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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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1.Objectives

The aim of this study was to investigate soil salinity problems in relation to new land releases at Fitzgerald near the south coast of Western Australia. In this preliminary investigation a fairly widely spaced set of bores was established to compare the groundwater hydrology regimes beneath cleared and virgin land. It was hoped that some predictions could be made about areas of the landscape which might be vulnerable to secondary salinity, as well as the rate of groundwater rise following clearing of native vegetation.

2.Summary

A large storage of soluble salts (over 100 kgm^2 in some profiles) was measured in the pallid zone clays under both cleared and virgin land conditions. This salt is available for mobilisation under changing hydrological conditions associated with clearing of the native vegetation.

Seasonal fresh to brackish perched watertables were found to overlie highly saline deep watertables at a number of valley sites on land which has been cleared for agriculture during the past 15 years. As the potentiometric surface approaches the ground surface the shallow ephemeral watertables are expected to become permanent and highly saline. Salinisation of the ground surface will then occur.

Salinity is encroaching where the potentiometric heads are at the ground surface. This occurs in headwaters of the Susetta and Hamersley Rivers.

3. Recommendations

It is recommended that one catchment be studied in greater detail. Relatively uniform slopes should be chosen for the establishment of bore transects, with nests of piezometers and observation wells. It is intended that two transects should be on cleared land, and a third on land which is uncleared on the upper half of the slope. This study should give some indication about how much extra water is being recharged to the watertable after clearing of the native vegetation.

Preliminary groundwater investigations in relation to soil salinity at Fitzgerald, Western Australia

C.J Henschke

Introduction

The investigations described in this report relate to an area of vacant Crown land to the north—west of Fitzgerald townsite, towards Lake Magenta (see Figure 1). Mallee Road forms the eastern boundary of this reserve.

Land along Mallee Road has been released for agricultural development at various stages during the past 15 years. At the time of writing it is not known how much, if any, of the vacant Crown land will be released for agriculture.

Investigations involved drilling and installation of piezometers at 25 sites on farms adjacent to Mallee Road in October 1979, and again in August 1981. The purpose of this exercise was to investigate the hydrology of some land which was already saline and other sites where salinity might be expected to develop in the future due to clearing of the native vegetation. Bores were drilled in virgin land, and land which had been cleared for up to 15 years, to compare groundwater levels with clearing history.

Climate

The climate is described as a dry warm Mediterranean type (Beard, 1976). Table I shows the mean monthly rainfall at Jerramungup taken over 70 years.

Table 1 Mean Rainfall

Month	J	F	M	A	M	J	J	A	S	0	N	D	TOTAL
Mean Rainfall(mm)	14	15	26	30	44	47	50	41	39	32	19	17	373

Severe local storms occasionally produce flooding of low—lying areas causing large financial losses for some farmers. Feldman (1974) reports that in November 1973 intense rains totalling up to 120 mm affected about 30 farmers in the Fitzgerald—Jacup district. Many crops were flattened and damaged by water. Some flats remained waterlogged for a few weeks following the rain. Other wet periods are reported to have occurred in October 1964, May 1966, May 1968 and November 1971.

Landform, Geology and Soils

The topographic relief is subdued, and landscapes are flat to gently undulating, with long slopes of a low angle developed on granite bedrock.

On the upper slopes there are ancient plateau soils consisting of deep yellow sands or yellow sand underlain by pisolitic laterite. On the middle slopes yellow earths are formed upon deeply weathered granite. Proceeding downslope the soil changes progressively from yellow to red in colour, acid to alkaline in reaction and from coarse to fine in texture. Salt lakes with associated lunettes may be found in the lowest parts of the landscape (Beard, 1976).

Northcote et al (1967) describes the soils in the southern area around Fitzgerald as hard setting loamy soils with mottled yellow or red clayey subsoils (Dy3.82, Dr2.43). In the Lake Magenta area to the north—east, the soils are described as calcareous and siliceous loamy soils of minimal development (Uml). Over the remainder of the area, the soils are mapped as hard and sandy alkaline yellow and yellow mottled soils (Dy) with lesser areas of Dg and Dr5.43 soils.

Topography and Drainage

Figure 2 is a topographic contour map of land adjoining the Mallee Road. A major drainage divide known as the Jarrahwood Axis (Laws, 1982) traverses the lower portion of this map. North of the divide, drainage is internal with lon9 palaeo—drainages and saltlakes such as Lake Magenta forming broad flat—floored valleys. South of the divide, drainage becomes more steeply incised and flows to the south coast.

In the central section of the study area is a topographic feature which has been called the “Mallee Road Sump” catchment (Feldman, 1974) (see figure 3). It has a total area of about 15,600 ha, with surface gradients of around 1 in 1,000. The catchment does not appear to have a surface outlet, and there are

3 blocks (1643, 1660 and 1661) in particular that are subject to flooding and waterlogging (Feldman, 1974).

