Research Project Series

Investigation of soils and groundwater in the Campaspe irrigation district

By

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To all of these people, the author extends his sincere thanks.

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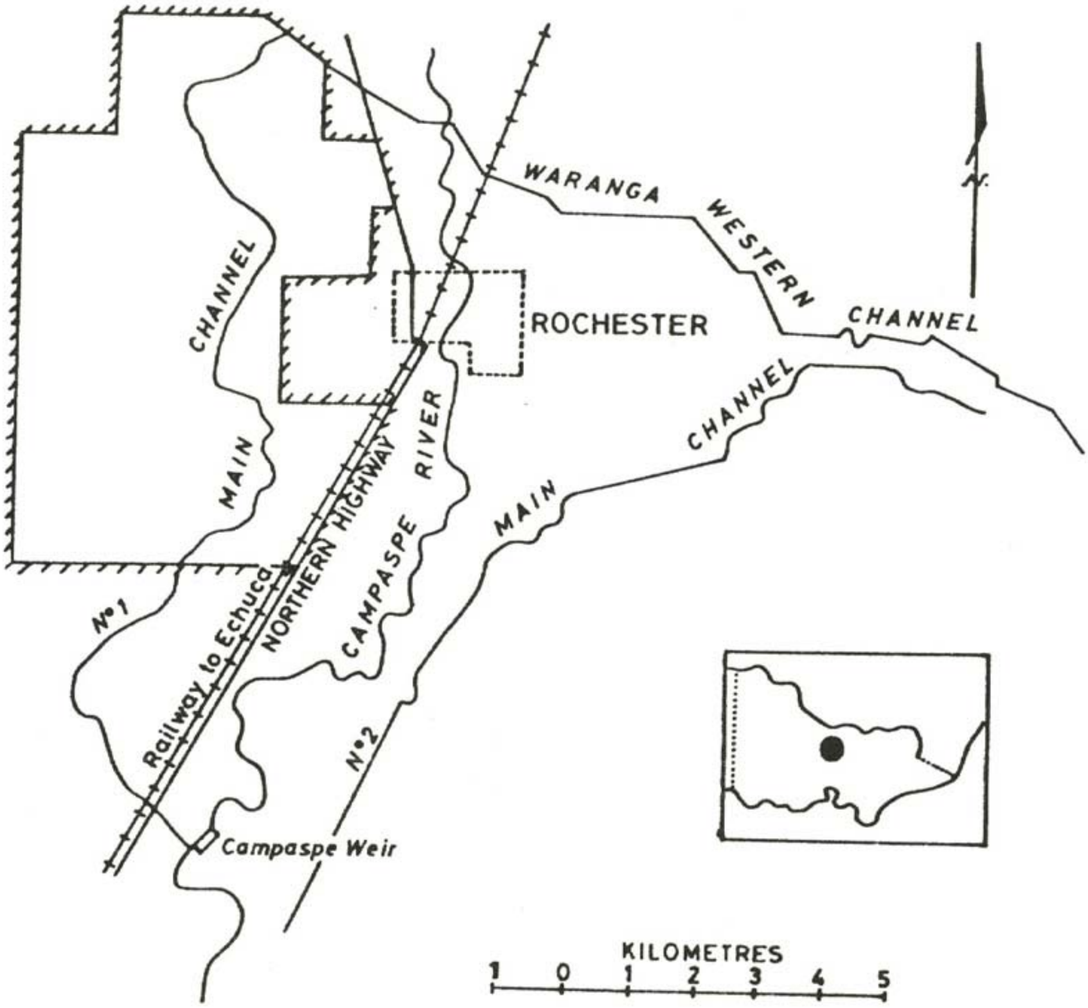

1. INTRODUCTION

The report is concerned with an investigation of selected soils and groundwater in the Campaspe Irrigation District. This investigation was carried out by the Victorian Department of Agriculture at the request of the State Rivers and Water Supply Commission of Victoria. Additional work was carried out by the author at his discretion to further elucidate the problem of pasture deterioration in the area. This additional work included observations on pasture growth and groundwater sodium absorption ratio (SAR) determinations.

The main area considered in this investigation is the recent sub-division by the Rural Finance and Settlement Commission, and some adjacent areas within the district. The total area covered by this report is 3624 ha and is bounded on the north by the Western main channel, on the east and south by rising ground and the west by a line determined by the limit of availability of supply, (see history of irrigation in the Campaspe Irrigation District, Appendix I). The area is part of the Parish of Rochester West, County of Bendigo.

For general information the section concerning the relationship between landscape and soil types is taken from Technical Bulletin No. 17, Department of Agriculture, Victoria and is included as Appendix II.

2. AIMS

The aims of the investigation as requested by the State Rivers and Water Supply Commission were to determine:-

(a) Soil Parameters

- (i) Current levels of salinity for the 0-30 cm and 90-120 cm layers as well as additional profile layers at most sites.
- (ii) The rate of salinisation for some of these sites by comparison of salinities with those of the 1959-62 survey (Technical Bulletin No. 17).
- (iii) Sodicity levels.
- (iv) Hydraulic conductivities.

(b) Groundwater Parameters

- (i) Salinity levels.
- (ii) Sodium adsorption ratios.
- (iii) Groundwater levels.

(c) Pasture Growth

3. GENERAL METHODS AND PROCEDURES

(a) Site Selection

Sites were selected within the main soil type map units and were representative of topographic situation, crop cover and land use to allow for sensible extrapolation of results to similar soils elsewhere in the irrigation areas. These sites were located for the purposes of comparison, as close as possible, to sites of the 1962 survey. The location of all sites used in the investigation is shown in Figure 2.

(b) Soil Analytical Methods

(i) Salinity was determined as Electrical Conductivity (µS/cm) and as NaCl (5) by calculation (Cl value x 1.65). These determinations were made on the 0-30 cm and the 90-120 cm depth samples for 315 sites, "“sites marked 15/3-15/5, 15/7-15/10, 15/13, 15/20-15/36, 16/1-15/25, 17/1-17/14 and 1-248” and on samples at the additional depths of 30-60 cm and 60-90 cm for 288 of the sites. Map unit classes from I to VI were used to illustrate areal distribution. The data are presented in tables for soil type profiles in Appendix III.

(ii) The comparison of salinity levels, in 1962 and 1979-80, in terms of NaCl%, is presented as a table 3.

(iii) Sodicity is considered in terms of the level of exchangeable sodium percentage (EP), above a reference limit.

(iv) Hydraulic conductivity was measured using the auger hole method of Maasland and Haskew, (1958).

(c) Groundwater

Salinity was determined as electrical conductivity (µS/cm).

(d) Pasture Growth

Pasture growth at each of 67 sites was assessed subjectively and grouped into one of eight classes on the basis of vigour and ground cover.

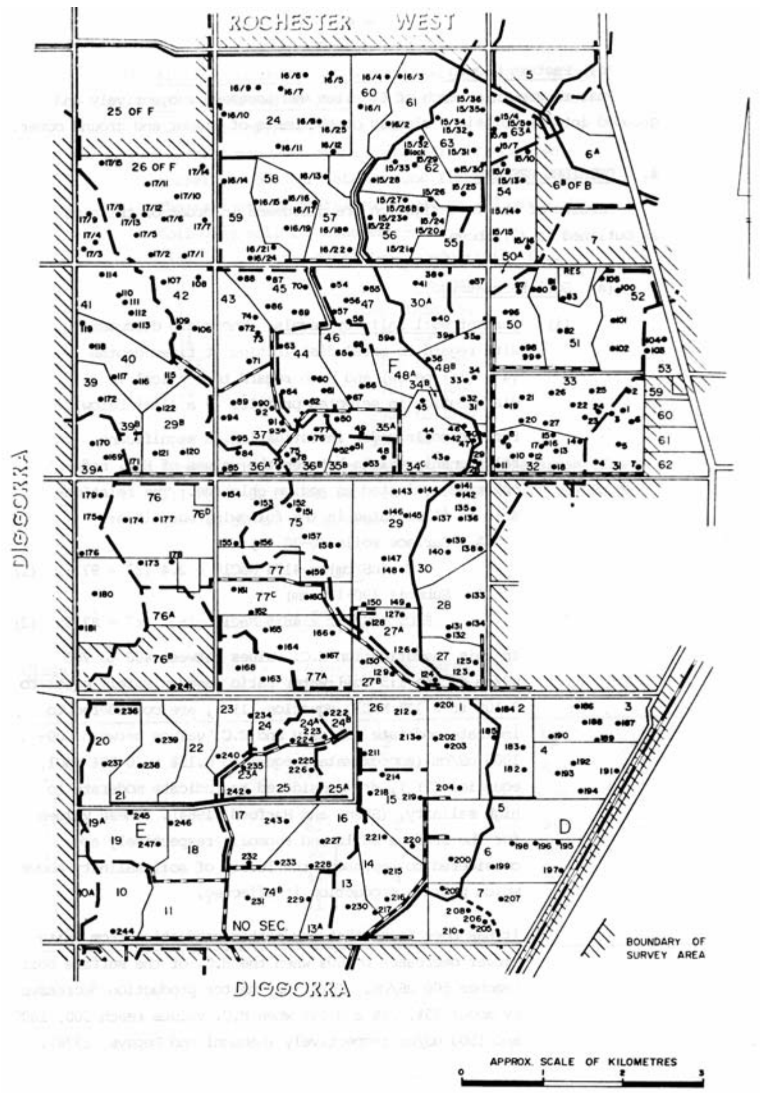

Figure 2 - Soil Sampling Sites

4. DETAILED RESULTS

Results of the investigation are discussed in order of the aims as outlined in (2) above.

(a) Soil Parameters

(i) ***Current soil salinity levels:*** These are discussed with regard to areal distribution at fixed depths (4 a (ii) below) and with regard to vertical distribution in selected profiles (4 a (iii) below).

For the soils under investigation, a significant relationship exists between the values of E.C. and chloride estimated as sodium chloride. The relationship is illustrated in the following equations:-

A. Surface soils (0-30 cm)
E.C. (µS/cm) = 4174 NaCl% – 2.4 (r^2 = 97.6) (1)

B. Subsoil (90-120 cm)
E.C. (µS/cm) = 4659 NaCl% + 15.7 (r^2 = 87.3) (2)

In this investigation E.C. values between 400 to 700 µS/cm in the 1:5 soil:water ratio (approximately equal to 0.10% to 0.17% NaCl, equation (1)), are considered to indicate moderate salinity and E.C. values between 700-1000 µS/cm (approximately equal to 0.15% to 0.50% NaCl, equation (2)), are considered to indicate moderate to high salinity, (Skene and Harford, 1964). These values for the surface soils and subsoils respectively are considered to represent the levels of soil salinity above which pasture production is affected.

It has been found that dry matter production from white clover decreases by 60% when the E.C. of the surface soil reaches 500 µS/cm. Total dry matter production decreases by about 15%, 37% and 59% when E.C. values reach 500, 1000 and 1500 µS/cm respectively (Mehanni and Repsys, 1978).

(ii) ***Areal distribution of salinity at the fixed depths of 0-30 cm and 90-120 cm:*** This is described using two salt maps, figures 3 and 4. The boundaries on the salt map were drawn using salinity figures, aerial photo interpretation and field observations. The salt status of the soils was mapped using the following salinity classes:-

Class	Electrical Conductivity (E.C.) (µS/cm)
I	Less than 150
II	150 to 400
III	401 to 700
IV	701 to 1000
V	1001 to 1500
VI	1501 to 2000

Accordingly, table 1 shows that the saline areas (Class III for 0-30 cm and Classes IV, V and VI for 90-120 cm) are 17% of the total area.

Table 1 - Extent of “Salt” Classes

Class	Area			
	0 – 30 cm depth		90 – 120 cm depth	
	ha	%	ha	%
I	2792	74	508	14
II	746	21	2079	57
III	63	2	519	14
IV	56		281	8
V	46	3	204	6
VI	11		33	1

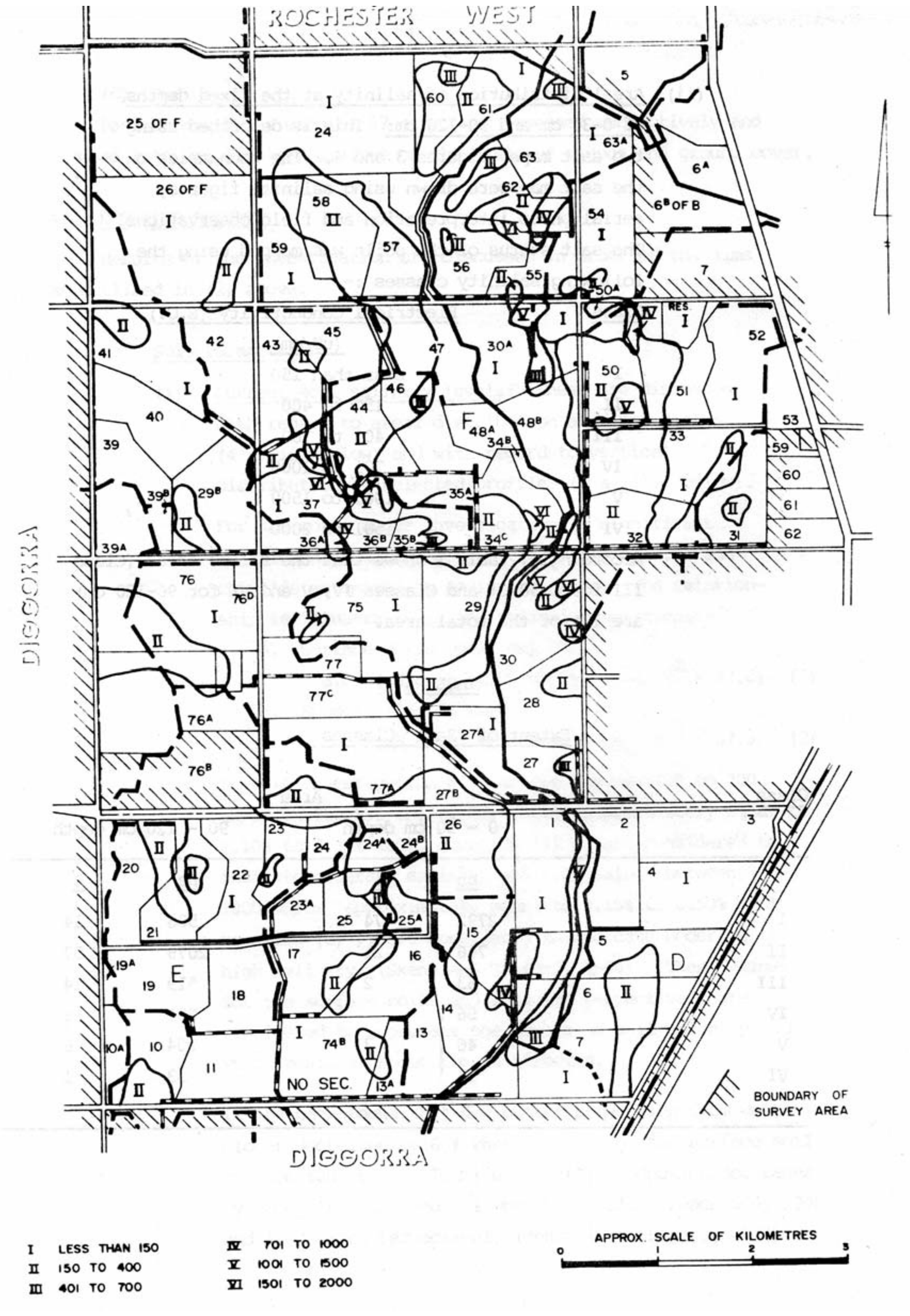

Figure 3 - Electrical Conductivities of 1:5 Extracts of Soil 0 to 30 Cm in Depth, in µs/cm

