CHAPER FOUR: METHODS AND MATERIALS

4.1 Surveys

4.1.1 Landholder Survey

The first stage of the project was to survey the extent and severity of saline/alkaline scalds in both the Bergen-Op-Zoom/Ohio and Harhnam landcare groups. A questionnaire (see Appendix A) was distributed to all members of both landcare groups to ascertain the location of saline/alkaline scalds and the number of these on each property. The questionnaire also served to educate landholders about the characteristics of saline/alkaline scalds and help them identify possible affected sites on their properties. The characteristics listed below were used as a general guide for landholders, with sites exhibiting one or a combination of the characteristics listed below:

(1) trees dying for no apparent reason;
(2) grasses dying and bare patches of soil appearing;
(3) soil becoming wet or waterlogged;
(4) stock congregating on, and licking the surface of the area;
(5) salt encrustations appearing on the soil surface;
(6) surface of the bare soil is "puffy" to walk over;
(7) excess quantities of runoff flowing from the area causing erosion of the site and area below it.

Source: (Hamilton and Lang 1978)

4.1.2 Field Survey

All properties which responded to the original questionnaire were visited and suspected saline/alkaline scalds inspected. A total of 50 scalds were classified according to their position in the landscape, slope, dimensions, site characteristics and vegetation and the results recorded on a data sheet (Appendix B). Site characteristics were categorised as follows:

a) Green spring - as the name implies these areas were natural springs possessing waterlogged conditions and green vegetation present all year round. The source of water for these springs is unknown but the springs are probably associated with a confined aquifer or fault which results in hydraulic pressure forcing water to the surface.

b) Scalded spring - these areas are similar in nature to green springs but do not possess vegetation

and consist of a waterlogged bare area. Salt incrustations are common on the surface of the waterlogged soils.

c) Green local - these areas are different to springs from bare areas in that they are not consistently waterlogged, but in periods of high rainfall they tend to become boggy and sticky with low water infiltration capacity. Vegetation is present on these sites all year round and generally consists of *Cynodon dactylon* (couch), *Hordeum marinum* (sea barley grass) and *Pennisetum alopecuroides* (swamp foxtail).

d) Scalded local - these areas are saline/alkaline scalds which are bare of vegetation all year round, but become sticky and boggy after rain and dry and crusty during dry periods.

Surface soil pH was determined in the field of all saline/alkaline scalds using a field test kit and 2M HCl was used to test for the presence of free carbonates/bicarbonates (Kreeb *et al.* 1995). Soil samples were collected from the centre of each scald using a 5 cm hand auger at 0-100mm, 100-200mm, 200-300mm and 300- 400 mm from the soil surface. The samples were subsequently analysed for pH and electrical conductivity. The pH of each sample was determined on a 1:5 soil:water mix using an Activon pH meter. Electrical conductivity was also determined using a 1:5 soil:water extract and a Radiometer Copehagen CDM 83 conductivity meter calibrated at 20^0C.

4.1.3 Installation of Piezometer Tubes

A total of 46 shallow piezometer tubes were installed at fourteen properties. Each piezometer tube consisted of a 50 mm PVC pipe inserted into a 300 mm wide hole produced by a drilling rig. The holes were 4 m deep to tap shallow groundwaters. The bottom 0.5 m of the PVC pipe was drilled with slots to allow groundwaters at that specific depth to enter the tube. Each piezometer was placed in the centre of the hole and gravel poured around the pipe to a depth of 1 m to ensure the holes in the PVC pipe would not be clogged with soil. Soil was then used to fill the remainder of the hole outside the PVC pipe. The top of the piezometer was then sealed using a mix of bentonite and cement which formed a plug at the surface of the soil. The piezometer was then cut at a height of 1 m from the soil surface and a black plastic cap fitted to ensure that no contamination of the water occurred (Fig. 4.1). One set of water samples was collected on 13/08/92 using a 12 volt submersible pump and analyses for electrical conductivity and pH were carried out. The location of each piezometer tube was determined by a geographic positioning system (GPS). Landholders were

requested to fence the piezometer tubes to avoid damage caused by stock (Plate 4.1). Piezometer tubes were not installed at all sites because of difficulties in getting the heavy drilling rig to some locations.

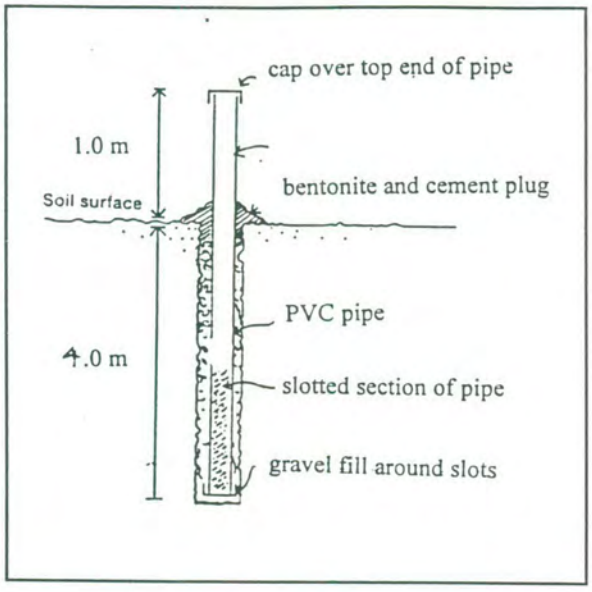

Figure 4.1 Diagrammatic representation of piezometer tubes used in the research study.