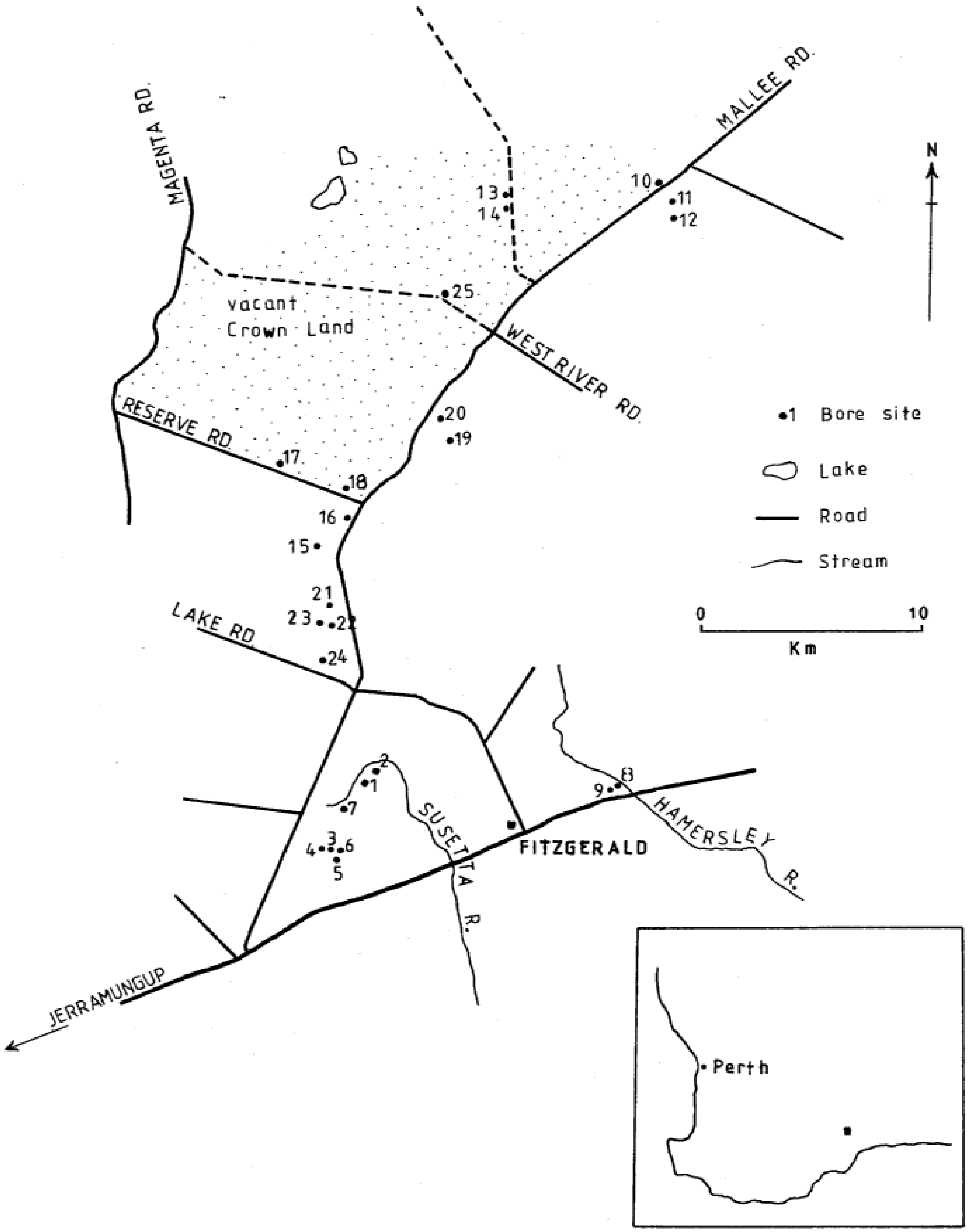

Figure 1 Location of drilling sites

(Inset shows location of study area)