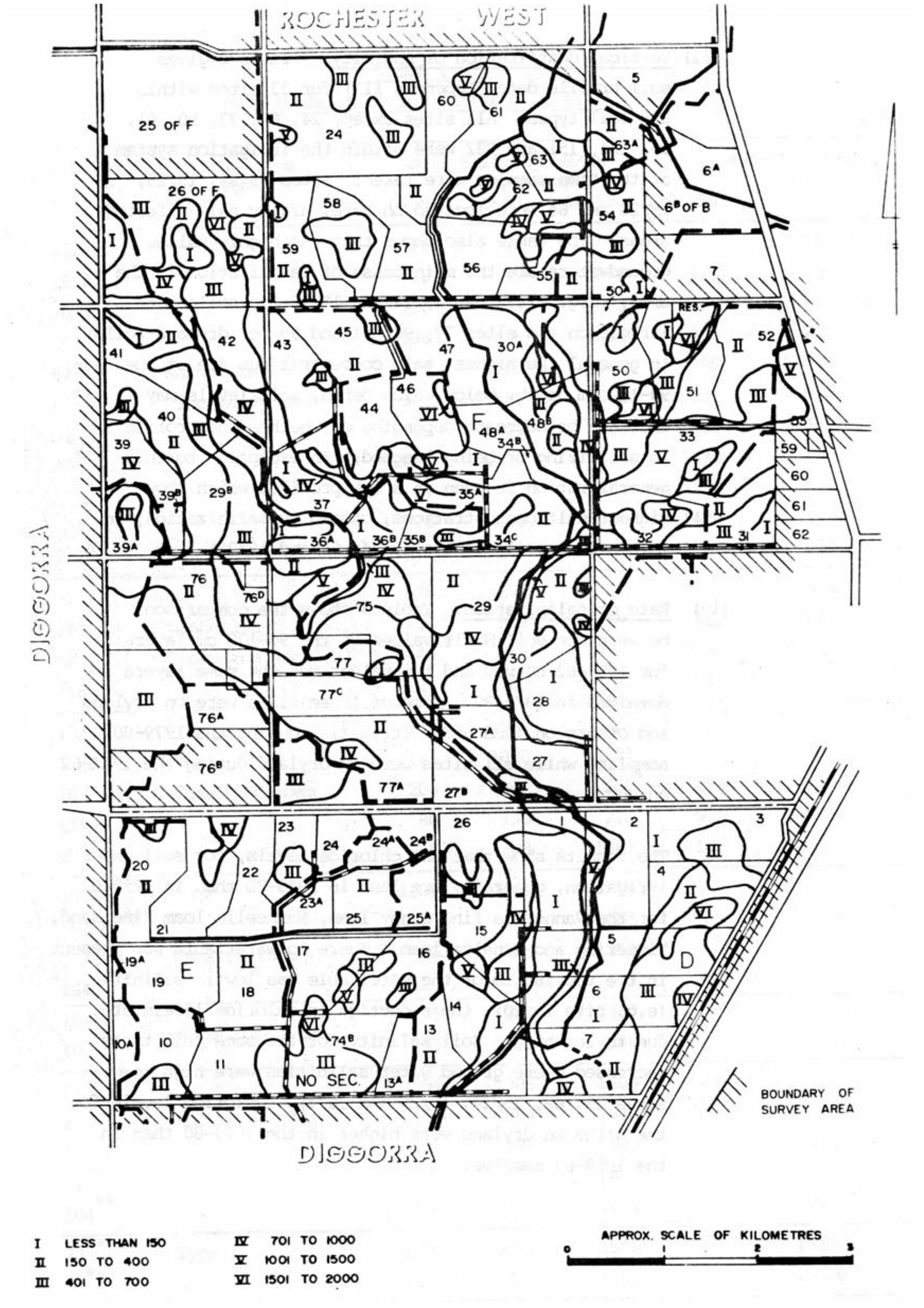

Figure 4 - Electrical Conductivities of 1:5 extracts of Soil 90 to 120cm in Depths, in µs/cm

(iii) ***Vertical distribution of salinity:*** Table 2 gives soil profile data (Appendix III) for 33 sites within six soil types. All sites except 24, 67, 77, 90, 91, 99, 104, 151 and 232 were within the irrigation system at the time samples were taken. Sites 15/24, 15/25, 15/26 and 64 were located on bare, highly salt affected areas. The table also shows that the highly saline groundwaters are the main cause of salinisation in the area, (e.g. sites 64, 15/24 and 15/26 for soil under irrigation and sites 77, 90, 91 and 99 for dryland soils). In general the highest salt concentrations are at the 90-120 cm depth, below which depth, salt levels may increase or decrease depending on whether the profile is salinising or being leached. An exception to this generalisation is seen in a few profiles which show highest salt concentrations, caused by salinisation, in the surface soils (sites 15/24, 64 and 15/26).

(iv) ***Rate of salinisation:*** Table 3 shows the comparison between the soil NaCl% values of the 90-120 cm layers for 1959-62 survey and the values for the same layers obtained in 1979-80. Some of these sites were on dryland and others on land under irrigation during the 1979-80 sampling while all sites were on dryland during the 1959-62 survey.

The results show that the chloride levels, for soil under irrigation, generally are less in 1979-80 than in 1959-62 for the Nanneella fine sandy loam, Nanneella loam fine sand, Timmering and Wanalta loam. Where no watertable was present in the top 180 cm or the watertable was low in salinity (e.g. site 16/20), the reduction in chloride levels are due to leaching. Soil salinity for the same soil types increased where ground water salinities were high (e.g. sites 25, 68, 15/24, 15/25 and 16/4). Chloride levels for the sites on dryland were higher in the 1979-80 than in the 1959-62 samples.

Table 2 - Profile Salinity for Selected Sites*

Site No.	Soil Type Map Unit	Soil Salinity µS/cm Depth (cm)				Watertable E.C. µS/cm
		0-30	30-60	90-120	120-150	
16/6		26	49	91		910
16/8		26	47	575	575	N.W.****
16/15		190	585	693		
25		136	698	1054	908	16200
64***	Nanneella fine sandy loam	2120	1700	800	895	13890
67**		141	688	968	851	N.W.
91**		3080	1064	807	887	14300
99**		1077	1077	1580	1780	27400
151**		97	447	700	1360	N.W.
194		78	208	1700	1470	N.W.
232**		132	1040	1860	1940	1820
31		126	274	750	1220	N.W.
34	Nanneella loam fine sand	209	572	726	919	10400
68		440	717	1070	2030	33600
148		284	1002	991	840	
15/3		120	535	929		
15/25***		868	1020	1207		
16/17	Timmering loam	206	145	287	298	1156
119		80	150	215	920	N.W.
221		219	883	1067	862	N.W.
15/24***		1880	1400	1159		
15/26***		1960	836	863		15600
17/10	Wanalta loam	55	365	1570		
164		115	182	713	970	N.W.
16/10	Wana clay loam	75	292	1367		N.W.
49		157	570	1360		N.W.
1		94	306	1200		N.W.
2	Rochester clay	130	364	1040		N.W.
3		168	399	1500		N.W.
24**		72		1400		N.W.
104**		101	173	1072		N.W.

Site No.	Soil Type Map Unit	Soil Salinity µS/cm Depth (cm)				Watertable E.C. µS/cm
		0-30	30-60	90-120	120-150	
77**	Type 1	1295	2080	1500		19300
90**		1170	1373	1196		22400

* Appendix III contains data for all sites

** Dry land

*** Bare land within the irrigation area

**** N.W. indicates the absence of a watertable

Table 3 - Changes in Sodium Chloride "Chloride Expressed as Sodium Chloride" Levels of the 90-120 cm soil layer over the period 1959-1980

Soil Type Map Unit	Site No.	E.C. of Watertable µS.cm 1979	Cl as NaCl% for the 90-120 cm soil layer		
			1959-62 Survey	1979-1980	
				Dry land	Land under Irrigation
	15/4	*-	.020	.030	
	15/7	-	.090	.120	
	15/16	-	.020		.010
	15/20	-	N.A.		.030
	15/21	-	.010		.020
	15/28	-	.010		.010
	15/11	-	.030		.030
	15/16	-	.020		.030
Nanneella	16/1	3,510	.140		.020
fine sandy	16/6	-	N.A.	.010	
loam	16/8	-	.020	.130	
	16/9	-	N.A.	.020	
	16/12	6,300	.020	.050	
	16/11	-	.010		.030
	16/15	-	.020		.160
	16/22	2,430	.015		.300
	16/25	14,000	N.A.		.080
	17/2	-	.129		.105
	17/3	-	.005	.140	
	17/4	-	.008	.145	
	17/6	-	.072		.010
	17/8	-	.111	.145	
	17/9	-	.011	.010	
	17/11	-	.100	.035	
	17/15	-	N.A.	.114	
	25	16,200			.239
	39	15,700	.007	.256	
	41	1,120	N.A.		.025
	93	2,540	.060		.040
	94	-	.013	.090	
	115	-	.055	.216	
	130	-	.135		.025
	161		.011	.022	
	182		.010		.003
	183	-	.037		.008
	185	7,530	.007	.226	
	190	1,860	.069		.015
	194	-	.016	.420	
	195	-	.096	.093	

Soil Type Map Unit	Site No.	E.C. of Watertable µS.cm 1979	Cl as NaCl% for the 90-120 cm soil layer		
			1959-62 Survey	1979-1980	
				Dry land	Land under Irrigation
Nanneella loam fine sand	27	-	.009	.317	
	28	-	N.A.	.130	
	37	-	.009	.060	
	68	33,600	.005		.596
	127	1,390	.235		.007
	148	-	.010		.254
Timmering loam	15/3	-	.170		.150
	15/23	-	.040		.070
	15/25	19,000	.100		.280
	15/29	-	.028		.010
	15/14	-	.113		.020
	15/15	-	.042		.020
	16/11	-	.020		.030
	16/17	-	.008		.040
	16/20	285	.170		.030
	16/21	61	.060		.030
	33	-	.133		.030
	52	3,020	N.A.		.035
	55	-	.019		.075
	113	-	.103		.041
	118	-	.040		.065
	120	-	.083	.101	
	191	-	.019		.040
Wanalta loam	15/9	-	.040	.230	
	15/10	-	.060		.020
	15/13	-	.080		.070
	15/14	-	.130		.140
	15/24	16,900	.019		.200
	15/26	15/600	.020		.100
	15/27	-	.030		.080
	15/30	-	.020		.050
	16/3	-	.190		.120
	16/4	16,300	.120		.290
	16/16	-	.070		.080
	16/19	-	.030		.110
	16/5	7,100	N.A.		.080
	16/6	910	N.A.		.010
	17/1	-	.040		.145
	17/2	-	.103	.265	
	17/10	-	.059	.250	
	7	-	.066		.015
	63	4,410	N.A.		.043
	143	-	.048		.038
	196	-	.133		.095
Wana clay loam	16/10	-	.088	.270	
	16/24	745	N.A.		.010
	16/4	-	.010		.010
	17/4	-	N.A.	.111	
Lockington sand	11	19,900	.027		.100
	15/32	-			
Rochester clay	159	-	.002	.002	
	6	-	.170		.030
Type 1h	197	-	.185	.210	
	156	-	N.A.		.107
Type 2	193	-	.009	.035	

N.A. Not Available

* Any watertable present is deeper than 180 cm.

(v) ***Soil sodicity***: In general, soil sodicity increased with depth for the selected sites. Forty of the 140 site were sodic (ESP more than 5, Mikhail, 1979) at the 0-30 cm depth while 66 of the 149 sites were sodic, (ESP between 5 and 10) or strongly sodic (ESP over 10) at the 90-120 cm depth.

The sodicity is related to the high sodium adsorption ratio (SAR) of the groundwater (see 4 (b) (ii)). Exchangeable cation data is given in Appendix IV.

(vi) ***Hydraulic Conductivity:*** Hydraulic conductivity was measured at 89 sites. These sites were distributed over the area and included the main soil types which are: Nanneella fine sandy loam, 38 sites; Nanneella loamy fine sand, 7 sites; Timmering loam, 18 sites; Wanalta loam, 16 sites; Wana clay loam, 4 sites; Type 1h, 3 sites; Type 1, 2 sites and Rochester clay, one site. Table 4 shows the range and means for the hydraulic conductivity for the main soil types. The results show that there is great variation in hydraulic conductivity within the same soil type. The results show that there is great variation in hydraulic conductivity within the same soil type. Surprisingly enough, the mean value for the hydraulic conductivity of Wanalta loam was higher than the mean values for the above soil types (0.96 m/day). The cause of this higher value was the considerable flow of water into the auger hole from a soil layer at about 80 to 100 cm depth.

Table 4 - Ranges and Means of the Hydraulic Conductivity (K) (m/day) for Selected Sites Under Investigation

	Nanneella fine sandy loam	**Nanneella loamy fine sand**	**Timmering loam**	**Wanalta loam**	**Wana clay loam**	**Type 1H**	**Type 1**
Range	0.12-2.14	.28-1.14	.04-1.94	0.03-3.26	0.10-0.24	0.75-1.86	0.18-0.34
Mean	0.85	0.65	0.44	0.96	0.18	1.14	0.26
No. of sites*	38	7	18	16	4	3	2

* Hydraulic conductivity for each site, Appendix V.

(b) Groundwater Parameters

(i) ***Salinity levels:*** Electrical conductivity values of the groundwater range from less than 300 to more than 33,000 µS/cm. This data is presented in Table 5 together with S.A.R. of the groundwater and E.C., E.S.P. and Ca/Mg ratios for the 90-120 cm soil layers. All sites except 16/6, 16/12, 16/25, 32, 38, 50, 77, 80, 83 and 185 were within areas under irrigation. Watertables in the dryland sites may have resulted from their proximity to irrigated land with high watertables, irrigation channels, shallow drains or farm dams.

The relationship between watertable salinity and soil salinity at the 90-120 cm depth is shown in the following regression equation:-

$$Ec_s = 59.6 + 0.058_w \qquad (100R^2 = 87)$$

Where Ec_s = Electrical conductivity of the soil layer at 90-120 cm.
Ec_w = Electrical conductivity of the groundwater.

The above equation suggests that for salinity levels of more than 6000 µS/cm in the groundwater, soil salinities in the 90-120 cm layer would be unfavourable for pasture growth.

(ii) Groundwater sodium adsorption ratio (S.A.R) values: Table 5 also shows the S.A.R values of the watertable. These values range between 1 and 29. In this investigation, the relationship between the S.A.R of the groundwater and the soil ESP is significant for the 90-120 cm soil layer and not significant for the 0-30 cm soil layer. The significant effect on the 90-120 cm soil layer is due to effective contact of this layer with groundwater resulting in sodium adsorption onto the clay matrix. The effect of the SAR of the groundwater on the ESP of the 0-30 cm soil layer depends on irrigation management and ground cover. Where the soil is under good irrigation management, with complete vegetation cover, continuous leaching will control salt movement up from the groundwater. The following regression equation shows this relationship.

$$ESP_s = 2.5 + 0.8\ SAR_w \qquad (100R^2 = 66)$$

Where ESP_s = Exchangeable sodium percentage of the soil at 90-120 cm depth.
SAR_w = Sodium adsorption ratio of the groundwater.

The above equation suggests that the maximum value of the SAR of the groundwater to maintain the soil ESP value for the 90-120 cm depth at 5 or less is 3.1. If a higher ESP, (6), value is allowed, then the allowable SAR value could be raised to 4.5. This maximum allowable SAR value is much lower than the value of 10 reported by Mikhail (1980) but the 3.1 figure is regarded as more accurate because of the larger number of samples and the wider range of soils in this investigation.

Table 5 - Salinities and Sodium Adsorption Ratios (SAR) of Watertables and Soil Salinities, Exchangeable Sodium Percentages (ESP) & Ca^{++}/Mg^{++} Ratios of the 90-120 cm Layers

Site No.	Depth (cm)	Watertable		Soil Layer (90-120 cm)		
		E.C. (μS/cm)	SAR	E.C. (μS/cm)	ESP	(Ca^{++}/Mg^{++})
15/24	67	16,900	25	1,159	17	0.6
15/25	27	19,100	29	1,381	20	0.6
15/26B	58	3,090	10	182		
16/1	38	3,510	8	109		
16/2	43	6,880	17	353		
16/4	22	16,300	21	1,297	22	0.4
16/5	57	7,100	27	484	12	0.4
16/6	59	910	4	91		
16/12	118	6,300	11	273	4	0.6
16/17	32	1,156	4	287	1	2.0
16/20	59	285	2	117	4	2.3
16/22	72	2,430	8	197		
16/24	63	745	6	174		
16/25	56	14,000	17	381	17	0.6
10	76	15,100	21	813	19	0.4
12	125	19,900	22	461	21	0.4
13	48	14,500	22	880	20	0.4
14	77	6,050	14	265	15	0.5
19	66	7,340	10	570	17	0.9
21	82	6,610	8	483	3	1.0
25	124	16,200	17	1,054	17	0.5
29	89	2,070	7	230	9	0.7
30	102	4,330	7	184	2	0.6
32	200	2,820	5	65	2	1.0
34	85	10,390	17	726	21	0.4
35	97	5,010	15	308	19	
38	100	14,890	16	788	23	0.5
39	90	15,700	21	1,127	13	0.6
41	85	1,120	4	112	2	4.5
42	62	1,480	3	157	3	1.6
43	80	3,810	5	265	4	0.6
44	112	6,360	9	492	10	0.6

Site No.	Depth (cm)	Watertable		Soil Layer (90-120 cm)		
		E.C. (µS/cm)	SAR	E.C. (µS/cm)	ESP	(Ca^{++}/Mg^{++})
50	146	19,400	12	1,450	8	0.7
52	109	3,020	10	258	9	0.7
54	61	7,050	10	408	13	0.5
55	59	6,250	15	400	12	0.8
56	97	1,930	3	173	2	1.0
58	87	3,030	7	234	9	0.9
60	101	3,810	8	245	7	0.5
62	90	21,300	12	1,270	10	0.5
63	65	4,410	10	225	13	0.5
64	54	13,890	12	806	13	1.0
65	76	5,910	11	364	13	0.6
66	67	3,990	11	214	14	0.7
68	86	33,600	20	2,070	16	0.4
72	37	4,580	12	268	16	0.7
73	35	2,170	8	704	14	0.7
76	33	5,900	7	370	6	0.7

TABLE 5 (continued)

Site No.	Depth (cm)	Watertable		Soil Layer (90-120 cm)		
		E.C. (µS/cm)	SAR	E.C. (µS/cm)	ESP	(Ca^{++}/Mg^{++})
77	102	19,300	13	1,500	16	0.4
78	112	2,100	5	150	4	0.6
79	59	2,230	5	210	6	2.4
80	99	5,190	14	385	16	0.6
83	135	33,500	14	1,930	15	0.4
84	95	2,250	8	118	13	0.8
87	82	3,570	9	201	11	0.8
90	106	22,400	14	1,460	15	0.4
93	83	2,540	3	151	11	1.0
96	54	1,700	4	167	6	0.9
97	40	1,950	3	68	6	1.1
98	85	10,060	12	691	16	0.6
99	99	27,400	21	1,580	10	0.4
106	85	7,370	12	472	16	0.6
123	51	14,700	14			
125	74	2,300	5	140	7	0.6
127	66	1,390	3	64	4	1.5
133	60	2,010	4	129		
134	84	1,800	4	135	3	1.5
135	61	6,010	10	477	10	0.5
136	78	2,260	5	253	5	1.0
138	85	14,500	11	780	11	0.8
139	50	2,380	6	81	6	1.3
140	85	6,250	10	242	12	0.3
141	87	5,980	10	485	14	0.7
149	75	1,670	4	180	6	1.4
152	100	4,360	12	458		
163	126	6,530	6	541	6	0.9
185	103	7,350	19	1,040	19	0.7
190	95	1,860	4	122	5	1.2
200	18	3,280	6	230	3	1.5
202	139	1,440	3	90	6	0.5
203	109	1,013	4	53		

Site No.	Depth (cm)	Watertable		Soil Layer (90-120 cm)		
		E.C. (µS/cm)	SAR	E.C. (µS/cm)	ESP	(Ca^{++}/Mg^{++})
205	108	1,440	3	192		
209	63	1,610	5	100	5	1.2
212	90	3,410	7	254	5	0.8
215	96	2,050	4	205	4	0.9
218	112	5,520	13	358	14	1.0
222	109	3,360	4	238	4	1.3
226	110	6,890	9	493	10	0.7
228	120	3,040	10	204	7	1.0

(iii) ***Groundwater levels:*** The investigation shows that the watertables at depths less than 2 m do not occur within the dryland with the exception of:-

(a) areas near the main irrigation channel, e.g. sites 16/6, 16/9 and 137,
(b) areas adjacent to irrigated land with shallow watertables, e.g. sites 16/12, 16/25 and,
(c) areas near shallow drainage channels, e.g. sites 91, 152, and 226.

