation and there is a risk of localized dust storms arising from the fallows during the summer and early autumn.

Erosion in the Survey Area

The forms of water erosion commonly found are sheet erosion, gully erosion and stream-bank erosion. They are related to each other in origin and development because they are different expressions of the same problem of misuse of the land. Wind erosion occurs in the forms of sand drift and dust storms. Catchment salting is included in this section because it is another manifestation of misuse of the land and it often occurs with sheet erosion and gully erosion.

Water Erosion

In *sheet erosion,* thin layers of topsoil over large areas of paddock and hillside are washed downslope. Sheet erosion typically occurs on sloping grazing land wherever the plant cover is sparse, for example, where the timber is over-cleared and the pastures are unimproved and overgrazed. Evidence of it is provided by the elevation of grass on small pedestals of topsoil, the exposure of tree roots and underlying rock, and the accumulation of eroded soil on the uphill side of obstructions such as rocks, fallen trees and netting fences.

A large part of the supply of plant nutrients is lost in the eroded topsoil. The exposed sub-surface horizon is a poorer habitat for pasture plants because of its inferior structure, lack of organic matter and lower reserves of nutrients. In many solodic soils it forms a thin, impermeable surface seal that reduces the infiltration of water into the soil and increases the volume and velocity of the run-off water. The increase in run-off water leads to gully erosion and stream-bank erosion.

Sheet erosion occurs also on fallowed cropland in association with rill erosion, in which many shallow gutters or rills develop in the cultivated soil.

Gully erosion is a consequence of sheet erosion. On sheet-eroded land, the erosive power of run-off water is increased and where the water is concentrated into a narrow channel it cuts deeply into the soil so forming a steep-sided watercourse or gully.

Gullies commonly develop in natural drainage lines between the slopes of undulating and rolling farm land. If not treated they will extend upslope by headward erosion. In badly eroded country, it is usual to see most drainage lines turned into deep, multi-headed gullies.

Some gullies develop away from the natural drainage system in those places into which run-off water has been directed, for example, in table drains on the roadside, in stock tracks, vehicle tracks and in plough lines.

Stream-bank erosion involves the undercutting and slumping of the banks of rivers and creeks and also of the sides of gullies. Most of the silt load of streams probably originates in this way. Stream-bank erosion can be serious in catchments that are over-cleared, overgrazed and sheet-eroded, and it occurs particularly when the volume and velocity of the stream suddenly increases after heavy rain over the catchment.

Plate 23 – Gullies are a sign that soil erosion is serious. Excessive clearing and over-grazed pastures are two contributing factors illustrated in this photograph.

Plate 24 – One indication of serious erosion is deposits of silt overlying the original ground surface. Here, about two feet of silt is exposed in the wall of a gully. The A horizon of the original soil is the white band across the centre of the picture

Catchment Salting

The salting of farmland arises from the accumulation of sodium chloride and other salts in the topsoil to levels that are toxic to pastures and crops. It occurs under irrigation and under dryland farming. One form of the latter type is called catchment salting because it typically occurs in small catchments in undulating grazing land. The salted areas are found at the bases of slopes where accessions of drainage and seepage water from the surrounding catchments accumulate. In the early stages of development (wetpan salting) the pasture species are replaced by salt-tolerant plants of negligible grazing value such as curly ryegrass (*Parapholis incurva*), buckshorn plantain (*Plantago coronopus*) Desmazeria (*Desmazeria acutiflora*) and yellow buttons (*Cotula coronopifolia*). As the level of salt continues to rise, all plant growth ceases and an area of bare, impervious soil develops. This acts as a starting point for sheet and gully erosion and is called the hardpan stage. Cope (1958) states that the early stages of salting are associated with a soluble salt content of about 0.2 per cent. and that the hardpan stage is associated with higher levels that in places exceed one per cent. By comparison, the levels commonly found in unaffected soils are less than 0.01 per cent.

In Victoria, catchment salting is most serious on solodic soils in undulating to hilly land cleared for sheep and cattle farms within the 20-inch and 30-inch isohyets (Cope 1958). The problem has developed since the land was cleared of its timber to encourage the growth of pastures for sheep and cattle. The causes, treatment and prevention of catchment salting have been discussed by a number of authors (e.g., Cope 1958 Downes 1949, 1958, 1959 Wagner 1957). Further reference is made to it in the chapter dealing with the Dundas land-system.

Plate 25 – Most salt areas occur at the bases of hill slopes. The killing and clearing of trees on the higher land contributes to this. The example of salting shown has developed to the hardpan stage.

Distribution of water Erosion and Salting

Within the area of the survey, sheet erosion, gully erosion and stream-bank erosion are widespread in the east, around Ararat, Moyston and Great Western, where there are rolling plains and hills of sedimentary rocks and granitic rocks. The high hazard in this area was outlined earlier in the chapter. Many creeks and drainage lines have become vertical-walled gullies with banks subject to undercutting and slumping. Rills and gullies have developed also in the table drains beside roads in some places.

There is negligible erosion on the flat surface of the tableland in the south-western part of the survey. However, in the narrow valleys of stream dissection, salting in particular, and sheet erosion have developed. Many drainage lines have extensive areas of salted land and some of the examples have reached the advanced stage in which all vegetation has been killed and the ground is bare and impervious to water. Gullies have developed in the salted areas.

Over the greater part of the northern plains, water erosion is almost non-existent because of the flat topography and the clay soils. South-west of Horsham there is a small area with different environmental features where water erosion is serious. Here the slopes are comparatively steep because the topography is undulating to rolling, and the soils are red and brown solonetzic soils. Sheet erosion, gullying and siltation are all present.

The basaltic plains in the south show little evidence of erosion particularly where the soils are heavy clays. Even on the solodic soils, erosion is slight because of the gentle topography and the introduced pastures.

Plate 26 – Wind erosion is uncommon in the survey area although individual examples can be severe, such as this blown-out sand dune near Horsham

Wind Erosion

Wind erosion occurs mainly as sand drift on many of the sand dunes and sandy lunettes where the ground-layer vegetation has been removed. The two land-forms suffer distortion and movement and often have large wind-blown hollows. These examples of wind erosion are spectacular but they are isolated and cause little damage to farms or public utilities.

On hot, windy days, dust storms can develop over the fallows on the wheat farms. This is more common under a two-year rotation of wheat-fallow than where a year's pasture of barrel medic has been introduced. The reason for this difference is that under the shorter rotation, the soil is cultivated more frequently, its levels of organic matter are low, and its structure and coherence are destroyed.