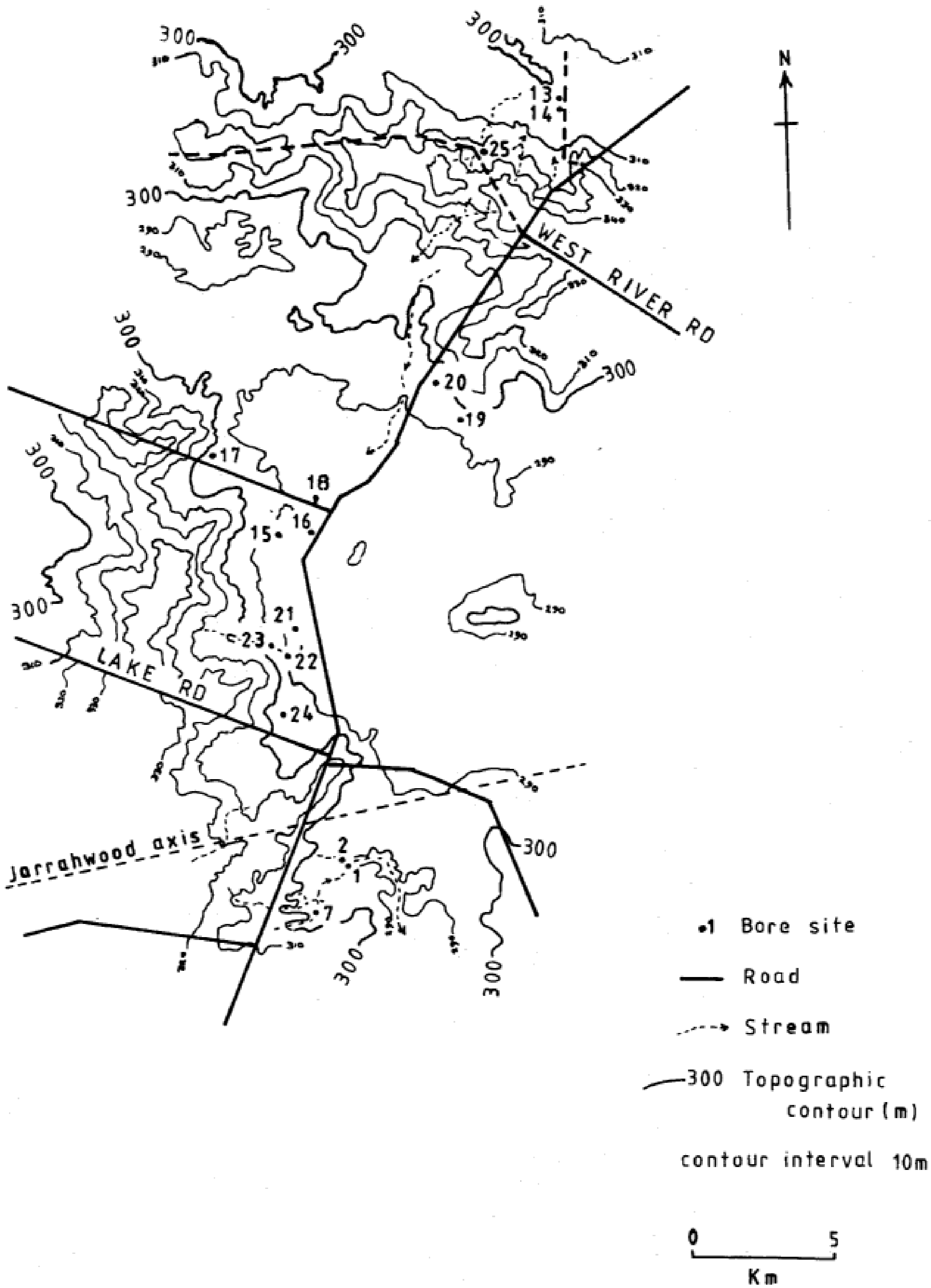

Figure 2 Topographic contour map of the Mallee Road area

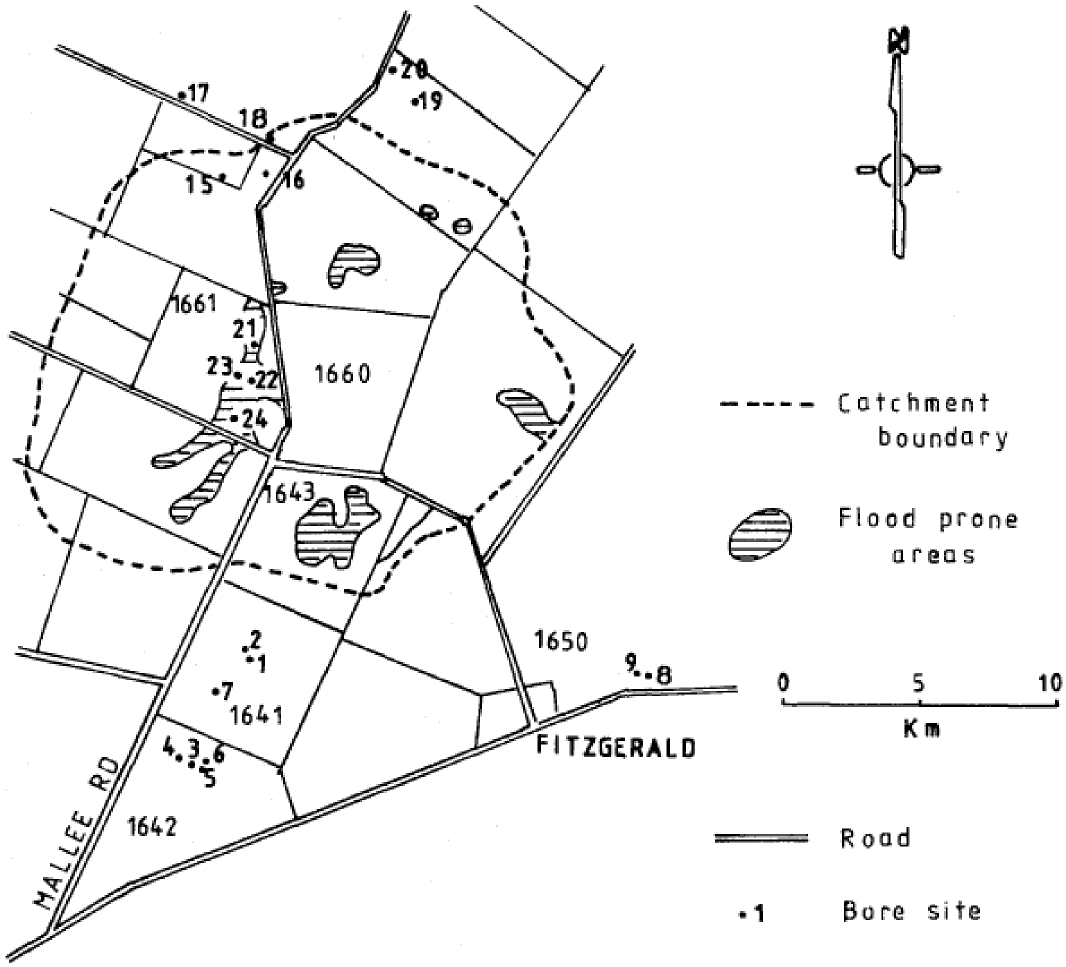

Figure 3 Map showing “Mallee Road Sump” catchment (after Feldman 1974)

Vegetation

The greater proportion of the area is occupied by mallee, with patches of mallee heath on the rises. Valley slopes, creeks, lakes and winter wet depressions bear patches of eucalyptus woodland which includes stands of E. occidentalis (flat—topped Yate) and E. salmonophloia (Salmon Gum).

Land Use

Blocks in the Mallee Road Sump catchment were released and taken up in the period 1962 to 1966. Clearing of land began in 1962 and by 1974, about 60 per cent of the total catchment had been cleared. Cropping occupied approximately 14 per cent and pasture 29 per cent of the total catchment in 1973/74. Of the remaining 40 per cent of uncleared land, 36 per cent was virgin bush, 1 per cent lakes and 3 per cent was regrowth and shelter belts (Feldman, 1974).

Results

Soils and Geology

Drilling logs for the 25 sites of investigation are given in Appendix I. Soils were generally found to consist of sands or sandy barns overlying sandy clays at depths of around 0.2 in. Deeply weathered kaolinitic clays of the pallid zone were encountered at most sites with granite bedrock being greater than 25 in depth in places. Drilling in the south—eastern sector of the vacant Crown Land area (sites 17 and 18) showed granite to be within 2.5 m of the ground—surface. Similarly, a test hole immediately to the west of site 20 in the Crown Land encountered bedrock at 2.4 m.

Profile Salt Storages

Soil samples were taken at four sites during drilling, to assess the amount of salt stored in the profiles. The data are shown in Appendix II and displayed graphically in figure 4. It should be noted that these profiles were derived from samples taken from a rotary drilling rig and therefore are not very precise.

Figure 4(a) shows the salt profile for site 25 located on vacant Crown Land. There is a total storage of 97 kgm^2 and a fairly uniform distribution with depth. Figure 4(b) is the profile at site 10, located on recently cleared land. It shows a step—wise increasing salt content with depth, i.e. 0.1% Cl from 1—7 m; 0.4% Cl from 9—18 m and 0.5% C1 from 20—22 m. There is 109 kgnr^2 of C1 stored in this profile. Figure 4(c) shows the profile at site 21 which has been cleared for 15 years. With 0.45% Cl at 2.5 m, there is a large storage of salt available for mobilisation by rising groundwaters. Site 24 (figure 4 (d))has been cleared for 17 years and shows a salt bulge from 9 to 15 m. There is 122 kgm'^{2} of C1 stored in this profile.