However, table 5 shows watertables in the irrigated areas are as shallow as 22 cm, (sites 16/4). Shallow watertables were also found close to field dams, e.g. sites 15/15, 19, and 33.

In general, land which is under irrigation but adjacent to dryland (e.g. sites 16/14, 31, 170) or to the Commission's deep drains, (e.g. sites 95, 107, 109, 155) does not have watertables within 2 metres of the surface.

Table 6 shows that 153 sites (i.e. 48% of all sites) had watertables occurring before 2 metres. Eighty-two percent of these sites had watertables occurring at depths less than 120 cm from the soil surface.

Table 6 - Groundwater Level

Depth to Watertable cm	No. of Sites	%
Less than 60	26	19
61 to 90	53	35
91 to 120	44	28
121 to 150	17	11
151 to 180	4	3
181 to 200	6	4
TOTAL:	153	

(c) ***Pasture Growth***

Table 7 shows the effects of E.C., as measured in a 1:5 soil water suspension, and ESP (for the 0-30 cm and 90-120 cm depths) on pasture growth. These effects are significant at the 1% level. The above factors negatively affected pasture growth.

The table also shows negative relationships between the groundwater E.C. and pasture growth and groundwater SAR and pasture growth. The correlations are significant at the 1% level.

Table 7 - The Correlation between Pasture Growth and Salinity and Sodicity of the Soils and Groundwater

Soils					Groundwater
Factors affecting pasture growth	**EC µS/cm**		**ESP**		**EC µS/cm SAR**
Depth	0-30	90-120	0-30	90-120	
Correlation	-0.52***	-0.69***	-0.11	-0.47***	-0.62*** -0.43***

N = 67
P 0.05 r = 0.232
P 0.01 r = 0.302

5. CONCLUSION AND COMMENTS

This investigation suggests that reduced pasture production, depending on the particular locality or soil, is due to either soil salinisation or excessive sodicity or both.

Salinisation and excessive sodicity are related to the effect of highly saline groundwater with high SAR values. In this study groundwater with moderate salinity (values less than 6000 µS/cm) and low SAR, (values less than 3.1) has no apparent effect on soil as far as salinity and sodicity are concerned.

In general, watertables in the area occur over heavy impervious clay layers superimposed on the general high sub-regional watertable. Some of the soil types such as Nanneella loamy fine sand and Timmering loam have lighter material underlaid by horizons of heavy clay. The capacity of this lighter material for holding water is very much less than that of the overlying zones. Development of a watertable is almost certain if water is applied to the soil in excess of the maximum water holding capacities of the horizons overlying an impervious layer.

(a) Cause of Rising Watertables

The area now under investigation was not irrigated to any extent during the period of the 1959-62 soil survey. Shallow watertables were not encountered in the soil types within this area. It was considered that watertables presented a risk for citrus and stone fruit which were growing on the Nanneella fine sandy loam and Timmering loam soil types in the nearby Bamawm and Ballendella localities during 1925-36 (Penman, 1936). The cause of these shallow watertables is the low permeability of the deep subsoils which occur at about 120-150 cm depth.

Skene and Harford (1964) had warned that these soil types would develop watertables readily under careless irrigation practices.

There are many factors contributing to the development of watertables. The assessment of each of these factors needs further investigation to determine its actual contribution. In general, some or all of the following factors could be concerned in watertable development:-

(i) Irrigation Management
Where farms are irrigated too frequently and with excess water, watertables are high.

(ii) Heavy Rainfall
During this investigation it was found that heavy rainfall after irrigation contributed to watertable development. Whereas watertables were observed at relatively deep levels in irrigated areas where rain had not fallen, watertables in similarly irrigated areas following rain were observed at levels closer to ground surface.

(iii) Seepage from Channels

Seepage from district and farm channels depends on the soil type through which the channel passes, the permeability of the soil layers of those soil types and the head of water in the channel. Nelson and Robinson (1967) reported that in Victoria, seepage from the channels ranged from 4% to 25% of water flowing in the channels under investigation.

This investigation shows clearly that there is seepage from the district channel in that the watertable was found to be shallower and lower in salinity the closer it is to the channel. Shallow watertables also have been found in dryland adjacent to the main channel. Further investigation is needed to determine the amount of seepage from this channel.

(iv) Seepage from Dams

It is evident from this study that seepage from farm dams, especially dams on Wanalta loam, does occur. Watertables are shallower nearer to these dams. Seepage from farm dams on Wanalta loam occurs from a layer about 85 to 100 cm from the surface. Seepage does not occur if the water level in these dams is below that layer. Further investigation is needed to determine the amount of seepage from these layers.

(b) Prevention of Salinisation

The first apparent solution to this problem would be to install a subsurface drainage system to prevent salinisation of the relatively unaffected areas. Leaching and addition of gypsum may also be required as steps in such improvement.

However, other long term requirements may be:-

(i) Improved Agricultural Practice

Planning agricultural practices such as:-

(a) land forming to select the best length and width of irrigation bars depending on soil types and water availability. This practice will improve field irrigation systems.

(b) Selecting, in cropping areas, the best crop rotation by using the whole soil (surface and subsoil) as a nutrient and moisture medium by using alternative shallow and deep rooted crops. The best crop rotation will protect crops from irrigation channel seepage. To avoid seepage each crop should be separated from other crops because of the variation in water requirements and timing of irrigation.

(ii) Efficiency of Water Used

(a) Educating the farmers to use only that volume of water required by plants and consistent with the water holding capacity of the particular soil.

(b) Controlling seepage from main and farm irrigation channels.

(c) Sealing farm dams where seepage occurs (e.g. Wanalta loam soil type).

(iii) Control of Runoff

Reducing surface runoff to a minimum by good water management including techniques such as water re-use.

(iv) Leaching Requirement

This is considered to be the amount of water that must drain continuously out of the rootzone in order to maintain a favourable salt level in the rootzone. In practice such a continuous discharge is not feasible. Percolation will occur only when rain or irrigation water is applied. When this occurs salt concentration in the soil-water mixture from which the extract is obtained will be subject to certain fluctuations.

The permissible magnitude of fluctuation should be determined and the irrigation and leaching system should be designed or adjusted in such a way that the salt level of the soil remains within an acceptable range.

(c) Reclamation of Salt Affected Soils

Where a soil has a high salt accumulation and a highly saline watertable (with more than 6000 µS/cm) subsurface drainage is essential. Leaching in these soils depends on many factors; the degree of soil salinisation, soil salt composition, soil pedology, the depth of the drains and the process and the period of leaching.

Addition of gypsum would be required for sodic and high percentage magnesium soils

(d) Interdepartmental Committee

The salinity problem in the Campaspe Irrigation District is currently under investigation. This investigation is carried out by an Interdepartmental Committee on Salinity Problems in the Campaspe Irrigation District. Many different aspects of the problem are being investigated by the Committee.

The results from this project provide a basis for a more comprehensive investigation of the land of the whole of the Northern Victorian irrigation system in respect of the “salinity” problem.

<u>Further work should include:-</u>

1. The definition of the problem e.g. salinity, sodicity, “magnesity” (high magnesium, structural drainage problems, etc.
2. Identification of basic causes, e.g. high watertables, drainage problems, initial soil composition, soil hydraulics, etc.
3. Management, environmental, geological and other factors contributing to such causes and their inter-relationships.
4. Possibilities of modifying management to treat local problems if the underlying causes cannot be found or are too intractable or too costly for prevention.
5. Production of a model to aid in the solution of individual problems for particular areas according to the soil type and in relation to currently measured soil salinity, sodicity, watertable and SAR levels.

REFERENCES

Best, R.J. (1929). A rapid electrometric method for determining chloride content of soil. J. Agric. Sci. 19:533 – 540.

Maasland, M. and Haskew, H.C. (1958). The auger hole method of measuring the hydraulic conductivity of soil and its application to the drainage problems. W.C.I.C. N.S.W. Bull. No. 2.

Mehanni, A.H., and Repsys, A.P. (1978). Watertable conditions and soil salinity status in part of the irrigation areas of the Goulburn Valley, Vict. Dept. of Agric., Res. Proj. Series No. 46.

Mikhail, E.H. (1978). An investigation of soil friability and plant growth. M. Agric. Sci. Thesis, Univ. of Melb.

Mikhail, E.H. (1980). A preliminary investigation of the problems of salt affected farms in part of the Campaspe Irrigation District, Vict. Dept. of Agric. Res. Proj. Series No. 83.

Penman, F. (1936). Soil conditions at Bamawm and Ballendella in relation to citrus growth. J. Dept. Agri. Vict. 34: 399 – 432 a.

Skene, J.K.M. and Harford, L.B. (1964). Soils and Land Use in the Rochester and Echuca Districts, Vict. Dept. of Agric. Tech. Bull. No. 17.

Appendix I - History of Irrigation in he Campaspe Irrigation District
State Rivers and Water Supply Commission

The Campaspe Irrigation District is the most recent proclaimed State Rivers and Water Supply Commission District. Water Supply is from Lake Eppalock, a storage of 312,000 ML on the Campaspe River. Water is released to the river and diverted to land on both sides of the Campaspe River by means of the Campaspe Weir.

The district has an area of 8700 ha, the greater part of which is suitable for irrigation.

The Campaspe Weir was built in the red-gum and stone era of the 1880's by the Campaspe Irrigation and Water Supply Trust and was concrete faced by the State Rivers and Water Supply Commission in 1951. With the construction of Lake Eppalock in 1963, a controlled river flow became available and development of the Campaspe District was possible. In the mid 1960's, a channel system was built to supply 2900 ha of private land on the east side of the Campaspe River and 5800 ha on the west side of the river. A total of 2900 ha have been acquired for closer settlement and subdivided into 63 farms. Generally closer settlement farms have 39 ha of commanded and suitable land.

The irrigation of pastures, both perennial and annual, for the grazing by dairy cattle, is the most common usage for water in the Campaspe District. Lucerne is also grown and is either grazed or cut for sale. There is small areas of market garden vegetables, mainly tomatoes.

The border check method of irrigation is used for pasture and lucerne and furrow irrigation for vegetables. The irrigation season extends from 15th August to 15th May.

Water usage appears high on some soils and averaged 611 mm in 1973-74 which was a very wet year (Table 1). The table shows that the highest average per ha was 808 mm in 1974-75.

Table 1 - Area and Water Usage for Campaspe Irrigation District

Year	Area ha	Total Water Usage ML	Average Water Usage per ha ML
1974 – 74	2,799	17,102	6.11
74 – 75	3,327	26,878	8.08
75 – 76	3,525	27,425	7.78
76 – 77	4,359	30,028	6.89
77 – 78	4,129	29,295	7.09
78 – 79	3,843	29,624	7.71
79 – 80	3,860	31,072	8.05

References: S.R. & W.S.C. Annual Reports

Surface drains were only constructed in the closer settlement area at the same time as the supply system. These drains discharge into the Rochester Irrigation Area drainage system, parts of which were enlarged for the purpose.

The freehold irrigated lands are not drained except where drains from the closer settlement area pass through.

Appendix II - Landscape relationships and guide to Soil Types (Skene and Harford, 1964)

Distribution of the soil types in the investigated area is related to the location of the prior streams and treeless plain.

The prior stream deposits comprise the soil type toposequences. The focal point of the prior stream sequences in this area is the prior stream channel. The soils in the beds of the channels are well drained brown soils with light textures (Type 1) and medium textures (Type 1 H).

Lockington sand is developed on sand removed by wind action from the prior stream bed. The sand or loamy sand deposit is always deeper than one metre. Nanneella loamy fine sand adjoins or may be intermingled with Lockington sand.

Nanneella fine sandy loam, Timmering loam and Wanalta loam are three brown soils with red-brown to reddish brown clay subsoils. These soil types grade into each other texturally. The surface texture becomes slightly heavier and shallower grading from Nanneella fine sandy loam to Wanalta loam when the parent material becomes finer. The Nanneella fine sandy loam and Timmering loam are distinguished from Wanalta loam by the presence of fine sandy clay loam or lighter textures in the deep subsoil. Nanneella fine sandy loam differs from Timmering loam in that a fine sandy loam texture occurs before 90 cm in the profile in Nanneella fine sandy loam.

Wana clay loam and Wanalta loam are almost similar in texture. Ideally, the brown surface and red-brown subsoil colours of Wanalta loam are distinctly different from the grey-brown and yellowish brown of Wana clay loam.

Wanalta loam, Wana loam and Carag clay form a colour sequence, surface colours downslope passing from brown through grey-brown to grey, and subsoil colours from red-brown through yellowish brown to yellow-grey. Textually, Wanalta loam and Wana loam are almost similar, the distinguishing feature being the absences of any reddishness in the B horizon of Wana loam. Wana clay loam is distinguished from Wana loam on the basis of surface texture.

Carag clay, a heavy-textured grey soil, is the lowest member in the prior stream landscape unit and occupies clearly defined depression and superimposed drainage ways.

Koyuga clay loam and Rochester clay soil types belong to the treeless plain unit. Difference between Koyuga clay loam and Wanalta loam, lie in the slightly heavier and shallower surface horizons, the somewhat duller coloured and more interactable subsoil clays, and the more common presence of gypsum in the deep subsoil of the Koyuga soil type.

Rochester clay is characterised by a gilgai micro relief of dominantly clay textures as the surface. This soil type is a grey soil and is often calcareous at the surface.

Appendix III - pH, Chloride and Electrical Conductivity for Soil Types under Investigation

Nanneella Fine Sandy Loam (NFSL)

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
15/8	0 – 30	5.8	.018	.030	107
	30 – 60	7.1	.036	.059	402
	60 – 90	8.7	.067	.110	463
	90 –120	9.3	.055	.090	467
	120 –150	8.9	.085	.139	632
	150 –180	8.9	.081	.133	631
15/20	0 – 30	6.5	.009	.015	49
	30 – 60	7.5	.008	.013	50
	60 – 90	7.5	.020	.033	72
	90 –120	8.7	.020	.033	110
	150 –180	8.7	.017	.028	214
16/2	0 – 30	7.5	.033	.054	238
	30 – 60	7.1	.024	.039	185
	60 – 90	8.2	.036	.059	246
	90 –120	9.0	.042	.069	353
	120 –150	8.8	.074	.121	566
	150 –180	8.8	.102	.167	726
16/6	0 – 30	6.3	.006	.010	26
	30 – 60	7.9	.006	.010	49
	60 – 90	8.6	.006	.010	92
	90 –120	8.9	.006	.010	91
	150 –180	8.4	.008	.013	117
16/8	0 – 30	6.4	.006	.010	20
	30 – 60	7.7	.012	.020	47
	60 – 90	8.8	.012	.020	141
	90 –120	8.9	.079	.130	575
	120 –150	8.8	.096	.157	660
16/9	0 – 30	5.9	.006	.010	33
	30 – 60	6.9	.006	.010	19
	60 – 90	7.9	.012	.020	53
	90 –120	8.3	.012	.020	63
	120 –150	8.6	.015	.025	113
	150 –180	9.0	.014	.025	186
16/12	0 – 30	6.2	.006	.010	33
	30 – 60	7.1	.006	.010	46
	60 – 90	7.9	.020	.033	121
	90 –120	8.7	.030	.049	273
	150 –180	8.8	.029	.048	229
16/15	0 – 30	6.4	.024	.040	190
	30 – 60	8.0	.061	.100	585
	60 – 90	8.3	.097	.159	885
	90 –120	8.3	.097	.159	693
	120 –150	8.0	.098	.161	766
	150 –180	7.9	.114	.187	813