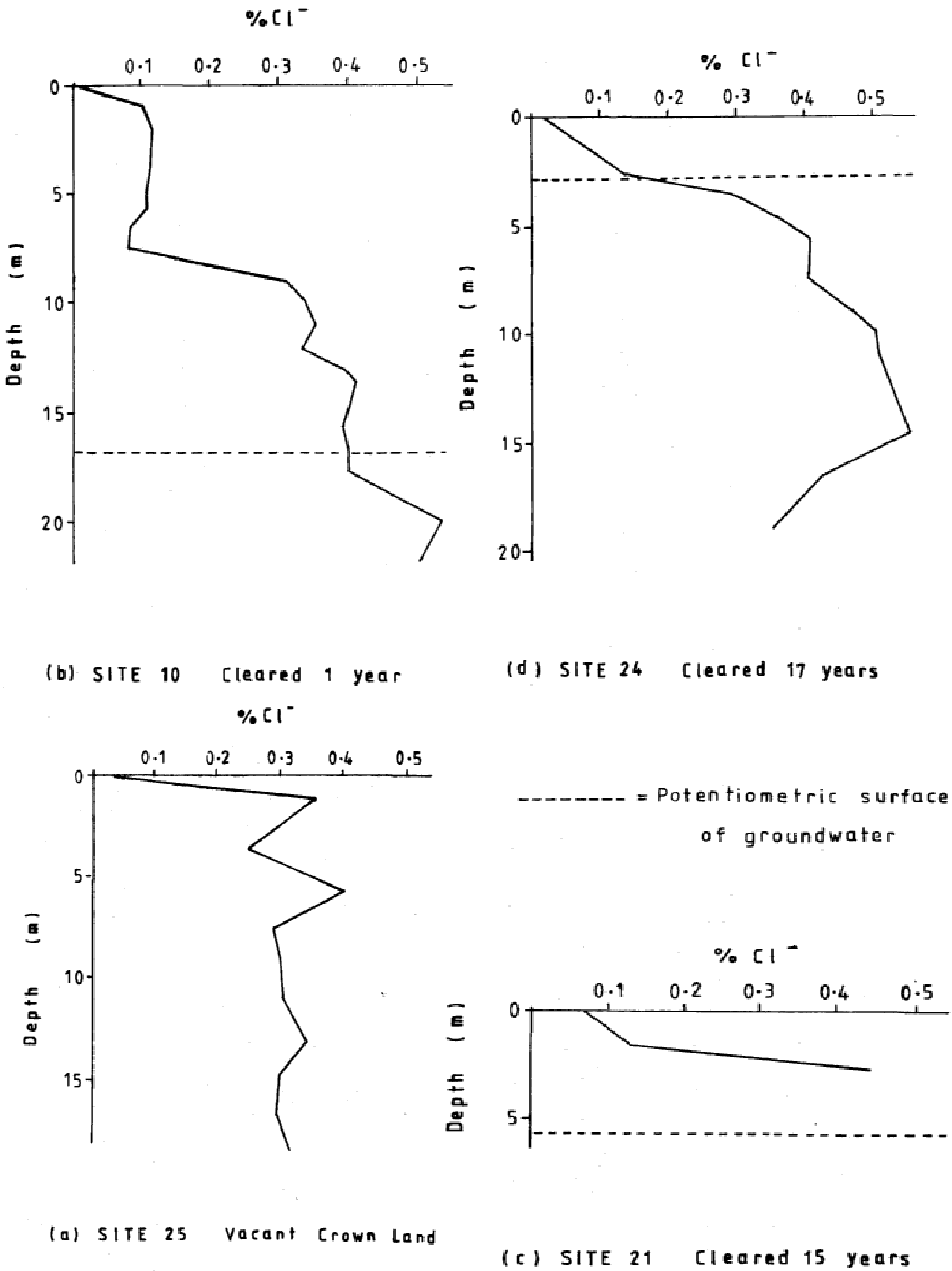

Figure 4 Soil salt profiles

Groundwater Hydrology

One of the aims of the drilling programme was to compare hydrological differences under cleared and virgin land, and to monitor groundwater changes after clearing of the native vegetation.

Table II shows the relationship between groundwater hydrology and clearing history for valley sites.

The data in Table II was plotted on a graph (see Figure 5). It shows that there is a significant ($p > 0.01$) correlation between clearing history and depth to groundwater. This suggests that groundwater is rising as a result of clearing, in this case at approximately $0.5 m/yr^{-1}$. Peck et al. (1979) concluded from studies conducted in the Darling Range, that after clearing of the native vegetation, 80 per cent of bores which intersected permanent aquifers showed increasing potentiometric head. In the 750 mm rainfall zone, water rose at rates of around 0.8 in per annum, while in the 1,100 mm rainfall zone the average rate of rise was 2 m per annum.

Perched Watertables

Perched watertables were observed at a number of valley sites in August 1981 and again in September 1982. It is assumed that these watertables are ephemeral, although no observations were carried out during the summer months.

Table II Groundwater Hydology and Clearing History

Clearing history	Site	Potentiometric surface BGL* (m)	Salinity (mgL^{-} Cl^{-})	Depth to bedrock (m)
Virgin Bush	13	6.9	25 000	>12
Virgin Bush	14	6.7	23 500	>12
Cleared 1 year	10	16.8	20 500	28
Cleared 2 years	16	1.9	20 500	> 6
Cleared 3 years	15	3.0	15 500	> 6
Cleared 5 years	11	15.0	22 000	>20
Cleared 10 years	20	10.2	19 000	>15
Cleared 14 years	21	2.7	16 539	> 6
Cleared 14 years	23	2.8	18 000	>10
Cleared 14 years	22	1.2	14 500	6.1
Cleared 15 years	1	0.1	6 000	6.1
Cleared 15 years	3	0.4	7 000	>10
Cleared 15 years	5	0.4	15 000	9
Cleared 15 years	7	0.1 Above GL	16 000	15
Cleared 15 years	8	0.2 Above GL	14 500	13
Cleared 17 years	24	3.0	17 000	>20

*BGL = Below Ground Level

At site 10, a perched watertable 0.75 in below the ground surface in August 1981, had a chloride content of 938 mgL^{-1}. The deep watertable was at 16.9 in and had a chloride content of 20 400 mgL^{-1}. At site 11, the salinity of the perched watertable increased from 11 263 $rngL^{-1}$ in 1981 to 22 357 mgL^{-1} in September 1982. The surrounding paddock has been cleared for about 5 years, and the deep watertable is 14.8 in below the ground surface. It has a salinity of 21 700 mgL^{-1}. Although the perched watertable is within 1.5m of the ground surface, salinity has not yet begun to appear at the soil surface. The paddock contains numerous waterlogged depressions during the winter. The relatively high salinity of the perched watertable is probably due to concentration by evaporation. As shown in figure 4a and 4b, near surface soils have an inherently high salt content (i.e. 0.36% Cl^- at 1.0m depth in native bush).

At site 22, a perched watertable at 0.2m has a chloride content of around 230 mgL^-. The potentiometric head of the deeper groundwater is 1.2m below the ground surface and its salinity is 14 600 mgL^- Cl^-. Similarly at site 23 the salinity of the shallow watertable at 0.5 m is around 1000 mgL^- Cl^-, while the deeper groundwater has a potentiometric head 2.8m below ground level and a salinity of around 19 000 mgL^- Cl^{-1}.

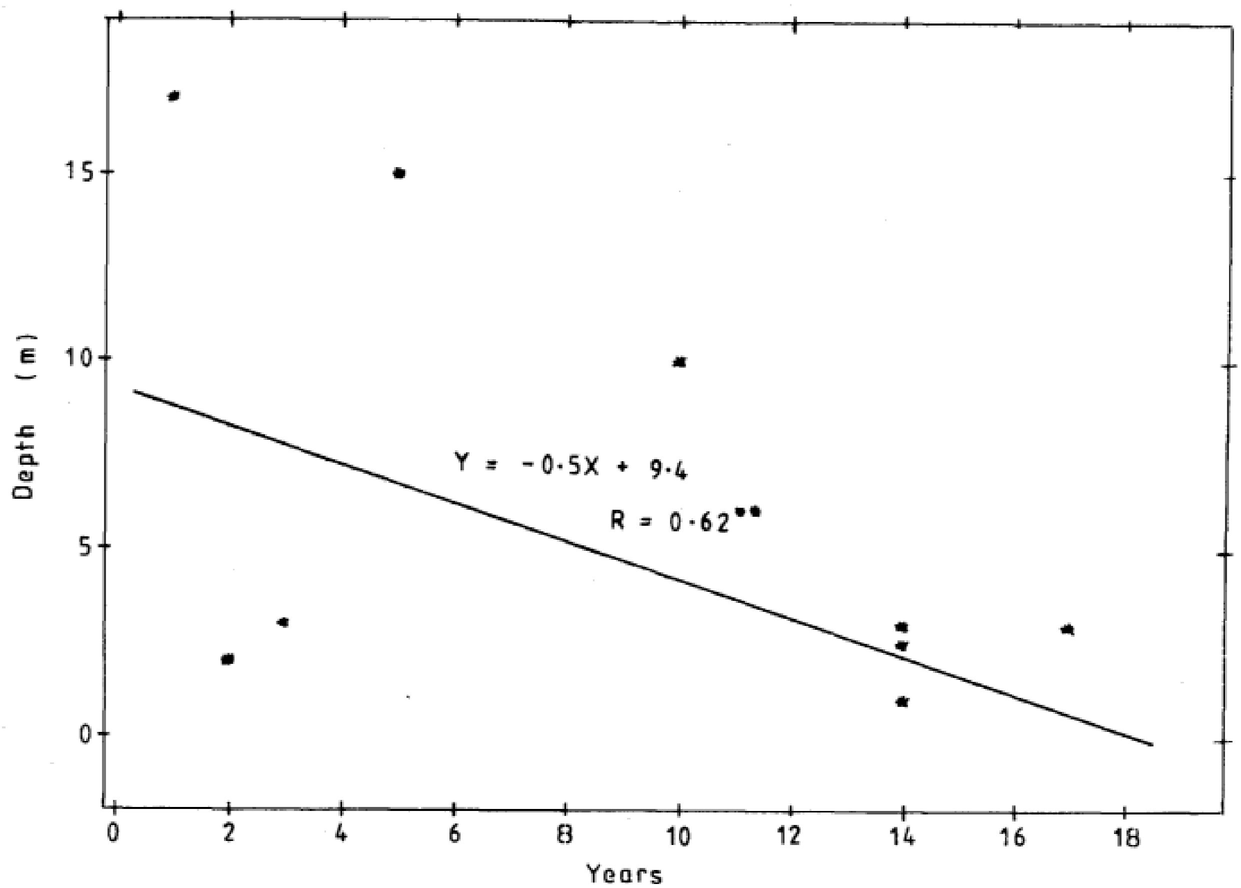

Figure 5 Graph showing depth to groundwater versus time after clearing

In each of the above cases, the direction of the hydraulic gradient is vertically downwards. It is possible then, that these perched watertables are acting as local recharge areas, and will lead to an increase of potentiometric head of the deeper groundwater. The perched watertables are relatively fresh or brackish at the present time. However, if and when the gradient reverses, (assuming sufficient hydraulic head from elevated recharge areas) inputs of salt from the groundwater, and concentration by evaporation could lead to a rapid increase in salinity of the shallow watertable. This is expected to happen in the near future at site 22, which has been cleared for 14 years.

Saline Encroachment

Figure 6 shows groundwater hydrographs for site 7 located in a rapidly expanding saline seep. The bores were drilled (see Appendix I for drilling log) in October 1979 when the seep had an area of approximately 5 m^2. By August 1981, the area had increased to almost 3 x lO^3 m^2. The trends of the bore hydrographs do not highlight this increase. Unfortunately only two or three readings of the bores were taken each year. It appears that the potentiometric head of the deep groundwater has not changed significantly over the three year period, indicating a delayed response in expression of soil salinity at the ground surface.