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
16/20	0 – 30	6.1	.006	.010	48
	30 – 60	7.4	.012	.020	44
	60 – 90	7.5	.014	.023	86
	90 –120	7.7	.018	.030	117
16/25	0 – 30	6.1	.018	.030	107
	30 – 60	7.2	.085	.139	564
	60 – 90	7.9	.139	.228	907
	90 –120	8.5	.048	.079	381
	120 –150	8.7	.070	.115	524
	150 –180	8.6	.064	.105	488
17/2	0 – 30	7.7	.018	.030	97
	30 – 60	7.5	.055	.090	397
	60 – 90	8.4	.066	.108	559
	90 –120	8.3	.105	.172	507
	120 –150	8.2	.056	.092	402
17/3	0 – 30	7.8	.010	.016	100
	30 – 60	8.6	.036	.059	132
	60 – 90	8.8	.067	.110	514
	90 –120	8.4	.140	.230	647
	120 –150	8.2	.092	.151	667
	150 –180	8.1	.124	.203	798
17/4	0 – 30	6.3	.006	.010	21
	30 – 60	8.4	.018	.030	141
	60 – 90	8.9	.079	.130	622
	90 –120	8.9	.145	.238	755
	120 –150	8.8	.095	.156	792
	150 –180	8.5	.094	.157	726
17/12	0 – 30	6.6	.006	.010	29
	30 – 60	7.6	.006	.010	35
	60 – 90	8.2	.002	.003	41
	90 –120	8.0	.006	.100	21
	120 –150	7.6	.005	.008	25
17/13	0 – 30	7.6	.006	.010	44
	30 – 60	8.7	.012	. 20	92
	60 – 90	9.3	.012	.020	173
	90 –120	9.1	.045	.074	254
	120 –150	8.9	.038	.062	372
17/15	0 – 30	7.1	.006	.010	58
	30 – 60	8.1	.024	.040	217
	60 – 90	8.9	.042	.069	385
	90 –120	8.4	.069	.113	664
	120 –150	8.0	.130	.213	892
	150 –180	7.6	.172	.282	1166
17/5	0 – 30	6.7	.006	.010	33
	30 – 60	8.6	.012	.020	121
	60 – 90	9.0	.061	.100	565
	90 –120	8.6	.185	.303	881
	120 –150	8.5	.168	.276	1118
	150 –180	8.5	.185	.303	1236

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
17/6	0 – 30	6.1	.012	.020	67
	30 – 60	7.3	.006	.010	22
	60 – 90	8.2	.012	.020	42
	90 –120	8.1	.010	.016	48
	120 –150	8.2	.010	.016	60
17/7	0 – 30	6.9	.024	.040	189
	30 – 60	7.1	.115	.189	799
	60 – 90	7.9	.170	.279	118
	90 –120	8.4	.161	.264	1150
	120 –150	8.8	.143	.235	1066
	150 –180	8.9	.112	.184	932
17/8	0 – 30	5.4	.006	.010	37
	30 – 60	6.9	.018	.030	128
	60 – 90	8.8	.048	.078	448
	90 –120	8.5	.088	.144	677
	120 –150	8.4	.121	.198	846
17/9	0 – 30	6.5	.005	.008	40
	30 – 60	6.8	.006	.010	39
	60 – 90	7.5	.006	.010	63
	90 –120	7.8	.007	.011	53
	120 –150	8.4	.008	.013	90
	150 –180	8.8	.009	.015	113
17/11	0 – 30	6.6	.006	.010	23
	30 – 60	8.6	.006	.010	118
	60 – 90	8.9	.006	.010	158
	90 –120	8.8	.021	.034	238
	120 –150	9.3	.036	.059	374
	150 –180	9.6	.061	.100	600
5	0 – 30	6.9	.015	.025	177
	30 – 60	7.6	.045	.074	323
	90 –120	9.3	.042	.069	564
7	0 – 30	7.2	.009	.015	67
	30 – 60	7.5	.015	.025	87
	90 –120	8.2	.009	.015	71
	120 –150	9.0	.024	.039	286
8	0 – 30	6.8	.015	.025	301
	30 – 60	8.3	.021	.034	159
	90 –120	8.7	.170	.279	1230
	120 –150	8.5	.009	.015	214
				.	570
9	0 – 30	6.3	.033	054	297
	30 – 60				
	90 –120	8.8	.036	.059	320
	120 –150				

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
19	0 – 30	6.6	.018	.030	163
	30 – 60	8.0	.100	.164	739
	90 –120	9.2			
	120 –150				
21	0 – 30	7.2	.018	.030	153
	30 – 60	7.7	.042	.069	344
	90 –120	8.9	.062	.102	483
	120 –150	8.8	.061	.100	493
22	0 – 30	6.2	.009	.015	79
	30 – 60	7.7	.018	.030	136
	90 –120	9.5	.018	.030	290
	120 –150				
23	0 – 30	6.4	.009	.015	72
	90 –120	9.1	.073	.120	660
	120 –150	8.9	.088	.144	863
25	0 – 30	6.4	.018	.030	136
	30 – 60	7.3	.106	.174	698
	90 –120	8.8	.145	.238	1054
	120 –150	8.7	.118	.194	908
39	0 – 30	6.4	.082	.134	520
	30 – 60	7.9	.134	.220	894
	90 –120	8.7	.155	.254	1127
	120 –150	8.9	.091	.149	764
40	0 – 30	6.6	.009	.015	61
	30 – 60	7.4	.006	.100	60
	90 –120	9.1	.015	.025	173
	120 –150				
41	0 – 30	7.1	.012	.020	76
	90 –120	8.8	.009	.015	112
	120 –150	8.8	.009	.015	125
42	0 – 30	6.9	.006	.010	86
	30 – 60	7.7	.012	.020	65
	90 –120	8.7	.012	.020	157
	120 –150	8.5	.009	.015	112
43	0 – 30	6.3	.136	.223	1500
	30 – 60	8.4	.091	.149	735
	90 –120	8.9	.024	.039	265
	120 –150				
64	0 – 30	6.2	.372	.610	2120
	30 – 60	7.6	.282	.462	1700
	90 –120	8.5	.075	.123	800
	120 –150	8.3	.127	.208	895

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
66	0 – 30	6.7	.006		61
	30 – 60	7.2	.006	.010	99
	90 –120	8.9	.030	.010	214
	120 –150	9.1	.030	.049	253
				.049	
67	0 – 30	6.8	.015		141
	30 – 60	7.5	.069	.025	688
	90 –120	8.7	.100	.113	968
	120 –150	8.6	.118	.164	851
				.194	
74	0 – 30	6.7	.027		166
	90 –120	8.3	.312	.044	1366
				.512	
75	0 – 30	6.8	.014	.623	133
	30 – 60	8.6	.009	.015	140
	90 –120	8.6	.008	.013	108
	120 –150	8.4	.005	.008	41
76	0 – 30	6.8	.024	.040	182
	30 – 60	7.7	.034	.056	470
	90 –120	8.8	.042	.069	370
	120 –150	8.9	.042	.069	377
78	0 – 30	6.7	.009	.015	100
	30 – 60	8.1	.028	.046	210
	90 –120	8.6	.015	.025	150
	120 –150	8.5	.008	.013	114
79	0 – 30	6.1	.103	.169	770
	30 – 60	6.6	.048	.079	365
	90 –120	8.0	.024	.040	210
	120 –150	8.2	.014	.023	152
80	0 – 30	5.2	.055	.090	728
	30 – 60	6.7	.061	.100	434
	90 –120	9.4	.041	.067	385
	120 –150	9.4	.042	.069	417
81	0 – 30	7.3	.014	.023	138
	30 – 60	7.4	.005	.008	43
	90 –120	8.5	.006	.010	79
	120 –150	8.8	.006	.010	75
83	0 – 30	5.0	.029	.048	175
	30 – 60	7.2	.074	.121	550
	90 –120	8.8	.318	.522	1930
	120 –150	8.7	.333	.546	2050
84	0 – 30	6.5	.009	.015	93
	90 –120	8.8	.010	.016	118
	120 –150	8.6	.010	.016	138
85	0 – 30	7.2	.010	.016	119
	30 – 60	7.4	.052	.085	321
	90 –120	8.9	.018	.030	187
	120 –150	8.9	.018	.030	207

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
86	0 – 30	7.3	.030	.049	193
	90 –120	8.7	.039	.034	331
89	0 – 30	8.4	.015	.025	190
	30 – 60	8.5	.020	.033	245
	90 –120	8.6	.010	.016	131
	120 –150	8.7	.010	.016	126
91	0 – 30	6.8	.533	.874	3080
	30 – 60	8.3	.179	.294	1064
	90 –120	8.2	.130	.213	807
	120 –150	8.3	.138	.226	887
92	0 – 30	7.1	.007	.011	101
	30 – 60	7.9	.100	.164	663
	90 –120	8.7			
	120 –150	8.6	.088	.144	685
93	0 – 30	6.4	.051	.084	106
	30 – 60	7.0	.021	.034	164
	90 –120	7.3	.024	.039	151
	120 –150	8.5	.021	.034	191
94	0 – 30	6.5	.003	.005	62
	30 – 60	7.5	.055	.090	343
	90 –120	8.7	.097	.159	770
	120 –150				
96	0 – 30	7.5	.051	.084	342
	30 – 60	8.0	.030	.049	247
	90 –120	9.0	.012	.020	167
	120 –150	9.2	.013	.021	210
97	0 – 30	7.3	.012	.020	96
	30 – 60	8.3	.003	.005	61
	90 –120	8.7	.008	.013	68
	120 –150	8.9	.012	.020	94
98	0 – 30	6.1	.245	.402	1690
	30 – 60	8.0	.079	.130	515
	90 –120	8.8			691
	120 –150	9.0	.067	.110	620
99	0 – 30	7.4	.152	.249	1077
	30 – 60	8.8	.164	.269	1070
	90 –120	8.8	.221	.362	1580
	120 –150	8.6	.270	.443	1780
109	0 – 30	6.5	.009	.015	116
	30 – 60	6.7	.105	.172	595
	90 –120	8.4	.152	.249	973
	120 –150	8.4	.189	.310	1188
	150 –180	8.4	.188	.308	1089
111	0 – 30	7.9	.020	.033	99
	30 – 60	8.7	.024	.040	167
	90 –120	9.0	.036	.059	346
	120 –150	9.7			459

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
112	0 – 30	7.2	.015	.025	146
	30 – 60	8.3	.084	.138	618
	90 –120	9.2	.065	.107	504
	120 –150	9.1	.040	.066	335
114	0 – 30	8.5	.031	.051	308
	30 – 60	8.7	.036	.059	317
	90 –120	9.2	.014	.023	185
	120 –150	8.9	.015	.025	174
	150 –180	8.9	.016	.026	188
115	0 – 30	6.4	.068	.112	58
	30 – 60	8.4	.138	.226	492
	90 –120	9.1	.149	.244	970
	120 –150	8.9			1032
129	0 – 30	7.1	.008	.013	116
	30 – 60	8.7	.007	.011	118
	90 –120	8.5	.004	.007	58
	120 –150	9.0	.015	.025	143
130	0 – 30	6.6	.004	.007	55
	30 – 60	8.1	.006	.010	123
	90 –120	8.9	.016	.026	200
	120 –150	9.0	.014	.023	170
131	0 – 30	6.0	.003	.005	61
	30 – 60	6.8	.002	.003	49
	90 –120	8.5	.002	.003	33
	120 –150	8.9	.002	.003	42
132	0 – 30	6.2	.012	.020	128
	30 – 60	7.2	.005	.008	86
	90 –120	8.6	.031	.051	256
	120 –150	8.5	.057	.093	422
	150 –180	8.5	.079	.130	549
133	0 – 30	6.9	.020	.033	170
	30 – 60	7.8	.028	.046	242
	90 –120	9.0			99
	120 –150	9.3			
134	0 – 30	7.1	.005	.008	81
	30 – 60	7.4	.010	.016	125
	60 – 90	7.9	.010	.016	112
	90 –120	8.8	.012	.020	135
	120 –150	9.1	.015	.025	190
135	0 – 30	7.5	.115	.189	753
	30 – 60	8.2	.114	.187	779
	60 – 90	8.9	.083	.136	610
	90 –120	9.0	.059	.097	477
	120 –150	9.3	.034	.056	336

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
136	0 – 30	6.7	.021	.034	318
	30 – 60	7.9	.031	.051	465
	60 – 90	8.8	.015	.025	144
	90 –120	8.9	.022	.036	253
	120 –150	8.8	.017	.028	168
139	0 – 30	7.2	.013	.021	130
	30 – 60	7.5	.015	.025	143
	60 – 90	7.7	.022	.008	106
	90 –120	8.1	.017	.007	81
	120 –150				
140	0 – 30	6.9	.003	.005	51
	60 – 90	6.9	.020	.033	160
	90 –120	8.4	.039	.064	242
	120 –150	8.6	.056	.092	401
142	0 – 30	7.2	.003	.005	57
	30 – 60	7.8	.025	.041	200
	90 –120	8.8	.042	.069	364
	120 –150	9.1	.014	.023	182
151	0 – 30	6.5	.005	.008	97
	30 – 60	7.8	.062	.102	447
	90 –120	9.1	.089	.146	700
	120 –150	8.6	.195	.320	1360
152	0 – 30	6.3	.005	.013	80
	30 – 60	7.7	.034	.056	241
	90 –120	9.1	.047	.077	458
	120 –150	8.8	.041	.067	290
153	0 – 30	6.3	.008	.013	107
	30 – 60	6.7	.085	.139	545
	90 –120	8.4	.168	.276	1203
	120 –150	8.6	.195	.320	1360
154	0 – 30				
	30 – 60	7.8	.024	.040	181
	90 –120	9.0	.022	.036	220
	120 –150	8.9	.045	.074	480
155	0 – 30	6.0	.004	.007	55
	30 – 60	7.4	.004	.007	53
	90 –120	8.6	.127	.208	800
	120 –150	8.6	.177	.290	1055
158	0 – 30	6.3	.003	.005	65
	90 –120	8.9	.012	.020	148
160	0 – 30	6.5	.005	.008	87
	30 – 60	7.5	.005	.008	93
	90 –120	8.8	.031	.051	253
	120 –150	8.9	.029	.048	219

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
161	0 – 30	6.6	.004	.007	52
	30 – 60	7.4	.005	.008	67
	90 –120	8.9	.014	.023	157
	120 –150	9.0	.017	.028	245
174	0 – 30	5.7	.013	.021	200
	30 – 60	7.5	.005	.008	113
	90 –120	9.4	.030	.049	414
	120 –150	8.8	.050	.082	467
175	0 – 30	8.6	.011	.018	178
	30 – 60	9.0	.016	.026	221
	90 –120	9.1	.040	.066	452
177	0 – 30	6.5	.005	.008	92
	90 –120	8.3	.010	.016	150
183	0 – 30	7.0	.002	.003	42
	30 – 60	9.1	.007	.011	120
	90 –120	7.8	.007	.011	120
	120 –150	8.1	.031	.041	302
185	0 – 30	6.3	.010	.016	137
	30 – 60	7.8	.087	.143	791
	90 –120	8.8	.147	.241	1025
	120 –150	8.9	.079	.130	589
	150 –180	9.0	.061	.100	508
186	0 – 30	6.6	.002	.003	46
	30 – 60	8.6	.010	.016	163
	90 –120	9.1	.009	.015	133
	120 –150	9.1	.008	.013	114
188	0 – 30	6.0	.005	.008	73
	30 – 60	8.1	.010	.016	135
	90 –120	8.9	.074	.121	586
	120 –150	9.1	.064	.105	490
189	0 – 30	6.6	.004	.007	73
	30 – 60	8.3	.008	.013	173
	90 –120	8.8	.067	.110	513
	120 –150	8.5	.116	.190	811
190	0 – 30	6.8	.004	.007	87
	30 – 60	7.7	.007	.011	115
	60 – 90	8.7	.012	.020	103
	90 –120	9.5	.026	.043	302
194	0 – 30	6.5	.005	.008	78
	30 – 60	7.8	.027	.044	208
	90 –120	8.9	.269	.441	1700
	120 –150	8.8	.246	.403	1470
195	0 – 30	7.3	.005	.008	89
	30 – 60	8.1	.008	.013	114
	90 –120	9.2	.060	.098	440
	120 –150	8.9	.097	.159	692

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
198	0 – 30	7.2	.023	.038	201
	30 – 60	8.5	.107	.175	771
	90 –120	9.5	.085	.139	509
	120 –150	9.5	.054	.089	509
199	0 – 30	6.2	.002	.003	25
	30 – 60	7.7	.003	.005	24
	90 –120	7.7	.004	.007	51
	120 –150	7.9	.005	.008	65
202	0 – 30	6.9	.006	.010	112
	30 – 60	8.1	.005	.008	109
	90 –120	8.2	.004	.007	90
	120 –150	8.3	.007	.011	114
203	0 – 30	8.6	.004	.007	85
	30 – 60	7.8	.060	.098	148
	90 –120	7.8	.002	.003	53
	120 –150	7.8	.004	.007	64
204	0 – 30	6.1	.002	.003	52
	30 – 60	7.5	.006	.010	112
	90 –120	9.4	.015	.025	127
	120 –150	9.6	.015	.025	128
205	0 – 30	7.4	.006	.010	105
	30 – 60	7.5	.006	.010	106
	90 –120	8.4	.016	.026	192
	120 –150	8.5	.023	.038	201
207	0 – 30	6.8	.004	.007	85
	30 – 60	7.6	.031	.051	202
	90 –120	9.0	.031	.051	347
	120 –150	9.3	.025	.041	312
208	0 – 30	6.5	.002	.003	42
	30 – 60	7.2	.003	.005	50
	90 –120	7.9	.005	.008	109
	120 –150	8.5	.018	.030	174
209	0 – 30	6.6	.072	.118	448
	30 – 60	7.5	.044	.072	309
	60 – 90	8.0	.018	.030	148
	90 –120	7.7	.005	.008	100
	120 –150	7.8	.003	.005	83
212	0 – 30	6.3	.032	.052	235
	30 – 60	8.2	.038	.062	290
	90 –120	9.2	.024	.039	254
	120 –150	9.2	.022	.036	196
213	0 – 30	5.9	.001	.002	39
	30 – 60	7.5	.008	.013	127
	60 – 90	9.1	.041	.067	351
	90 –120	9.4	.095	.156	710
	120 –150	9.2	.151	.248	1010
	150 –180	9.3	.140	.230	953

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
216	0 – 30	6.5	.003	.005	62
	30 – 60	7.4	.003	.0055	67
	90 –120	7.9	.004	.007	76
	120 –150	8.5	.003	.005	68
217	0 – 30	7.2	.002	.003	52
	30 – 60	7.8	.003	.005	65
	90 –120	8.8	.016	.026	180
	120 –150	8.7	.012	.020	149
219	0 – 30	7.0	.014	.0230	134
	30 – 60	8.8	.097	.159	730
	90 –120	9.1	.113	.185	809
	120 –150	9.0	.103	.169	774
220	0 – 30	9.0	.106	.174	796
	30 – 60	9.0	.106	.174	798
	90 –120	7.7	.073	.120	520
	120 –150	6.5	.009	.015	104
232	0 – 30	5.5	.175	.287	132
	30 – 60	6.3	.175	.287	1040
	90 –120	8.8	.298	.489	1860
	120 –150	8.9	.308	.505	1940
231	0 – 30	6.8	.004	.007	70
	30 – 60	7.5	.028	.046	170
	90 –120	8.6	.080	.131	547
	120 –150	9.1	.056	.092	500
Nanneella Loamy Fine Sand (Nlfs)					
20	0 – 30	6.3	.015	.025	128
	30 – 60	7.2	.045	.074	296
	90 –120	8.9	.158	.259	1070
	120 –150	8.9	.100	.164	770
26	0 – 30	5.4	.030	.049	228
	30 – 60	6.4	.112	.184	690
	90 –120	8.4	.152	.249	1030
	120 –150				
27	0 – 30	5.5	.027	.044	224
	30 – 60	7.7	.192	.315	1203
	90 –120	8.9	.148	.242	1040
	120 –150				
28	0 – 30	6.1	.012	.020	88
	30 – 60	7.4	.094	.154	660
	90 –120	9.3	.079	.130	660
	120 –150	9.4	.061	.100	565
29	0 – 30	6.1	.055	.090	290
	30 – 60	8.3	.024	.039	152
	90 –120	9.2	.018	.030	230
	120 –150	9.1	.030	.049	210

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
30	0 – 30	6.8	.012	.020	107
	30 – 60	8.4	.024	.039	267
	90 –120	8.9	.018	.030	184
	120 –150	8.9	.015	.025	191
31	0 – 30	6.8	.015	.025	126
	30 – 60	7.5	.048	.079	274
	90 –120	8.7	.112	.184	750
	120 –150	8.6	.170	.279	1220
32	0 – 30	5.8	.003	.005	24
	30 – 60	6.8	.006	.010	30
	90 –120	8.3	.009	.015	65
	120 –150	7.9	.009	.015	56
34	0 – 30	6.7	.024	.039	209
	30 – 60	7.7	.103	.169	752
	90 –120	9.3	.088	.144	726
	120 –150	9.1	.118	.194	919
35	0 – 30	6.1	.021	.034	182
	30 – 60	7.7	.033	.054	319
	90 –120	9.5	.024	.039	308
	120 –150	9.3	.033	.054	446
45	0 – 30	6.4	.003	.005	52
50	0 – 30	6.3	.018	.030	114
59	0 – 30	6.1	.006	.010	53
	30 – 60	8.0	.009	.015	101
	90 –120	9.0	.009	.015	93
	120 –150	9.1	.006	.010	76
68	0 – 30	5.9	.070	.115	440
	30 – 60	6.7	.103	.169	717
	90 –120	8.6	.361	.592	2070
	120 –150	8.5	.355	.582	2030
107	0 – 30	6.3			41
	30 – 60	7.4			49
	90 –120	8.8	.049	.080	407
	120 –150	8.9	.101	.166	741
123					
	30 – 60	8.6	.007	.011	106
124	0 – 30	6.4			39
	30 – 60	7.8			147
	90 –120	9.1	.072	.118	582
	120 –150	9.1	.092	.151	715

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
125	0 – 30	6.8	.061	.100	486
	30 – 60	8.8	.068	.112	585
	60 – 90	9.4	.022	.036	265
	90 –120	9.2			140
	120 –150	8.9			129
126	0 – 30	6.0			127
	30 – 60	7.5			46
	60 – 90				
	90 –120	7.1			137
	120 –150	8.5	.195	.320	1300
127	0 – 30	6.7			68
	30 – 60	7.3			89
	60 – 90	7.5			90
	90 –120	7.8			64
	120 –150	8.2			69
128	0 – 30	6.3			37
	30 – 60	6.8			48
	90 –120	7.3			127
	120 –150	9.0			100
148	0 – 30	7.5	.038	.062	289
	30 – 60	8.3	.155	.254	1002
	90 –120	8.9	.163	.267	991
	120 –150	9.0	.127	.208	840
149	0 – 30	7.3			76
	30 – 60	8.8			109
	60 – 90	9.1	.012	.020	165
	90 –120	9.2	.015	.025	180
	120 –150	9.1	.015	.025	171
157	0 – 30	6.0			45
	30 – 60	6.2			32
	90 –120	8.8			152
	120 –150	9.3			127
	Timmering Loam (T i l)				
15/3	0 – 30	6.7	.012	.020	120
	30 – 60	8.4	.048	.078	535
	60 – 90	8.7	.097	.159	899
	90 –120	8.9	.091	.149	929
	120 –150	8.8	.064	.105	605
	150 –180	8.7	.117	.192	532
15/25	0 – 30	6.4	.127	.208	868
	30 – 60	8.4	.139	.228	1020
	60 – 90	8.5	.158	.259	1207
	90 –120	8.3	.170	.279	1381
	120 –150	8.6	.120	.197	918
	150 –180	8.8	.099	.162	714
15/35	0 – 30	7.6	.006	.010	89
	30 – 60	8.7	.030	.049	145
	60 – 90	8.7	.012	.020	176
	90 –120	8.8	.012	.020	183
	120 –150	8.8	.015	.025	268

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
16/11	0 – 30	7.2	.006	.010	21
	30 – 60	8.4	.006	.010	89
	60 – 90	8.8	.012	.020	68
	90 –120	9.1	.018	.030	172
	120 –150	8.9	.029	.048	298
16/17	0 – 30	8.5	.024	.039	206
	30 – 60	7.7	.018	.030	145
	60 – 90	8.6	.024	.039	241
	90 –120	8.9	.024	.039	287
	120 –150	8.9	.029	.048	298
	150 –180	9.0	.022	.036	323
16/21	0 – 30	6.1	.018	.030	116
	30 – 60	7.6	.024	.039	167
	60 – 90	8.5	.024	.039	204
	90 –120	8.8	.018	.030	153
33	0 – 30	6.4	.006	.010	65
	30 – 60	6.9	.018	.030	135
	90 –120	9.2	.018	.030	224
	120 –150	9.0	.015	.025	203
51	0 – 30	6.9	.012	.020	148
	30 – 60	7.4	.030	.049	285
	90 –120	8.7	.036	.059	350
	120 –150	8.5	.030	.049	371
52	0 – 30	7.2	.024	.039	91
	30 – 60	8.0	.024	.039	164
	90 –120	8.9	.021	.034	258
	120 –150	8.7	.018	.030	162
54	0 – 30	6.4	.036	.059	239
	30 – 60	7.8	.048	.079	350
	90 –120	9.2	.042	.069	408
	120 –150				
55	0 – 30	6.9	.048	.079	341
	30 – 60	8.2	.070	.115	523
	90 –120	9.1	.045	.074	400
	120 –150				
56	0 – 30	6.9	.009	.015	64
	30 – 60	7.1	.015	.025	79
	90 –120	8.8	.015	.025	173
	120 –150	8.6	.006	.010	89
58	0 – 30	6.2	.024	.039	160
	30 – 60	8.2	.045	.074	386
	90 –120	9.0	.015	.025	234
	120 –150	8.9	.027	.044	265
60	0 – 30	7.0	.022	.036	157
	30 – 60				
	90 –120	9.0	.021	.034	245
	120 –150	8.9	.030	.049	206

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
61	0 – 30	6.7	.009	.015	65
	30 – 60	7.2	.101	.164	38
	90 –120	8.2	.008	.013	48
	120 –150				
65	0 – 30	6.3	.048	.079	202
	30 – 60	8.3	.036	.059	402
	90 –120	9.1	.036	.059	364
	120 –150	9.1	.049	.080	487
71	0 – 30	6.6	.052	.085	315
72	0 – 30	7.3			72
	90 –120	9.0	.033	.054	268
73	0 – 30	7.3	.004	.007	89
	30 – 60	7.8	.006	.010	110
	90 –120	8.8	.092	.151	704
	120 –150	8.7	.006	.010	114
74	0 – 30	6.7	.027	.044	166
	90 –120	8.3	.200	.328	1366
	120 –150	8.3	.127	.208	937
86	0 – 30	7.3	.030	.049	193
	30 – 60	8.1	.048	.079	382
	90 –120	8.7	.039	.064	331
	120 –150	8.6	.040	.066	388
87	0 – 30	7.1	.010	.016	102
	30 – 60	7.9	.013	.021	172
	90 –120	8.8	.024	.039	201
	120 –150	8.7	.023	.038	153
88	0 – 30	6.8	.010	.016	92
	30 – 60	7.5	.010	.016	99
	90 –120				
	120 –150	8.6	.015	.025	98
100	0 – 30	7.0	.009	.015	82
	30 – 60	7.6	.024	.039	190
	90 –120	8.9	.033	.054	350
	120 –150	9.0	.027	.044	262
106	0 – 30	6.9			97
	30 – 60	8.0	.018	.030	170
	90 –120	9.2	.046	.075	472
	120 –150				
110	0 – 30	7.3	.029	.048	211
	30 – 60	7.3			79
	90 –120				
	120 –150	8.6	.015	.025	98

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
113	0 – 30	7.2			126
	30 – 60				
	90 –120	9.4	.026	.043	345
	120 –150	9.3	.022	.036	225
116	0 – 30	7.2			90
	30 – 60	8.0	.014	.023	150
	90 –120	9.0	.014	.023	256
	120 –150	9.2	.012	.020	218
119	0 – 30	7.3			80
	30 – 60	7.9	.018	.030	150
	90 –120	9.1	.013	.021	215
	120 –150	9.0			930
120	0 – 30	6.7			117
	30 – 60	7.5	.036	.059	325
	90 –120	8.6	.065	.107	494
	120 –150	8.5	.060	.148	460
121	0 – 30	6.9	.009	.015	165
	30 – 60	8.1			104
	90 –120	9.2	.017	.028	285
	120 –150	9.3	.017	.028	312
122	0 – 30	7.4			80
	30 – 60	8.0			88
	90 –120	9.3	.013	.021	194
	120 –150	9.5			373
144	0 – 30	7.0			54
	30 – 60	7.6			84
	90 –120	7.8			155
	120 –150	9.3	.025	.041	241
	0 – 30	6.6			70
	30 – 60	6.8			82
	90 –120	7.9	.026	.043	197
	120 –150	8.9	.034	.056	303
146	0 – 30	7.0			74
	30 – 60	8.3			118
	90 –120	8.8	.019	.031	217
	120 –150	8.9			119
147	0 – 30	6.6			69
	30 – 60	7.6	.027	.044	203
	90 –120	9.0	.108	.177	797
	120 –150	9.2	.084	.138	700
187	0 – 30	6.0			32
	30 – 60	7.3			99
	90 –120	8.6	.145	.238	1019
	120 –150	8.7			977

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
191	0 – 30	6.9			98
	30 – 60	8.3	.026	.043	224
	90 –120	9.5	.026	.043	302
	120 –150				
221	0 – 30	6.2	.034	.056	219
	30 – 60	6.4	.115	.189	883
	90 –120	8.4	.084	.138	1067
	120 –150	8.4	.090	.148	862
Wanalta Loam (Wl)					
15/10	0 – 30	6.1	.003	.005	25
	30 – 60	8.6	.030	.049	99
	60 – 90	8.7	.006	.010	104
	90 –120	9.0	.012	.020	115
	120 –150	9.0	.016	.026	216
	150 –180	9.2	.012	.020	224
15/24	0 – 30	6.3	.309	.507	1880
	30 – 60	7.7	.188	.308	1400
	60 – 90	8.5	.127	.208	1125
	90 –120	8.6	.121	.198	1159
	120 –150	8.4	.079	.130	788
	150 –180	8.5	.075	.123	709
15/26	0 – 30	6.1	.233	.382	1960
	30 – 60	8.8	.091	.149	836
	60 – 90	8.7	.085	.139	845
	90 –120	8.9	.060	.098	863
	120 –150	8.8	.072	.118	810
	150 –180	8.5	.057	.093	647
15/26B	0 – 30	6.7	.018	.030	109
	30 – 60	7.5	.018	.030	138
	60 – 90	8.7	.018	.030	210
	90 –120	9.1	.018	.030	182
	120 –150	8.9	.031	.051	321
	150 –180	9.1	.021	.034	308
15/27	0 – 30	6.8	.055	.090	371
	30 – 60	8.0	.091	.149	645
	60 – 90	8.2	.091	.149	643
	90 –120	8.7	.048	.079	401
	120 –150	8.7	.044	.072	409
15/28B	0 – 30	8.0	.085	.139	601
	30 – 60	8.7	.073	.120	590
15/30	0 – 30	7.9	.024	.039	165
	30 – 60	8.7	.042	.069	335
	60 – 90	8.8	.036	.059	347
	90 –120	9.1	.030	.049	393
	120 –150	9.1	.042	.069	533
16/5	0 – 30	6.7	.006	.010	40
	30 – 60	8.3	.018	.030	109
	60 – 90	8.8	.042	.069	389
	90 –120	9.0	.048	.079	484

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
	120 –150	8.7	.085	.139	683
16/7	0 – 30	7.6	.012	.020	58
	30 – 60	9.2	.024	.039	290
	60 – 90	9.1	.055	.090	500
	90 –120	9.3	.036	.059	465
	120 –150	9.4	.033	.054	458
17/1	0 – 30	7.4	.024	.039	174
	30 – 60	7.6	.127	.208	524
	60 – 90	8.2	.115	.189	803
	90 –120	8.0	.088	.144	626
	120 –150	8.2	.064	.105	740
17/10	0 – 30	6.9	.012	.020	55
	30 – 60	8.1	.042	.069	365
	60 – 90	8.7	.133	.218	1272
	90 –120	8.5	.152	.249	1570
	120 –150	8.8	.146	.239	1490
	150 –180	8.9	.132	.216	1360
10	0 – 30	7.1	.030	.049	241
	30 – 60	8.0	.070	.115	631
	90 –120	8.7	.100	.164	813
	120 –150	8.5	.085	.139	775
11	0 – 30	6.3	.027	.044	209
	30 – 60	8.3	.055	.090	485
	90 –120	8.7	.061	.100	461
	120 –150	8.9	.048	.079	425
12	0 – 30	6.9	.027	.044	238
	30 – 60				
	90 –120	8.7	.133	.218	1070
	120 –150	8.7	.133	.218	1155
13					
	0 – 30	7.1	.015	.025	137
	30 – 60	8.4	.027	.044	243
	90 –120	8.9	.094	.154	880
	120 –150	8.9	.106	.174	977
15					
	0 – 30	6.8	.009	.015	63
	30 – 60	7.4	.018	.030	118
	90 –120	9.3	.027	.044	320
	120 –150	9.2	.024	.039	328
16	0 – 30	6.4	.024	.039	147
	30 – 60	8.5	.139	.228	1002
	90 –120	8.9	.130	.213	950
17	0 – 30	6.2	.015	.025	147
	30 – 60	8.4	.064	.105	513
	90 –120	9.0	.109	.179	820
18	0 – 30	7.1	.015	.025	136
	30 – 60	8.5	.055	.090	431
	90 –120	9.1	.055	.090	550

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
48	0 – 30	7.5	.015	.025	219
	30 – 60	8.3	.033	.054	381
	90 –120	8.9	.021	.034	273
	120 –150	9.0	.021	.034	260
53	0 – 30	7.0	.045	.074	455
	30 – 60	7.5	.021	.034	164
	90 –120	8.5	.073	.120	605
	120 –150	8.3	.067	.110	487
57	0 – 30	6.9	.048	.079	336
	30 – 60	8.2	.045	.074	390
	90 –120	8.8	.042	.069	405
	120 –150	8.5	.039	.064	330
63	0 – 30	6.8	.015	.025	142
	30 – 60	7.9	.052	.085	373
	90 –120	9.1	.028	.046	255
69	0 – 30	7.2	.015	.025	148
	30 – 60	8.4	.038	.062	342
	90 –120	8.8	.024	.039	277
143	0 – 30	7.1	.016	.026	155
	30 – 60	7.9	.005	.008	81
	90 –120	7.1	.024	.039	238
162	0 – 30	6.5	.007	.0115	116
	30 – 60	7.8	.017	.028	169
	90 –120	8.7	.017	.028	216
	120 –150	7.6	.017	.028	160
164	0 – 30	7.2	.008	.013	115
	30 – 60	2.7	.023	.038	182
	90 –120	8.7	.088	.144	713
	120 –150	8.6	.129	.212	970
165	0 – 30	7.2	.006	.010	105
	30 – 60	8.0	.004	.009	90
	90 –120	8.7	.015	.025	158
	120 –150	8.6	.028	.046	234
166	0 – 30	6.9	.008	.013	94
	30 – 60	8.3	.084	.138	405
	90 –120	8.8	.063	.103	324
167	0 – 30	7.3	.003	.005	79
	30 – 60	7.5	.033	.054	238
	90 –120	8.8	.031	.051	264
	120 –150	8.8	.028	.046	220
197	0 – 30	6.2	.015	.025	136
	30 – 60	8.2	.017	.028	159
	90 –120	8.9	.134	.220	926
	120 –150	8.9	.118	.194	818