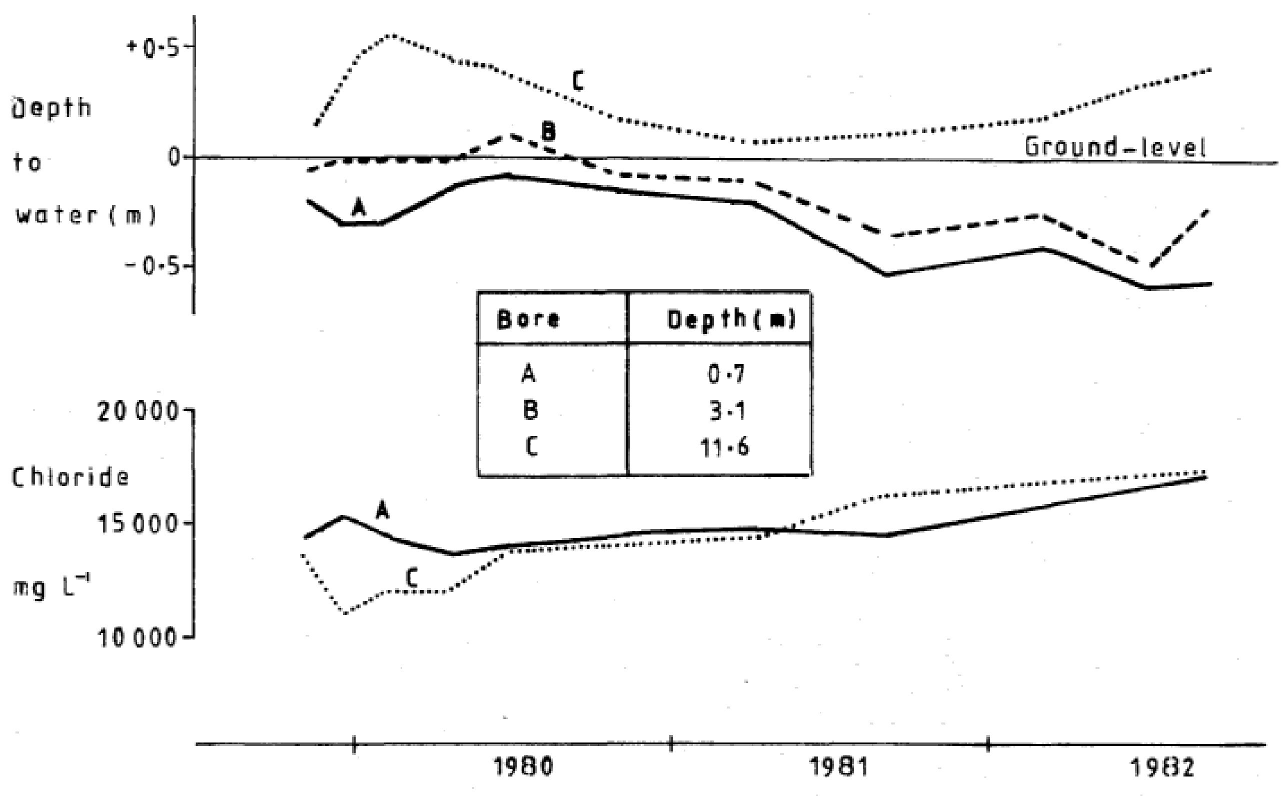

Figure 6 Hydrographs, site 7

Sites 1, 3, 5, 6 and 8 (Location NOS. 1641, 1642, 1650 — see fig. 3) occur on salt-affected land, in the headwaters of the Hamersley and Susetta Rivers. It is possible that these valleys were saline before the clearing of native vegetation. However, salinity appears to be continuing to encroach in these areas, for example at site 6 the saltland boundary moved 5 to 10m upslope in the period October 1979 to August 1981.

Piezometers installed in salt affected land show the semi—confined nature of the deeper groundwater. Potentiometric heads are above ground level at a number of sites, showing that an upwards gradient for flow exists. This situation is expected to develop in many of the recently cleared valley sites.

Conclusions

Drilling on saline land showed the presence of semi—confined aquifers with potentiometric surfaces near to, or above the ground surface. In the valleys of more recently cleared land seasonal brackish perched watertables were found to overlie deeper highly saline watertables. Highly saline watertables were found beneath virgin bush in low lying areas.

Borehole analysis showed that groundwater rises at 0.5m/yr^{-1} after clearing. In some recently cleared areas the depth to saline groundwater was already very shallow, i.e. 2 or 3 in.

In recently cleared valley floors, where perched watertables overlie deeper groundwater, the perched watertables could be acting as local recharge areas, adding to the deeper groundwater. Increases in potentiometric head resulting from recharge in upslope areas could eventually induce a reversal of hydraulic gradient in these valleys. A reversal of flow means there will be an injection of salt from the saline groundwater into the relatively fresh watertables. Concentration by evaporation would then produce an expression of salinity at the ground surface.

Hence the potential exists for development of secondary salinity in the Mallee Road sump catchment and other cleared catchments to the north. The aerial extent of salinity development is uncertain, but it is expected that salinity will manifest itself as isolated pockets in small depressions at the base of slopes, rather than extending out and engulfing whole valleys.

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Appendices

Appendix 1 - drilling logs

Site 1 – saline gully, north of farm-house

Depth (m)	Profile description
0.0—0.5	Grey moist sand
0.5—0.9	White wet clayey sand
0.9—1.8	White moist sandy clay
1.8—2.1	Yellowish mottled coarse sandy clay
2.1—2.6	Red coarse sandy clay
2.6—2.9	White fine sandy clay
2.9—3.2	Orange smooth clay
3.2—3.7	Orange wet fine clayey sand
3.7—4.6	Yellow wet clayey sand
4.6—6.1	Weathered granite
6.1	Bedrock

Site 2 — upslope from site 1 in wheat crop

0.0 —0.2	Brown sand
0.2—0.5	Cream sandy clay
0.5—1.8	Orange mottled sandy clay
1.8—2.7	Red moist gritty clay
2.7—4.6	Orange smooth clay
4.6—7	Brown coarse wet gritty clay
7	Hole terminated in white gritty kaolinite

Site 3 — saline valley, south of house

0.0 —0.5	Grey moist sand
0.5—0.9	Orange gritty clay
0.9—3.7	White sandy kaolinite
3.7—7	White wet quartz—kaolinite
7	Hole terminated

Site 4 — higher up valley in clover pasture

0.0 —0.5	Cream gritty sand
0.5—0.9	Yellow gritty clay
0.9—6.4	Cream and grey—brown quartz—kaolinite
6.4—9.1	White wet gritty weathered granite
9.1	Close to bedrock