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
181	0 – 30	6.5	.008	.013	55
	90 –120				
182	0 – 30	7.2			43
	90 –120	8.3			56
	120 –150	8.2			56
	150 –180	8.4			54
196	0 – 30	6.4	.020	.033	159
	30 – 60	8.0	.055	.090	409
	90 –120	9.1	.061	.100	589
	120 –150	9.2	.042	.069	447
215	0 – 30	7.2			121
	30 – 60	7.9			114
	90 –120	8.5	.024	.039	205
	120 –150	8.5			123
223	0 – 30	6.8	.031	.051	221
	30 – 60	7.3	.380	.623	258
	90 –120	8.3	.0152	.085	344
224	0 – 30	7.1	.026	.043	188
	30 – 60	7.8	.029	.048	241
	90 –120	8.6	.036	.059	295
	120 –150	8.6	.035	.057	273
225	0 – 30	7.2	.057	.093	391
	30 – 60	7.5	.099	.162	699
	90 –120	8.5	.057	.093	393
	120 –150	8.7	.046	.075	339
226	0 – 30	7.6	.074	.121	490
	30 – 60	7.5	.106	.174	735
	90 –120	8.2	.068	.112	483
	120 -150	8.3	.072	.118	499
227	0 – 30	7.6	.054	.089	490
	30 – 60	8.1	.110	.180	798
	90 –120	8.9	.063	.103	637
	120 –150	8.8	.070	.115	811
229	0 – 30	6.5	.020	.033	216
	30 – 60	7.8	.029	.048	281
	90 –120	8.4	.029	.048	278
	120 –150	8.4	.025	.041	220
230	0 – 30	7.5	.004	.007	63
	30 – 60	7.8	.009	.015	134
	90 –120	8.7	.023	.038	193
	120 –150	8.6	.017	.028	153
234	0 – 30	7.1	.008	.013	121
	30 – 60	8.0	.033	.054	257
	90 –120	8.7	.033	.054	274

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
235	0 – 30	7.0	.006	.010	99
	30 – 60	7.8	.025	.041	214
	90 –120	8.5	.021	.034	532
236	0 – 30	6.4	.032	.052	285
	30 – 60	8.5	.049	.080	447
	90 –120	8.9	.089	.146	680
237	0 – 30	8.1	.014	.023	187
	30 – 60	8.7	.014	.023	199
	90 –120	8.8	.025	.041	270
242	0 – 30	7.4	.007	.013	102
	30 – 60	8.1	.009	.015	122
	90 –120	8.9	.015	.025	238
244	0 – 30	7.1	.015	.025	178
	30 – 60	7.8	.033	.054	283
	90 –120	9.1	.038	.062	505
	120 –150	9.1	.046	.075	489
245	0 – 30	6.9	.010	.016	120
	30 – 60	7.6	.012	.020	146
	90 –120	9.0	.017	.028	209
	120 –150	8.9	.020	.033	286
246	0 – 30	7.5	.008	.013	116
	30 – 60	8.2	.013	.021	149
	90 –120	8.8	.024	.039	297
	120 –150	8.4	.030	.049	217
247	0 – 30	6.5	.009	.015	114
	30 – 60	8.5	.021	.034	270
	90 –120	8.8	.015	.025	177
	120 –150	8.8	.015	.025	177
Wana Clay Loam (W^aCl)					
16/10	0 – 30	7.1	.018	.030	75
	30 – 60	7.8	.060	.098	492
	60 – 90	8.3	.145	.238	1229
	90 –120	8.3	.164	.269	1367
	120 –150	8.5	.163	.267	1550
	150 –180		.124	.203	1121
16/14	0 – 30	6.9	.006	.010	40
	30 – 60	7.4	.006	.010	39
	60 – 90	7.3	.006	.010	43
	90 –120	7.4	.006	.010	48
	120 –150	7.5	.008	.013	66
	150 –180	7.6	.008	.013	69
17/14	0 – 30	7.3	.012	.020	58
	30 – 60	7.7	.030	.049	206
	60 – 90	9.0	.048	.079	472
	90 –120	8.7	.067	.110	664
	120 –150	8.8	.070	.114	713
	150 –180	8.6	.089	.146	867

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
44	0 – 30	7.2	.012	.020	152
	30 – 60	7.8	.024	.039	203
	90 –120	8.7	.067	.111	492
	120 –150				
49	0 – 30	6.9	.018	.030	157
	30 – 60	7.7	.072	.118	570
	90 –120	8.5	.194	.318	1360
70	0 – 30	6.2	.012	.020	135
	30 – 60	6.1	.103	.169	674
	90 –120	8.8	.080	.131	655
	120 –150	8.7	.041	.067	398
108	0 – 30	6.9			65
	30 – 60	7.1			103
	90 –120	9.2	.023	.038	264
	120 –150	9.0	.027	.044	282
165	0 – 30	7.6	.017	.028	160
	30 – 60	8.4	.023	.038	206
	90 –120	8.5	.074	.121	541
	120 –150	8.4	.075	.123	575
211	0 – 30	7.3	.015	.025	160
	30 – 60	8.3	.063	.103	452
	90 –120	8.9	.076	.125	555
	120 –150	8.9	.076	.125	638
218	0 – 30	7.3			136
	30 – 60	7.3	.004	.007	301
	90 –120	8.6	.048	.079	358
	120 –150	8.7	.051	.084	353
222	0 – 30	7.8	.035	.057	234
	30 – 60	7.9	.030	.049	218
	60 – 90	7.9	.028	.046	237
	90 –120	8.4	.030	.049	238
	120 –150	8.7	.026	.043	212
228	0 – 30	7.2	.009	.015	114
	30 – 60	8.2	.020	.033	190
	90 –120	8.8	.022	.036	204
	120 –150	9.0	.026	.098	217
233	0 – 30	7.4	.058	.095	293
	30 – 60	8.6	.103	.169	740
	90 –120	8.6	.220	.361	1490
	120 –150				
238	0 – 30	7.4	.020	.033	172
	30 – 60	7.7	.042	.069	382
	90 –120	8.7	.054	.089	407
240	0 – 30	7.5	.026	.043	203
	30 – 60	7.8	.040	.066	310
	90 –120	8.5	.056	.092	414

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
241	0 – 30	7.0	.009	.015	110
	30 – 60	8.6	.043	.071	403
	90 –120	8.9	.114	.187	741
	120 –150				
243	0 – 30	7.8	.022	.036	228
	30 – 60	8.7	.032	.052	375
	90 –120	9.1	.036	.059	412
Rochester Clay (Rc)					
1	0 – 30	6.8	.009	.015	94
	30 – 60	7.7	.052	.085	306
	90 –120	8.7	.145	.238	1200
	120 –150	8.8	.118	.194	1088
2	0 – 30	7.7	.009	.015	130
	30 – 60	8.9	.027	.044	364
	90 –120	8.5	.163	.267	1040
	120 –150	8.8	.142	.233	370
3	0 – 30	7.3	.015	.025	168
	30 – 60	8.9	.036	.059	399
	90 –120	8.7	.142	.233	1500
	120 –150	8.8	.118	.194	1310
4	0 – 30	7.1	.015	.025	142
	30 – 60	8.0	.018	.030	151
	90 –120	9.4	.024	.039	410
	120 –150				
5	0 – 30	6.9	.015	.025	177
	30 – 60	7.6	.045	.074	323
	90 –120	9.3	.042	.069	564
6	0 – 30	7.1	.015	.025	145
	90 –120	9.3	.018	.030	290
	120 –150	9.2	.018	.030	328
14	0 – 30	6.9	.018	.030	170
	30 – 60	7.1	.030	.049	231
	90 –120	8.8	.036	.059	265
	120 –150	8.7	.033	.054	264
24	0 – 30	6.2	.009	.015	72
	30 – 60		.005	.090	
	90 –120	8.6	.200	.328	1400
	120 –150	8.5	.188	.308	1380
101	0 – 30	7.0	.006	.010	56
	30 – 60	8.0	.007	.011	82
	90 –120	9.1	.012	.020	210
	120 –150	9.4	.012	.020	347

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
102	0 – 30	7.2	.009	.015	70
	30 – 60	7.6	.018	.030	212
	90 –120	9.2	.048	.079	600
	120 –150	9.2	.061	.100	690
103	0 – 30	6.6			69
	30 – 60	7.5	.016	.026	138
	90 –120	9.1	.063	.103	642
	120 –150	9.0	.087	.143	807
104	0 – 30	6.6			101
	30 – 60	7.9	.016	.026	173
	90 –120	8.5	.148	.243	1072
	120 –150	8.6	.091	.149	710
Type 1 H					
46	0 – 30	6.8	.006	.010	67
	30 – 60	8.0	.033	.054	230
	90 –120	8.9	.009	.015	116
95	0 – 30	6.6	.010	.016	148
	90 –120	8.6	.009	.015	131
137	0 – 30	6.5			78
	30 – 60	7.5	.052	.085	369
	90 –120	8.8	.182	.298	1211
	120 –150	9.0	.166	.272	1148
141	0 – 30	6.8	.242	.397	1400
	90 –120	9.2	.057	.093	485
	120 –150	9.2	.055	.090	507
156	0 – 30	6.1	.033	.054	202
	30 – 60	7.4	.085	.139	524
	90 –120	7.8	.068	.112	410
	120 –150	9.3	.012	.020	127
173	0 – 30	5.7	.015	.025	218
	30 – 60	7.7	.010	.020	115
	90 –120	9.1	.032	.052	434
	120 –150	9.1	.054	.089	626
192	0 – 30	7.0	.011	.018	115
	30 – 60	7.7	.014	.023	145
	90 –120	8.4	.034	.056	318
	120 –150	8.7	.013	.021	209
200	0 – 30	5.6	.230	.377	1370
	30 – 60	7.1	.040	.066	258
	90 –120	7.7	.033	.054	230
	120 –150	7.8	.022	.036	169
201	0 – 30	6.2	.008	.013	101
	30 – 60	7.7	.111	.182	816
	90 –120	9.0	.145	.238	1040

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
206	0 – 30	6.6	.010	.016	114
	30 – 60	7.8	.022	.036	172
	90 –120	8.9	.023	.038	227
210	0 – 30	6.3	.012	.020	146
	30 – 60	8.2	.049	.080	380
	90 –120	8.7	.115	.189	814
	120 –150	8.9	.062	.102	563
Lockington Sand (Ls)					
15/32	0 – 30	6.1	.003	.005	22
	30 – 60	7.0	.006	.010	34
	60 – 90	6.8	.006	.010	22
	90 –120	7.9	.006	.010	20
	120 –150	8.4	.006	.010	28
159	150 –180	9.5	.021	.034	495
	0 – 30	7.3	.001	.002	14
	30 – 60	6.9	.002	.003	21
	90 –120	7.3	.002	.003	14
	120 –150	7.2	.002	.003	23
Koyuga Clay Loam (K^{a}cl)					
117	0 – 30	7.2	.004	.007	57
	30 – 60	7.4	.018	.030	153
	90 –120	9.4	.018	.030	307
	120 –150	9.5	.023	.038	326
169	0 – 30	7.0	.008	.013	112
	30 – 60	7.6	.020	.033	164
	90 –120	9.0	.017	.028	154
	120 –150	8.9	.020	.033	158
170	0 – 30	5.9	.011	.018	123
	30 – 60	7.3	.020	.033	186
	90 –120	9.3	.035	.057	452
	120 –150	9.2	.038	.062	468
171	0 – 30	7.1			157
	90 –120	8.6	.093	.153	835
	120 –150	8.8	.024	.039	874
172	0 – 30	6.5	.002	.003	57
	30 – 60	7.9	.012	.020	134
	90 –120	9.0	.058	.095	735
	120 –150	8.9	.068	.112	815
Carag Clay (C^{r}c)					
214	0 – 30	6.5	.035	.057	216
	30 – 60	7.7	.135	.221	863
	90 –120	8.8	.067	.110	623
	120 –150	9.1	.035	.057	267
239	0 – 30	6.6	.014	.023	170
	30 – 60	8.0	.051	.084	434
	90 –120	8.8	.112	.184	720
	120 –150	8.7	.065	.107	579

Site No.	Depth Cm	pH	Cl%	NaCl%	E.C. uS/cm
Wana Loam (W^a^l)					
138	0 – 30	6.6	.090	.148	642
	30 – 60	8.3	.187	.307	1360
	90 –120	8.7	.105	.172	780
168	0 – 30	6.6	.005	.008	97
	30 – 60	6.5	.012	.020	142
	90 –120	8.6	.071	.116	542
	120 –150	8.4	.075	.123	530
Type 1					
77	0 – 30	7.8	.249	.408	1295
	30 – 60	8.3	.339	.556	2080
	90 –120	8.7	.231	.379	1500
	120 –150	8.6	.179	.294	1250
90	0 – 30	7.0	.191	.313	1170
	30 – 60	8.2	.219	.359	1373
	90 –120	8.6	.215	.353	1460
	120 –150	8.6	.170	.279	1196

Appendix IV - Exchangeable Cation Data for Soil Samples

Soil Site	Depth	Ca		Mg		Na		K		Total me
		me	%	me	%	me	%	me	%	
15.3	0 – 30	9.5	56	6.5	38	0.8	5	0.3	2	17.1
"	30 – 60	5.0	31	8.8	54	1.7	11	0.7	4	16.2
"	60 – 90	5.5	26	11.5	54	3.6	17	0.6	3	21.2
"	90 –120	8.5	29	14.0	48	6.2	21	0.8	3	29.5
15.9	90 –120	11.5	42	13.8	50	1.2	4	1.0	4	27.5
15.22	90 –120	9.0	60	5.0	33	0.4	3	0.7	5	15.1
15.23	90 –120	8.0	35	12.5	54	2.0	9	0.6	3	23.1
15.24	0 – 30	6.8	42	7.0	43	1.8	11	0.7	4	16.3
"	30 – 60	7.9	31	12.5	50	4.0	16	0.2	3	25.1
"	60 – 90	6.5	32	9.4	46	4.0	19	0.7	3	20.6
"	90 –120	9.8	30	16.0	49	5.7	17	1.1	3	32.6
15.25	0 – 30	6.3	51	3.9	32	1.3	11	0.8	7	12.3
"	30 – 60	8.0	41	7.2	37	3.7	19	0.7	4	19.6
"	60 – 90	5.7	33	8.8	51	2.0	12	0.7	4	17.2
"	90 –120	6.0	27	11.0	49	4.6	20	0.9	4	22.5
15.26	90 –120	15.0	34	19.0	43	8.7	20	1.0	2	43.7
15.31	90 –120	3.0	40	3.5	47	0.5	7	0.5	7	7.5
15.34	90 –120	1.8	46	1.5	38	0.2	5	0.4	10	3.9
15.35	90 –120	9.0	36	14.5	58	0.5	2	1.1	4	25.1
16.4	90 –120	4.3	23	9.9	51	4.1	22	0.7	4	19.0
16.5	0 – 30	3.7	52	2.4	34	0.4	6	0.6	8	7.1
"	30 – 60	6.2	36	8.6	50	1.4	8	0.9	5	17.1
"	60 – 90	6.0	36	8.5	51	1.5	9	0.8	5	16.8
"	90 –120	6.0	25	13.7	57	2.9	12	1.3	5	23.9
16.8	0 – 30	2.3	62	0.8	22	0.1	3	0.5	14	3.7
"	30 – 60	4.5	60	2.2	29	0.4	5	0.4	5	7.5
"	60 – 90	2.3	40	2.7	47	0.4	7	0.3	5	5.7
"	90 –120	4.8	27	10.5	58	1.6	9	1.1	6	18.0
16.10	0 – 30	8.0	37	11.2	52	1.6	7	0.7	3	21.5
"	30 – 60	9.5	32	16.5	57	2.5	9	0.6	2	29.1
"	60 – 90	7.5	29	12.6	49	4.8	19	0.7	3	25.6
"	90 –120	8.2	24	19.0	51	5.4	16	1.0	3	33.6
16.12	0 – 30	3.2	62	1.0	19	0.3	6	0.7	14	5.2
"	30 – 60	5.5	61	2.6	29	0.3	3	0.6	7	9.0
"	90 –120	6.7	55	4.3	35	0.5	4	0.7	6	12.2
16.18	0 – 30	9.0	61	5.0	34	0.3	2	0.5	3	14.8
"	30 – 60	8.5	46	7.5	40	2.2	12	0.8	4	19.0
"	60 – 90	6.0	38	7.0	45	2.2	14	0.5	3	15.7
"	90 –120	9.2	40	9.5	41	3.9	17	0.6	3	23.2

Soil Site	Depth	Ca		Mg		Na		K		Total me
		me	%	me	%	me	%	me	%	
16.17	0 – 30	6.0	63	3.0	31	0.1	1	0.5	5	9.6
“	30 – 60	8.5	56	5.5	36	0.4	3	0.8	5	15.2
“	60 – 90	7.5	49	6.2	40	0.9	6	0.8	5	15.4
“	90 –120	7.0	37	9.5	50	1.5	8	0.9	6	18.9
16.19	90 –120	4.0	22	10.4	57	3.1	17	0.8	4	18.3
16.20	0 – 30	3.0	60	0.9	18	0.3	6	0.8	16	5.0
“	30 – 60	7.0	65	3.0	28	0.1	1	0.6	6	10.7
“	90 –120	2.1	53	1.5	37	0.2	5	0.2	5	4.0
16.25	0 – 30	3.9	53	1.7	23	0.1	2	0.6	8	7.3
“	30 – 60	5.5	47	5.0	43	0.6	5	0.6	5	11.7
“	60 – 90	4.7	44	4.7	44	0.8	8	0.4	4	10.6
“	90 –120	2.0	30	3.2	48	1.1	17	0.3	5	6.6
17.5	0 – 30	2.4	47	1.8	35	0.5	10	0.4	8	5.1
“	30 – 60	7.0	43	6.5	40	2.1	13	0.5	3	16.1
“	60 – 90	10.0	30	16.1	49	4.9	15	1.9	6	32.9
17.7	0 – 30	4.2	32	7.7	59	0.8	6	0.4	3	13.1
“	30 – 60	8.5	32	16.0	60	1.6	6	0.5	2	26.6
“	60 – 90	8.1	27	17.2	58	3.7	13	0.6	2	29.6
17.10	0 – 30	3.4	36	4.1	44	1.1	12	0.6	6	9.4
“	30 – 60	5.5	26	11.5	54	3.7	17	0.5	2	21.2
“	60 – 90	6.1	23	13.6	51	6.5	24	0.7	3	26.9

Soil Site	Depth	Ca++		Mg++		Na+		K+		H+		CEC
		me	%	me	%	Me	%	me	%	me	%	me
1	0 – 30	3.5	26	4.1	30	.7	5	.4	3	4.9	36	13.6
1	90 –120	6.8	25	15.4	58	3.7	14	.8	3	-	-	26.7
2	0 – 30	8.0	26	14.5	48	2.2	7	.9	3	4.8	16	30.4
2	90 –120	6.3	24	15.2	57	4.4	16	.9	3	-	-	26.8
3	0 – 30	7.8	26	12.2	41	2.4	8	1.1	4	6.0	20	29.5
3	90 –120	8.4	28	15.8	52	4.9	16	1.3	4	-	-	30.4
8	0 – 30	4.0	27	2.4	16	.3	2	2.4	16	5.7	39	14.8
8	90 –120	6.5	32	11.6	57	.6	3	1.6	8	-	-	20.3
10	90 –120	4.5	19	10.8	46	4.5	19	.5	2	3.2	14	23.5
12	0 – 30	6.7	24	15.8	57	4.5	16	.5	2	-	-	27.5
12	90 –120	4.5	20	12.7	55	4.9	21	.9	4	-	-	23.0
13	0 – 30	3.5	26	4.5	33	.7	5	.3	2	4.7	34	13.7
13	90 –120	5.3	21	13.3	53	5.0	20	1.3	5	-	-	24.9
14	0 – 30	4.4	31	4.0	28	.7	5	.5	4	4.6	32	14.2
14	90 –120	6.5	28	12.3	53	3.4	15	.9	4	-	-	23.1
16	0 – 30	4.3	30	3.6	25	.6	4	.9	6	5.1	35	14.5
16	90 –120	5.7	24	12.3	53	4.1	18	1.3	6	-	-	23.4
19	0 – 30	2.5	25	2.3	23	.6	6	.8	8	3.8	38	10.0
19	90 –120	2.5	23	6.0	56	1.8	17	.4	4	-	-	10.7
21	0 – 30	4.6	38	2.6	21	.5	4	.7	6	3.7	31	12.1
21	90 –120	6.7	44	6.8	44	.6	4	1.3	8	-	-	15.4
25	0 – 30	4.1	25	3.9	24	.6	4	.5	3	7.1	44	16.2
25	90 –120	4.8	26	9.9	54	3.2	17	.6	3	-	-	18.5
29	0 – 30	3.5	39	1.0	11	.1	1	1.8	11	3.3	37	8.9
29	90 –120	4.8	35	6.5	47	1.2	9	1.2	9	-	-	13.7
30	0 – 30	5.2	43	2.3	19	.3	2	1.2	10	3.2	26	12.2
30	90 –120	3.5	32	6.3	57	.2	2	1.1	10	-	-	11.1
31	0 – 30	6.0	58	1.7	17	.2	2	.5	5	1.9	18	10.3
31	90 –120	4.3	43	4.3	43	.6	6	.7	7	-	-	9.9
32	0 – 30	1.8	28	1.2	18	.1	2	.5	8	2.9	45	6.5
32	90 –120	3.9	47	3.9	47	.2	2	.3	4	-	-	8.3
34	0 – 30	3.9	37	2.7	26	.4	4	.5	5	3.0	29	10.5
34	90 –120	3.2	21	8.1	54	3.1	21	.7	5	-	-	15.1
35	0 – 30	5.5	29	3.0	16	.5	3	.8	4	9.0	48	18.8
35	90 –120	3.5	28	6.0	49	2.3	19	.5	4	-	-	12.3
38	0 – 30	5.5	34	6.1	37	1.0	6	1.4	9	2.4	15	16.4
38	90 –120	5.0	23	10.5	49	5.0	23	1.0	5	-	-	21.5
39	0 – 30	5.5	40	3.3	24	.3	2	1.0	7	3.7	27	13.8
39	90 –120	5.1	29	9.0	52	2.2	13	1.0	6	-	-	17.3
41	0 – 30	5.1	39	3.8	29	.3	2	.7	5	3.1	24	13.0
41	90 –120	6.7	76	1.5	17	.2	2	.4	5	-	-	8.8
42	0 – 30	4.0	41	2.3	23	.2	2	.5	5	2.8	29	9.8
42	90 –120	6.9	58	4.3	36	.3	3	.5	4	-	-	12.0
43	0 – 30	4.8	31	3.4	52	.5	3	2.5	16	4.1	27	15.3
43	90 –120	3.3	33	5.7	58	.4	4	.5	5	-	-	9.9
44	0 – 30	5.2	32	5.3	33	.4	2	.7	4	4.5	28	16.1
44	90 –120	5.6	32	9.5	54	1.8	10	.6	3	-	-	17.5
50	0 – 30	3.9	46	.8	10	1.0	12	.5	6	2.2	26	8.4
50	90 –120	4.0	35	5.5	50	.9	8	.8	7	-	-	11.1
52	0 – 30	5.6	37	4.4	29	.7	5	.4	3	4.1	27	15.2
52	90 –120	7.0	37	9.6	51	1.8	9	.6	3	-	-	19.0
54	0 – 30	4.7	30	3.8	25	.5	3	.8	5	5.7	37	15.5
54	90 –120	5.7	29	10.5	53	2.6	13	.6	3	-	-	19.7
55	0 – 30	4.1	38	2.8	26	.4	4	.7	6	2.8	26	10.8
55	90 –120	3.9	36	5.1	47	1.3	12	.6	6	-	-	10.9
56	0 – 30	3.5	33	2.4	23	.3	3	.2	2	4.1	40	10.5
56	90 –120	9.0	47	9.0	47	.4	2	.9	5	-	-	19.3
58	0 – 30	7.1	33	3.8	17	.9	4	.2	1	9.8	45	21.8

Soil Site	Depth	Ca++		Mg++		Na+		K+		H+		CEC
		me	%	me	%	Me	%	me	%	me	%	me
58	90 –120	9.7	42	10.8	47	2.0	9	.7	3	-	-	23.2
60	0 – 30	5.8	39	3.8	26	.5	3	.5	3	4.3	29	14.9
60	90 –120	5.5	28	12.2	62	1.3	7	.7	4	-	-	19.7
62	0 – 30	4.5	49	3.0	33	.5	5	1.2	13	-	-	9.2
62	90 –120	4.8	27	8.9	56	1.6	10	1.1	7	-	-	15.9
63	0 – 30	4.9	31	4.4	28	1.1	7	.2	1	5.3	33	15.9
63	90 –120	5.7	26	12.4	57	2.7	13	.8	4	-	-	21.6
64	0 – 30	7.5	49	2.6	17	.6	4	1.3	8	3.4	22	15.4
64	90 –120	10.2	42	10.0	41	3.2	13	.7	3	-	-	24.1
65	0 – 30	3.6	26	3.0	22	.5	4	1.2	9	5.6	40	13.9
65	90 –120	7.2	32	11.1	50	3.0	13	1.0	4	-	-	22.3
66	0 – 30	2.0	25	1.7	22	.3	4	.1	1	3.8	48	7.9
66	90 –120	6.1	33	9.1	49	2.6	14	.6	3	-	-	18.4
68	0 – 30	2.6	30	1.4	16	.3	3	.4	5	4.0	46	8.7
68	90 –120	3.4	23	8.5	58	2.4	16	.4	3	-	-	14.7
71	0 – 30	5.6	32	5.1	29	1.0	6	.3	2	5.7	32	17.7
72	0 – 30	4.9	36	3.6	26	.7	5	.3	2	4.1	30	13.6
72	90 –120	6.8	33	10.1	49	3.3	16	.5	2	-	-	20.7
73	0 – 30	5.2	36	4.0	27	.6	4	.6	4	4.2	29	14.6
73	90 –120	7.2	33	10.8	50	3.0	14	.5	2	-	-	21.5
76	0 – 30	4.2	41	2.9	28	.4	4	.7	7		20	10.2
76	90 –120	5.6	36	8.3	53	1.0	6	.7	4	-	-	15.6
77	0 – 30	9.9	62	3.1	24	.5	3	1.8	11	-	-	16.0
77	90 –120	3.1	20	8.1	53	2.4	16	1.0	7	-	-	15.2
78	0 – 30	3.9	29	3.8	29	.6	5	.4	3	4.6	35	13.3
78	90 –120	6.8	40	8.7	51	.6	4	.9	5	-	-	17.0
79	0 – 30	3.5	27	1.4	11	.7	2	2.6	20	5.0	39	12.8
79	90 –120	10.2	67	4.3	26	.9	6	.9	6	-	-	16.3
80	0 – 30	2.43.	32	.8	11	.1	1	1.0	14	3.1	42	7.4
80	90 –120	0	31	4.7	48	1.6	16	.4	4	-	-	9.7
83	0 – 30	1.3	19	.6	9	.1	1	.4	6	4.6	66	7.0
83	90 –120	2.6	23	6.8	60	1.7	15	.3	3	-	-	11.4
84	0 – 30	4.4	41	1.8	17	.2	2	.9	8	3.5	32	10.8
84	90 –120	3.0	37	3.8	46	1.1	13	.3	4	-	-	8.2
87	0 – 30	5.9	40	3.2	22	.6	4	.7	5	4.3	29	14.7
87	90 –120	9.0	39	11.2	49	2.6	11	.4	2	-	-	23.0
88	0 – 30	5.1	30	3.0	22	.6	4	.9	5	6.5	38	16.9
88	90 –120	8.2	37	10.9	49	2.6	12	.4	2	-	-	22.1
90	0 – 30	9.7	48	5.5	27	.5	2	1.5	7	3.0	15	20.2
90	90 –120	4.0	21	11.4	59	2.8	15	1.0	5	-	-	19.2
91	0 – 30	5.5	48	1.8	16	.6	5	1.4	12	2.1	18	11.4
91	90 –120	6.3	38	8.0	48	.9	5	1.6	10	-	-	16.8
92	0 – 30	5.0	39	3.3	26	.4	3	.9	7	3.2	25	12.8
93	0 – 30	3.1	28	2.3	21	.5	5	.6	5	4.6	41	11.1
93	90 –120	5.0	39	4.9	38	.5	4	.3	2	2.2	17	12.9
96	0 – 30	2.9	17	1.7	27	.5	8	.1	2	1.0	16	6.2
96	90 –120	5.5	44	5.8	47	.7	6	.4	3	-	-	12.4
97	0 – 30	1.8	43	1.2	29	.2	5	.2	5	.8	19	4.2
97	90 –120	2.3	47	2.1	43	.3	6	.2	4	-	-	4.9
98	0 – 30	5.7	43	1.9	14	.8	6	1.1	8	3.9	29	13.4
98	90 –120	5.9	32	8.5	46	2.4	13	1.7	9	-	-	18.5
99	0 – 30	7.5	42	5.0	28	1.1	6	1.9	11	2.3	13	17.8
99	90 –120	2.4	21	6.4	55	1.8	16	1.0	9	-	-	11.6
106	0 – 30	5.6	38	3.0	20	1.0	7	.4	3	4.7	32	14.7
106	90 –120	5.4	28	9.4	49	3.1	16	1.1	6	-	-	19.0
125	0 – 30	4.9	35	3.9	27	.9	6	.7	5	3.8	27	14.2
125	90 –120	3.0	31	5.2	54	.7	7	.7	7	-	6	9.6
127	0 – 30	3.5	34	2.2	21	.4	4	.3	3	3.9	38	10.3

Soil Site	Depth	Ca++		Mg++		Na+		K+		H+		CEC
		me	%	me	%	Me	%	me	%	me	%	me
127	90 –120	3.8	47	2.5	31	.3	4	.2	2	1.3	16	8.1
133	0 – 30	3.1	35	2.1	24	.5	5	.2	2	2.9	33	8.8
134	0 – 30	2.8	34	2.0	24	.3	4	.3	4	2.9	35	8.3
134	90 –120	4.1	55	2.7	36	.2	3	.4	5	-	-	7.4
135	0 – 30	6.0	43	4.6	33	1.1	8	1.2	9	2.7	19	13.9
135	90 –120	2.9	25	6.1	53	1.2	10	1.3	11	-	-	11.5
136	0 – 30	5.2	35	3.5	23	.8	5	.7	5	4.8	32	15.0
136	90 –120	7.0	45	6.8	44	.8	5	.9	6	-	-	15.5
138	0 – 30	7.8	35	6.0	27	1.4	6	1.0	5	5.8	26	22.0
138	90 –120	6.9	37	8.6	46	2.1	11	1.2	6	-	6	18.8
139	0 – 30	2.4	34	1.9	27	.3	3	.2	4	2.3	32	7.1
139	90 –120	1.8	50	1.4	39	.2	6	.2	6	-	-	3.6
140	0 – 30	3.2	35	1.8	20	.3	3	.7	8	4.2	46	9.2
140	90 –120	1.4	20	4.3	62	.8	12	.4	6	-	-	6.9
141	0 – 30	4.6	38	2.4	20	.9	8	1.1	9	3.0	25	12.0
141	90 –120	4.0	31	5.9	45	1.8	14	1.3	10	-	-	13.0
149	0 – 30	3.8	38	2.9	29	.2	2	.5	5	2.5	24	9.9
149	90 –120	6.6	51	4.8	37	.8	6	.7	5	-	-	12.9
163	90 –120	10.8	43	11.8	47	1.6	6	.7	3	-	-	24.9
168	0 – 30	3.9	31	3.8	30	.5	4	.6	5	3.7	30	12.5
168	90 –120	9.0	38	11.0	47	3.1	13	.4	2	-	-	23.5
170	90 –120	6.0	24	14.0	57	3.8	16	.7	3	-	-	24.5
173	90 –120	6.7	31	11.4	52	3.2	15	.5	2	-	-	21.8
174	0 – 30	2.9	23	2.7	21	.3	2	.4	3	6.5	51	12.8
176	0 – 30	4.8	24	5.7	29	1.1	6	.5	3	7.5	38	19.6
179	0 – 30	11.0	36	13.0	42	.8	3	.8	3	5.0	16	30.6
179	90 –120	6.3	29	12.6	58	2.4	11	.6	3	-	-	21.9
183	0 – 30	2.2	33	1.4	21	.2	3	.5	7	2.4	36	6.7
183	90 –120	3.5	49	2.9	40	.2	3	.6	8	-	-	7.2
185	0 – 30	4.2	43	1.2	12	.1	1	.8	8	3.5	36	9.8
185	90 –120	5.0	32	6.7	44	2.9	19	.8	5	-	-	15.4
188	0 – 30	4.0	29	1.6	12	.1	1	1.1	8	6.8	50	13.6
188	90 –120	5.5	34	7.7	47	2.1	13	1.1	7	-	-	16.4
190	0 – 30	3.1	31	2.9	29	.2	2	.4	4	3.5	34	10.1
190	90 –120	4.0	49	3.4	42	.4	5	.3	4	-	-	8.1
192	0 – 30	4.9	38	3.1	24	.2	2	1.2	9	3.4	27	12.8
192	90 –120	10.9	57	6.0	32	.6	3	1.5	8	-	-	19.0
193	90 –120	4.5	39	5.3	46	1.3	11	.5	4	-	-	11.6
196	90 –120	5.6	27	10.8	52	3.0	14	1.5	7	-	-	20.9
200	0 – 30	4.1	31	2.1	16	.9	7	.8	6	5.5	41	13.4
200	90 –120	6.2	47	4.1	31	.4	3	.6	5	1.8	14	13.1
202	90 –120	2.5	31	4.8	59	.5	6	.3	4	-	-	8.1
207	90 –120	6.8	37	8.3	45	1.8	10	1.6	9	-	-	18.5
208	90 –120	2.8	28	5.3	52	.4	4	.4	4	1.0	10	9.9
209	90 –120	3.7	42	3.0	34	.4	5	.3	3	1.4	16	8.8
210	0 – 30	6.6	44	1.9	13	.1	1	1.3	9	5.1	34	15.0
211	0 – 30	8.9	47	4.7	25	.6	3	.6	3	4.3	23	19.1
212	0 – 30	2.6	31	1.5	18	.7	8	.3	4	3.2	39	8.3
212	90 –120	3.8	38	5.0	49	.5	5	.8	8	-	-	10.1
213	90 –120	1.7	22	4.2	53	.5	6	1.5	19	-	-	7.9
214	0 – 30	8.5	43	4.2	21	.7	4	.5	3	5.7	-	19.6
214	90 –120	10.7	44	9.8	40	.7	3	3.3	13	-	-	24.5
215	0 – 30	6.6	47	3.0	22	.7	5	.3	2	3.3	24	13.9
215	90 –120	7.4	42	8.6	49	.7	4	.8	5	-	-	17.5
217	90 –120	6.1	62	2.9	30	.4	4	.4	4	-	-	9.8
218	0 – 30	6.0	38	3.7	23	.8	5	.4	3	4.9	31	15.8
218	90 –120	9.2	43	8.9	42	2.9	14	.4	2	-	-	21.4
219	90 –120	4.1	22	9.7	53	3.6	20	.9	5	-	-	18.3