Depth (m)	Profile description

Site 5 — saline valley

0.0 —0.5	Grey—cream moist coarse sand
0.5—2.7	Cream and orange moist quartz—kaolinite
2.7—4.6	Grey smooth clay
4.6—7.3	Brown silty clay
7.3—9	Brown wet gritty clay
9	Bedrock

Site 6 — upslope of site 5 in rye grass (slightly salt affected land)

0.0—0.5	Brown coarse sand
0.5—0.9	Mottled orange moist clay
0.9—5.5	Cream gritty moist kaolinite
5.5—9.0	White gritty wet kaolinite
9	Hole terminated

Site 7 — small salt scald appearing in wheat crop in a poorly defined drainage line

0.0— 0.2	White moist sand
0.2— 0.9	Mottled orange—greenish sandy clay with iron stone gravel
0.9— 3.7	Orange and bluey—grey gritty clay
3.7— 9.1	Brownish—white quartz—kaolinite
9.1—12.8	White wet quartz—kaolinite
12.8—13.7	Weathered rock
13.7	Hole terminated in clear quartz and white feldspar grit

Site 8 — saline valley

0.0 —1.0	Grey and pink mottled tight sandy clay
1.0—7.3	Brown and white gritty kaolinite
7.3—10	Grey wet gritty kaolinite
10	Close to bedrock

Site 9 — upslope of site 8

0.0—0.2	Grey coarse sand
0.2—0.9	Orange sandy clay with quartz gravel
0.9—1.8	Mottled red quartz—kaolinite
1.8—4.5	White dry quartz—kaolinite
4.5—4.9	Orange weathered granite
4.9	Granite rock

Depth (m)	Profile description
Site 10 — non—saline valley (boundary of uncleared and recently cleared land)	
0.0 —0.3	Cream to grey loamy sand
0.3— 0.5	Grey wet coarse sand
0.5— 1.8	Orange—yellow sandy clay
1.8— 2.8	Orange—greenish dry sandy clay loam
2.8— 9.0	Grey sand clay loam
9.0—16.0	Greenish—grey sandy kaolinite
16.0—21.0	Cream silty kaolinite
21.0—23.0	Yellow gritty kaolinite
23.0—25.0	Khaki wet coarse sandy and gritty clay
25	Fairly close to bedrock
Site 11 — non—saline waterway in recently cleared land	
0.0 — 0.3	Grey—brown loamy sand
0.3—3—1.5	Grey sandy clay; limestone pebbles at 0.6 m
1.5— 3.6	Orange—red mottled sandy clay
3.6—15.5	White sandy kaolinite
15.5—18.0	Grey moist sandy kaolinite
18.0—19.2	White gritty wet sandy kaolinite
19,2	Hole terminated
Site 12 — middle slope of hillside	
0.0 —0.3	Brown gravelly sandy loam
0.3— 0.6	Orange sandy clay
0.6— 4.5	Mottled sandy clay
4.5— 18.5	Cream sandy kaolinite
18.5	Hole terminated in white most gritty kaolinite
Site 13 — uncleared valley (vacant Crown Land)	
0.0—0.2	Brown sand
0.2—2.4	Grey—brown sandy clay
2.4—3.5	Red—brown sandy clay
3.5—6.5	White quartz kaolinite
6.5—12	Brown gritty moist sandy kaolinite
12	Hole terminated
Site 14 — 300m south of site 13	
0.0—0.3	Yellow—grey sand
0.3—2.7	Grey—brown sandy clay
2.7—5.5	Red—brown sandy clay
5.5—11.0	Brown gritty clay
11—12	White wet sandy clay

Depth (m)	Profile description
12	Hole terminated

Depth (m)	Profile description

Site 15 — 300m northwest of farm—house

0.0—0.5	Grey sand
0.5—5.5	Grey moist sandy clay
5.5—6.4	Yellow wet clay
6.4	Hole terminated

Site 16 — recently cleared paddock

0.0—0.5	Grey sand
0.5—3.5	Yellow sandy clay
3.5—6.4	White sandy kaolinite
6.4	Hole terminated

Site 17 — uncleared valley (vacant Crown Land)

0.0—0.3	Brown sand
0.3—3.0	Grey sandy clay
3.0—4.2	Red—brown sandy clay
4.2—8	Yellowish gritty sandy clay
8	Drill unable to penetrate further

Site 18 — native scrub (vacant Crown Land)

0.0—0.5	Orange brown coarse sandy clay
0.5—2.5	Reddish brown sandy clay
2.5	Granite rock

Site 19 — upper slope. Paddock cleared for 10 years but adjoining paddocks only cleared for 5 years and 1 year

0.0— 0.3	Grey sand
0.3— 3.0	Yellow grey sandy clay
3.0— 9.0	Brown gritty sandy clay
9.0—13.7	Pink moist sandy clay
13.7	Hole terminated

Site 20 — lower slope, non—saline drainage line. Paddock cleared for 10 years, but adjoining area cleared 2—3 years

0.0—0.3	Grey sand
0.3—4.5	Grey sandy clay
4.5—11.0	Brown sandy clay
11.0—13.7	Grey gritty sandy clay
13.7	Hole terminated

Depth (m)	Profile description

Site 21 — non saline depression, subject to flooding. Paddock cleared in 1966

0.0—0.2	Grey sandy loam
0.2—1.5	Orangy—greenish coarse sandy clay
1.5—1.9	Red sandy clay
1.9—2.1	Cream clayey sand
2.1—2.4	Red sandy clay
2.4—2.7	Orangy—brown sandy clay loam
2.7—6.2	Cream—brown wet coarse sandy clay

Site 22 — non saline depression at the convergence of two streams —swamp nearby

0.0—2.4	Grey wet coarse gritty sand
2.4—2.8	Red—brown wet pebbly sandy clay
2.8—5.5	Brown wet coarse sandy clay
5.5—6.1	Yellowy—brown gritty clay
6.1	Granite rock