Soil Site	Depth	Ca++		Mg++		Na+		K+		H+		CEC
		me	%	me	%	Me	%	me	%	me	%	me
220	0 – 30	6.4	37	6.7	39	3.6	21	.6	3	-	-	17.3
220	90 –120	7.5	38	6.8	34	1.8	9	.6	3	3.2	16	19.9
221	0 – 30	4.7	26	4.1	23	1.2	7	.3	2	7.6	42	17.9
221	90 –120	7.6	33	9.7	42	5.5	24	.4	2	-	-	23.2
222	0 – 30	6.1	39	4.1	26	1.4	9	.5	3	3.5	22	15.6
222	90 –120	10.6	52	7.9	39	.8	4	.9	4	-	-	20.2
223	0 – 30	4.4	36	2.8	23	.3	2	.9	7	3.9	32	12.3
223	90 –120	6.0	39	7.0	46	1.9	12	.4	3	-	-	15.3
224	0 – 30	7.5	36	5.5	27	.7	3	1.4	7	5.6	27	20.7
224	90 –120	7.5	32	12.3	53	2.8	12	.5	2	-	-	23.1
225	0 – 30	4.5	27	4.8	28	1.8	11	.8	5	5.0	30	16.9
225	90 –120	8.7	37	11.0	47	3.1	14	.5	2	-	-	23.6
226	0 – 30	3.0	32	2.6	28	1.0	11	.6	6	2.1	23	9.3
226	90 –120	5.7	35	8.3	52	1.6	10	.5	3	-	-	16.1
227	0 – 30	6.7	35	5.8	31	1.4	7	.6	3	4.5	24	19.0
227	90 –120	5.8	27	11.0	52	3.7	17	.8	4	-	-	21.3
228	0 – 30	7.7	43	3.9	55	.7	4	1.0	6	4.7	26	18.0
228	90 –120	10.5	44	11.0	46	1.6	7	.7	3	-	-	23.8
229	0 – 30	4.9	36	2.7	20	.4	3	1.4	10	4.4	32	13.8
229	90 –120	8.7	45	9.1	47	.8	4	.7	4	-	-	19.3
230	0 – 30	3.9	36	2.9	27	.4	4	.6	6	2.9	27	10.7
230	90 –120	10.0	52	7.5	39	.7	4	1.0	5	-	-	19.2
231	0 – 30	1.5	27	.5	9	.2	4	1.1	20	2.3	41	5.6
231	90 –120	5.4	50	3.5	33	1.2	11	.6		-	-	10.7
232	0 – 30	1.4	23	.7	11	.2	3	.5	8	3.4	55	6.2
232	90 –120	2.9	21	6.8	48	3.9	28	.5	4	-	-	14.1
233	0 – 30	4.7	28	5.1	31	1.2	7	1.0	6	4.6	28	16.6
233	90 –120	4.5	26	8.3	49	3.7	22	.5	3	-	-	17.0
234	0 – 30	5.1	38	3.3	24	.7	5	.2	1	4.3	32	13.6
234	90 –120	8.1	42	8.8	46	1.8	9	.4	2	-	-	19.1
235	0 – 30	5.8	31	5.5	29	.8	4	.4	2	6.3	34	18.8
235	90 –120	10.8	45	11.0	46	1.8	7	.5	2	-	-	24.1
236	0 – 30	2.5	24	1.7	16	.3	3	1.9	18	4.0	38	10.4
236	90 –120	3.2	25	7.0	55	1.8	14	.7	6	-	-	12.7
237	0 – 30	8.1	66	3.2	26	.5	4	.4	3	-	-	12.2
237	90 –120	6.3	37	9.4	55	.9	5	.5	3	-	-	17.1
238	0 – 30	5.0	36	4.1	29	.9	6	.5	4	3.5	25	14.0
238	90 –120	5.8	34	9.4	55	.9	5	.9	5	-	-	17.0
239	0 – 30	4.6	34	2.4	18	.6	4	1.0	7	4.8	36	13.4
239	90 –120	5.3	29	9.0	50	2.9	16	.8	4	-	-	18.0
240	0 – 30	6.3	44	3.0	21	1.7	12	.5	3	2.8	20	14.3
240	90 –120	9.7	44	10.1	46	1.0	5	1.0	5	-	-	21.8
241	0 – 30	5.2	30	5.1	29	.6	3	.7	4	5.9	34	17.5
241	90 –120	7.4	27	15.1	55	4.1	15	.7	3	-	-	27.3
242	0 – 30	4.7	39	3.3	27	.3	2	.4	3	3.4	28	12.1
242	90 –120	7.4	39	10.1	53	1.1	6	.6	3	-	-	19.2
243	0 – 30	7.1	32	8.0	36	1.7	8	.9	4	4.8	21	22.5
243	90 –120	5.0	30	9.1	54	1.9	11	.7	4	-	-	16.7
244	0 – 30	4.2	30	3.3	24	.5	4	1.1	8	4.7	34	13.8
244	90 –120	6.8	27	14.1	56	3.9	15	.6	2	-	-	25.4
245	0 – 30	3.2	30	2.4	22	.4	4	.9	8	3.9	36	10.8
245	90 –120	5.7	35	8.8	53	1.2	7	.8	5	-	-	16.5
246	0 – 30	3.4	33	3.0	28	.7	7	.2	2	2.9	28	10.2
246	90 –120	9.3	46	8.9	44	1.3	6	.9	4	-	-	20.4
247	0 – 30	5.9	35	2.9	17	.5	3	1.3	8	6.1	37	16.7
247	90 –120	8.6	43	9.4	47	1.3	6	.6	3	-	-	19.9

Appendix V - Depth to Watertables and Hydraulic Conductivity (K) for selected sites under investigation

Soil Type	Site No.	Depth of Watertable cm	K m/day
	15/15	100	.12
Nanneella fine sandy loam	15/21	81	.88
	15/31	63	.50
	15/35	51	.31
	15/36	54	.86
	16/1	38	1.56
	16/2	43	1.63
	16/12	118	.66
	16/15	111	.18
	16/22	72	2.00
	16/25	56	1.13
	19	66	.51
	21	82	2.14
	22	111	.19
	25	124	.22
	42	62	1.20
	43	80	1.13
	62	90	.21
	64	54	.29
	76	33	.21
	78	112	.19
	79	59	.38
	80	99	.61
	91	76	.20
	93	83	.16
	96	54	.77
	99	99	.21
	135	61	1.89
	136	78	1.63
	139	50	1.41
	140	85	2.07
	152	100	.20
	185	103	1.47
	190	95	.41
	202	139	1.08
	205	108	1.08
	209	63	1.56
	212	90	0.92
Mean			0.85
SD			0.63
	29	89	1.14
Nanneella loam fine sand	32	200	.28
	35	97	.27
	50	146	.28
	68	86	.49
	125	51	1.06
	127	66	1.06
Mean			.65
SD			.41

Soil Type	Site No.	Depth of Watertable cm	K m/day
	15/23	82	1.94
Timmering loam	15/25	27	.93
	15/35	51	.31
	16/17	32	1.23
	16/20	59	1.65
	33	104	.28
	52	109	.05
	54	61	.19
	55	59	.27
	56	97	.14
	58	87	.16
	60	101	.14
	65	76	.04
	71	44	.16
	72	37	.12
	73	35	.18
	87	82	.04
	106	85	.04
Mean			0.44
S.D.			0.59
	15/24	67	.84
	15/26	46	.26
	15/26B	62	3.26
	15/27	57	.38
Wanalta loam	16/3	28	3.13
	16/4	22	1.69
	16/15	57	2.44
	16/16	72	.18
	16/18	67	.84
	16/19	70	1.76
	10	76	.03
	12	103	.09
	13	48	.10
	63	65	.18
	215	96	.08
	48	79	.07
Mean			.96
S.D.			1.14
	16/24	63	.29
Wana clay loam	44	112	.10
	163	126	.17
	218	112	.17
Mean			.18
S.D.			.08
	47	108	.75
Type 1H	200	18	.80
	141	87	1.86
Mean			1.14
S.D.			.63
Type 1	77	102	.34
	90	106	.18
Mean			.26
S.D.			.11
Rochester clay	14	77	.09

Appendix VI - Depth to Watertables

Site No.	Depth to watertable cm.	Site No.	Depth to watertable cm.
15/15	100	34	85
15/20	90	35	97
15/21	81	36	160
15/22	79	*38	90
15/23	82	*39	90
15/24	67	41	85
15/25	27	42	62
15/26	47	43	80
15/27	57	44	112
15/28	76	*47	108
15/29	66	48	79
15/30	102	*50	146
15/31	63	52	109
15/32	84	54	61
15/33	105	55	59
15/34	80	56	97
15/35	51	57	125
15/36	54	58	87
16/1	38	59	115
16/2	43	60	101
16/3	28	61	50
16/4	22	62	90
* 16/5	57	63	65
* 16/6	59	64	54
* 16/9	45	65	76
*16/12	118	66	67
16/13	135	68	86
16/15	111	69	76
16/16	72	71	44
16/17	32	72	37
16/18	45	73	35
16/19	70	75	140
16/20	59	76	33
16/21	67	77	102
16/22	72	78	112
16/23	51	79	59
16/24	63	*80	99
*16/25	56	81	90
10	76	82	100
11	125	*83	135
12	103	84	95
13	48	86	80
14	77	87	82
19	66	88	130
20	110	89	95
21	82	90	106
22	111	*91	76
25	124	*92	120
26	110	93	83
27	150	*94	155
29	98	96	54
30	102	97	40
32	200	98	85
33	104	99	99

Site No.	Depth to watertable cm.	Site No.	Depth to watertable cm.
106	85	190	95
110	190	192	140
114	200	193	95
123	74	200	18
125	51	201	190
127	66	202	139
132	175	203	109
133	60	205	108
134	84	207	165
135	61	209	63
136	78	212	90
*137	90	214	85
138	85	215	96
139	50	218	112
140	85	220	140
148	140	222	109
149	75	225	100
*152	100	226	110
156	75	228	1250
163	126	229	120
182	130	232	120
183	120	243	100
*185	103	246	150

* DRY LAND

Appendix VII - Watertable Salinities me/L

Site No.	E.C. µS/cm	Ca++	Mg++	Na+	K+
15/24	16,900	22.0	59.2	113.0	.5
15/25	19,100	23.0	62.5	134.8	1.3
15/26	3,090	5.5	8.3	19.1	.3
16/1	3,510	8.0	10.0	16.1	.5
16/2	6,880	7.0	21.9	45.2	.4
16/4	16,300	11.0	72.5	101.7	1.0
16/5	7,300	7.0	2.8	44.3	1.0
16/6	933	3.4	1.8	4.0	.05
16/12	6,430	12.0	22.8	32.2	1.3
16/17	1,157	3.3	3.4	5.0	.4
16/20	275	.7	.6	1.0	.2
16/22	2,430	4.0	6.3	13.5	.4
16/23	4,130	16.0	11.1	18.3	1.1
16/24	745	1.1	1.5	4.8	.2
16/25	14,000	22.0	44.8	80.9	.7
10	15,100	11.0	48.3	115.6	.4
12	19,900	17.0	61.7	140.8	1.2
13	14,200	4.5	36.7	97.4	.9
14	6,050	3.2	17.5	45.2	.7
19	7,340	4.4	16.7	54.3	.5
21	6,610	6.9	27.5	33.9	1.4
25	16,200	14.5	50.0	98.3	1.0
29	2,070	1.0	4.3	10.7	1.0
30	4,330	3.4	12.5	18.3	2.1
32	2,820	3.6	12.1	12.8	.5
34	10,500	4.9	26.7	67.0	1.4
35	4,870	2.4	10.0	38.3	.7
38	4,740	1.4	9.2	37.8	.7
39	15,700	2.0	27.5	78.3	2.5
41	1,120	3.4	1.3	5.7	.3
42	1,480	4.8	4.0	6.0	.4
43	3,810	5.0	16.7	17.0	1.1
44	6,360	8.3	21.7	35.0	.6
47	1,269	2.8	3.3	5.1	.7
50	19,200	44.0	80.0	93.9	2.8
52	2,860	2.2	7.5	20.9	.3
54	7,050	4.7	25.0	40.9	.5
55	6,250	7.0	15.8	40.0	1.1
56	1,930	2.9	7.1	5.9	.6
58	3,030	2.8	8.8	17.8	.4
60	3,810	2.8	11.7	22.6	.4
62	21,300	31.7	95.3	101.0	4.5
63	4,410	2.0	13.3	27.8	.4
64	13,890	35.0	45.0	72.2	1.1
65	5,740	36.0	13.3	30.9	.6
66	3,940	3.8	8.3	27.6	.3
68	33,600	43.2	150.0	193.0	1.7
71	11,100	3.3	40.0	55.7	.4
72	4,580	3.2	10.0	30.9	.2
73	2,170	3.2	4.2	14.3	.1
76	5,900	9.5	20.8	27.4	1.1

Site No.	E.C. µS/cm	Ca++	Mg++	Na+	K+
77	19,200	22.2	81.7	96.5	2.3
78	2,100	3.2	6.7	11.1	.7
79	2,230	6.6	3.8	10.7	.8
80	5,150	3.3	10.0	37.0	.6
83	33,500	34.0	141.7	197.8	1.4
84	2,250	2.8	4.0	14.6	.4
87	3,570	3.7	10.0	22.2	.1
88	1,830	1.7	2.9	13.0	.1
90	22,400	25.3	100.0	111.3	2.0
91	14,300	35.0	41.7	35.7	3.6
92	15,900	18.3	51.7	89.6	.7
93	2,540	7.7	8.3	9.6	.3
96	1,700	4.0	4.6	8.3	.3
97	1,950	5.7	5.0	6.1	.4
98	10,060	10.9	31.7	56.5	2.7
99	27,400	24.0	104.0	165.2	4.8
106	7,370	7.6	24.2	49.6	1.2
123	14,700	22.5	51.7	83.5	2.0
125	2,300	3.9	13.3	12.6	.9
127	1,390	4.3	3.9	6.5	.5
133	2,010	7.2	4.6	10.2	.1
134	1,800	5.6	5.0	8.0	.7
135	6,010	5.9	22.5	36.1	2.8
136	2,260	4.5	8.3	11.3	.8
138	14,500	34.0	63.3	76.5	1.9
139	2,380	6.3	1.8	11.5	.3
140	6,250	6.5	25.8	38.7	.9
141	5,980	6.2	25.8	38.3	2.2
149	1,670	4.2	3.8	8.5	.5
152	4,360	3.8	10.0	31.0	.4
163	6,530	11.7	31.7	30.0	.3
185	7,350	6.0	15.8	63.0	.7
190	1,860	4.7	6.7	10.0	.2
200	3,280	8.5	9.2	17.0	.4
202	1,440	2.8	7.5	7.0	.6
203	1,013	1.3	3.5	6.0	.1
205	1,440	4.9	6.0	6.0	.6
209	1,610	3.0	3.9	10.0	.2
212	3,410	3.8	15.0	20.0	.7
215	2,050	4.5	10.0	11.0	.4
218	5,520	9.5	12.5	43.0	.1
222	3,360	9.0	14.2	12.0	.6
226	6,890	9.0	27.5	40.0	.4
228	3,040	4.2	7.5	23.0	.2
232	1,820	5.0	10.3	7.0	.5

Appendix VIII - PASTURE GROWTH

Site No.	Pasture Growth Class	Site No.	Pasture Growth Class
15/24	8	140	2
15/25	8	141	3
16/17	2	149	1
16/20	1	185	6
16/25	7	190	2
10	3	200	3
12	3	202	2
13	3	212	5
14	2	215	5
19	3	218	6
21	1	222	5
25	3	225	5
30	3	226	6
34	3	228	2
35	5	232	7
39	6		
41	5		
42	3		
43	6		
44	5		
52	4		
54	5		
55	3		
56	2		
58	2		
60	3		
62	8		
63	3		
64	8		
65	3		
66	3		
68	8		
72	7		
77	4		
78	5		
79	5		
83	8		
87	4		
90	6		
91	8		
92	8		
93	4		
96	4		
97	4		
99	7		
106	5		
127	2		
134	3		
135	5		
136	2		
138	5		
139	2		

Pasture Growth Classes

1 = Very good
2 = Good
3 = Good with slight affected check bank
4 = Fair
5 = Fair with affected check bank
6 = Poor
7 = Very poor
8 = Bare land (no growth)

Appendix IX - Chemical Methods:

Air dried (2 mm) soil was used for all analyses.

Electrical Conductivity (E.C.) pH and Chloride

A 1:5 soil water suspension was shaken for one hour, the electrical conductivity was determined using a conductivity cell. The same suspension was used to determined pH using a glass electrode. Chloride was determined by argentometric titration using the electrometer method of Best (1929).

Exchangeable Cations

After the removal of soluble salts by washing with a 10 per cent solution of ethanediol in methylated spirit, exchangeable cations were leached using 1 M ammonium chloride adjusted to pH 8.5. Calcium magnesium, sodium and potassium were determined in the leachate using atomic absorption spectrophotometry. Hydrogen (acidity) ions have been determined on soil with pH 8 or less by Mehlichs Barium Chloride Triethanolamine method (reference pH 8.0) using the modification of Peech et al. (1962).

Exchangeable Sodium Percentage (ESP)

$$\frac{Na^{+} \times 100}{CEC}$$

where CEC = cation exchange capacity
SAR = Sodium Adsorption Ratio, which is

$$\frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where Na^{+}, Ca^{++} and Mg^{++} are concentrations in m.e./L in the groundwater.