Site 23 — non saline valley upstream from site 22

0.0—0.3	Grey sandy loam
0.3—0.9	Grey wet sand
0.9—1.2	Cream wet gritty sandy clay loam
1.2—1.9	Reddish—brown wet clayey sand
1.9—9.1	White moist gritty sandy kaolinite
9.1	Hole terminated in pink wet gritty kaolinite

Site 24 — broad non saline flat, west of farm—house. Paddock cleared in 1964

0.0—0.3	Grey sand
0.3—2.8	Mottled brown sandy clay
2.8—12.0	White to pink to brown sandy kaolinite
12.0—19.2	Grey moist sandy clay
19.2	Hole terminated in grey wet sandy clay

Site 25 — non saline gully, West River Road (vacant Crown Land) —Blue Mallets and Mallee scrub

0.0— 0.6	Grey sandy loam
0.6 —1.2	Mottled greeny—grey kaolinite
1.2—3.7	Pinkish gritty kaolinite
3.7—16.5	Cream to white gritty kaolinite
16.5—20.1	Grey sandy clay
20.1	Hole terminated because of difficult drilling

Appendix ii - profile salt storages

Site 10

Depth (m)	Soil texture	% Cl^-
0	LS	0.006
1.0	SC	0.10
2.0	SCL	0.12
3.0	SC	0.24
3.7	SCL	0.12
4.5	SCL	0.12
5.5	SCL	0.12
6.5	SCL	0.08
7.3	SCL	0.08
9.0	C	0.32
10.0	SC	0.34
11.0	SC	0.36
12.0	SC	0.34
13.0	SC	0.39
13.7	SC	0.42
14.5	SC	0.41
15.5	SC	0.39
16.5	SC	0.40
17.5	C	0.41
19.0	SC	0.10
20.0	SC	0.54
22.0	SC	0.51

The total amount of chloride stored in this profile is 109 kgm^{-2}*

Site 21

0	SL	0.07
1.5	SC	0.13
2.5	SCL	0.45

The total amount of chloride stored in this profile is 11 kgm^{-2}

Depth (m)	Soil texture	% Cl^-
Site 24		
0	5	0.02
2.0	SC	0.11
2.7	SC	0.14
3.5	SC	0.29
4.5	SC	0.36
5.5	SC	0.41
7.3	SC	0.41
9.0	SC	0.47
10.0	SC	0.50
11.0	SC	0.51
13.0	SC	0.36
14.5	SC	0.55
16.5	SC	0.43
19.0	SC	0.35

The total amount of chloride, stored in this profile is 122 kgm^{-2}

Depth (m)	Soil texture	% Cl^-
Site 25		
1.0	SC	0.36
3.5	SC	0.25
5.5	SC	0.40
7.3	SC	0.28
9.0	SC	0.30
11.0	SC	0.31
13.0	SC	0.34
14.5	SC	0.30
16.5	SC	0.29
18.3	SC	0.33

The total amount of chloride stored in this profile is 97 kgm^{-2}

***** The profile bulk density was assumed to be 1,700 kg m^{-3} for these calculations

Appendix iii - bore hole data

Bore No.	Depth (m)	Screen length (m)	Depth to water below ground level (m) 27.8.81	21.9.82	$C1^-$(mgl^{-1}) 27.8.81	21.9.82
1A	0.57	0.57	0.46	0.37	19,715	24,078
1B	2.09	0.89	0.19	0.00	9,342	9,276
1C	5.92	1.83	0.12	0.10AGL*	5,702	5,979
2A	0.77	0.77	0.51	Mud	8,282	-
2B	2.31	0.97	1.09	1.38	17,743	18,260
2C	5.99	1.83	1.20	1.28	19,967	20,536
3A	1.00	1.00	0.55	—	6,919	—
3C	6.57	1.50	0.39	0.34	7,196	10,015
4A	1.06	1.06	Dry	Dry	—	—
4C	8.35	1.43	1.81	1.80	12,398	14,796
5A	0.96	0.96	0.49	0.46	16,589	21,959
5B	2.92	1.00	0.40	0.32	16,690	23,369
SC	9.53	1.38	0.43	0.24	15,428	22,560
6A	2.84	2.84	0.65	0.50	10,706	8,964
6C	7.77	1.95	0.61	0.41	8,585	12,220
7A	0.89	0.89	0.52	0.54	14,862	16,794
7B	3.25	1.00	0.34	0.21	15,873	17,046
7C	11.94	2.00	0.11 AGL	0.42AGL	16,277	16,996
8A	0.94	0.94	0.21	0.24	19,948	54,832
8B	2.87	1.00	0.02 AGL	0.21AGL	18,609	25,747
8C	10.51	2.00	0.21 AGL	0.41AGL	14,670	21,750
9A	0.67	0.67	Dry	Dry	—	—
9C	4.16	1.94	3.09	3.20	8,560	10,481
1OA	2.09	2.09	0.75	Dry	938	—
1OC	21.13	2.00	16.86	16.52	20,422	19,879
11A	2.45	2.45	1.42	2.38	11,263	22,357
11C	18.60	2.00	15.02	14.80	21,736	23,016
12C	17.21	2.00	Dry	Dry	—	—
13C	13.25	2.00	6.92	6.95	24,972	24,381
14C	9.50	2.00	6.65	6.74	23,404	24,128

Bore No.	Depth (m)	Screen length (m)	Depth to water below ground level (m) 27.8.81	21.9.82	C1$^-$(mgl^{-1}) 27.8.81	21.9.82
15C	3.16	2.00	3.09	2.29	15,570	21,802
L6C	4.97	2.00	1.92	2.24	20,523	20,233
17A	1.41	1.41	Dry	Dry	—	—
18A	1.91	1.91	Dry	1.91	—	—
19C	12.13	2.00	8.09	8.08	20,574	22,155
20C	12.01	2.00	10.22	9.74	18,911	20,335
21A	2.32	2.32	Dry	1.10	—	1,649
21C	5.87	1.65	2.70	2.49	—	28,832
22A	0.65	O.65	0.22	0.30	237	223
22C	5.05	2.00	1.22	1.28	14,609	—
23A	0.77	0.77	0.50	0.58	866	1,790
23C	7.92	2.00	2.84	2.79	18,248	19,474
24C	18.91	2.00	3.05	2.44	16,883	16,946
25C	18.72	2.00	Dry	Dry	—	—

*AGL = Above Ground Level