Plate 4.1 Fenced off piezometer tubes at "Wollun Station", Wollun (20.12.93).

4.1.4 Detailed Investigation of a Scald at "Adgin Green", Uralla

A scald on the property "Adgin Green", Uralla was sampled in detail as little information was available concerning the below ground distribution of salts of saline/alkaline scalds on the Northern Tablelands. An area of 20 metres by 24 metres was pegged out in a 4 by 5 metre grid (Plate 4.2) and at each grid intersection a soil core was removed intact at 0-100 mm, 100-200 mm, 200-300 and mm 300-400 mm using a hydraulic soil corer which was mounted on a 4WD supplied by Lanfax laboratories. A surface map was generated of the scald areas by sketching the location of bare patches within the grid (Fig. 4.2). Laboratory analyses of the soil samples (see Appendix C) were carried out by Lanfax Laboratories, Armidale for the following parameters:

(a) exchangeable cations: sodium, calcium, magnesium, potassium
(b) anions: sulphates, chlorides, carbonates
(c) electrical conductivity
(d) sodium adsorption ratio (SAR)
(e) exchangeable sodium percentage (ESP)
(f) pH
(g) bulk density
(h) total soluble salts (cations + anions) for 0-100 mm, 100-200 mm, 200-300 mm and 300- 400 mm levels.

Exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) were calculated using the results from the cations. The results were then plotted in graph form with an overlay of the actual position of the scald relative to the soil samples (Appendix D). Comparisons of sodium levels, SAR, EC and pH were then made between the soil cores and the bare scalded area to see if a correlation existed. The total soluble salt load for each core and for each layer over the grid area were calculated.

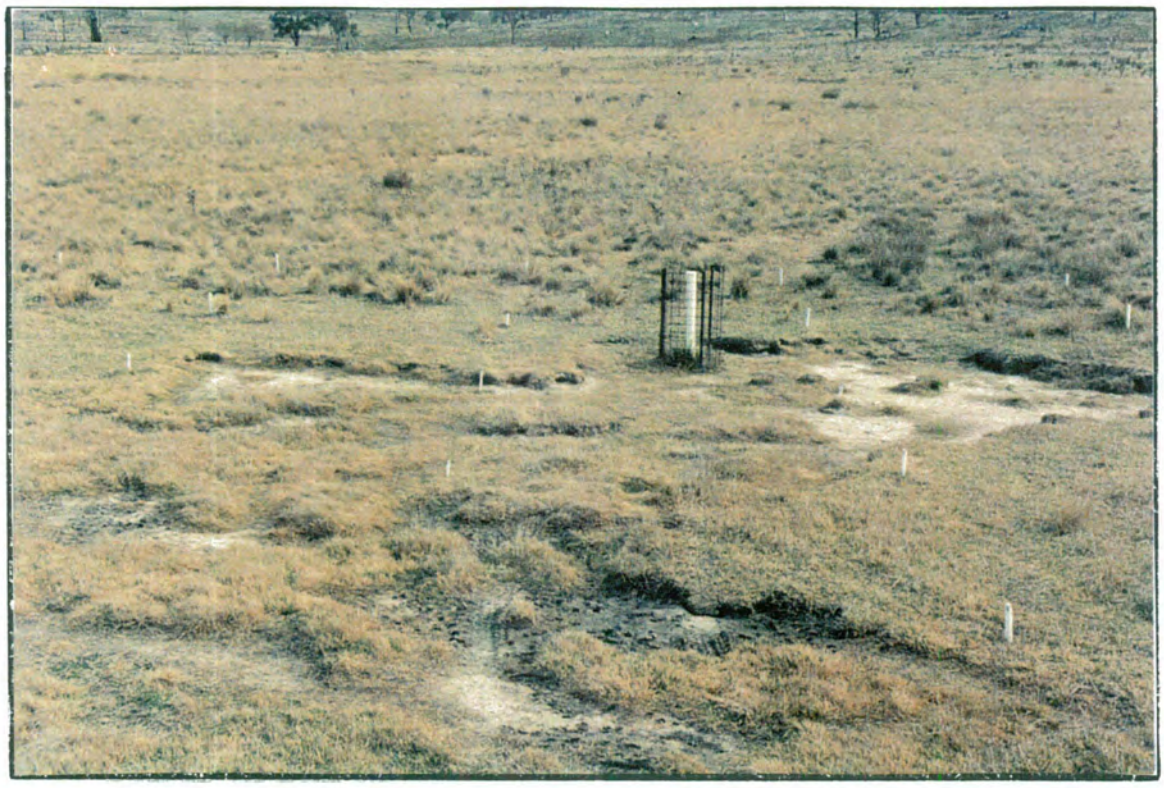

Plate 4.2 Grid system of pegs for removal of soil cores at "Adgin Green", Uralla (10.10.92).

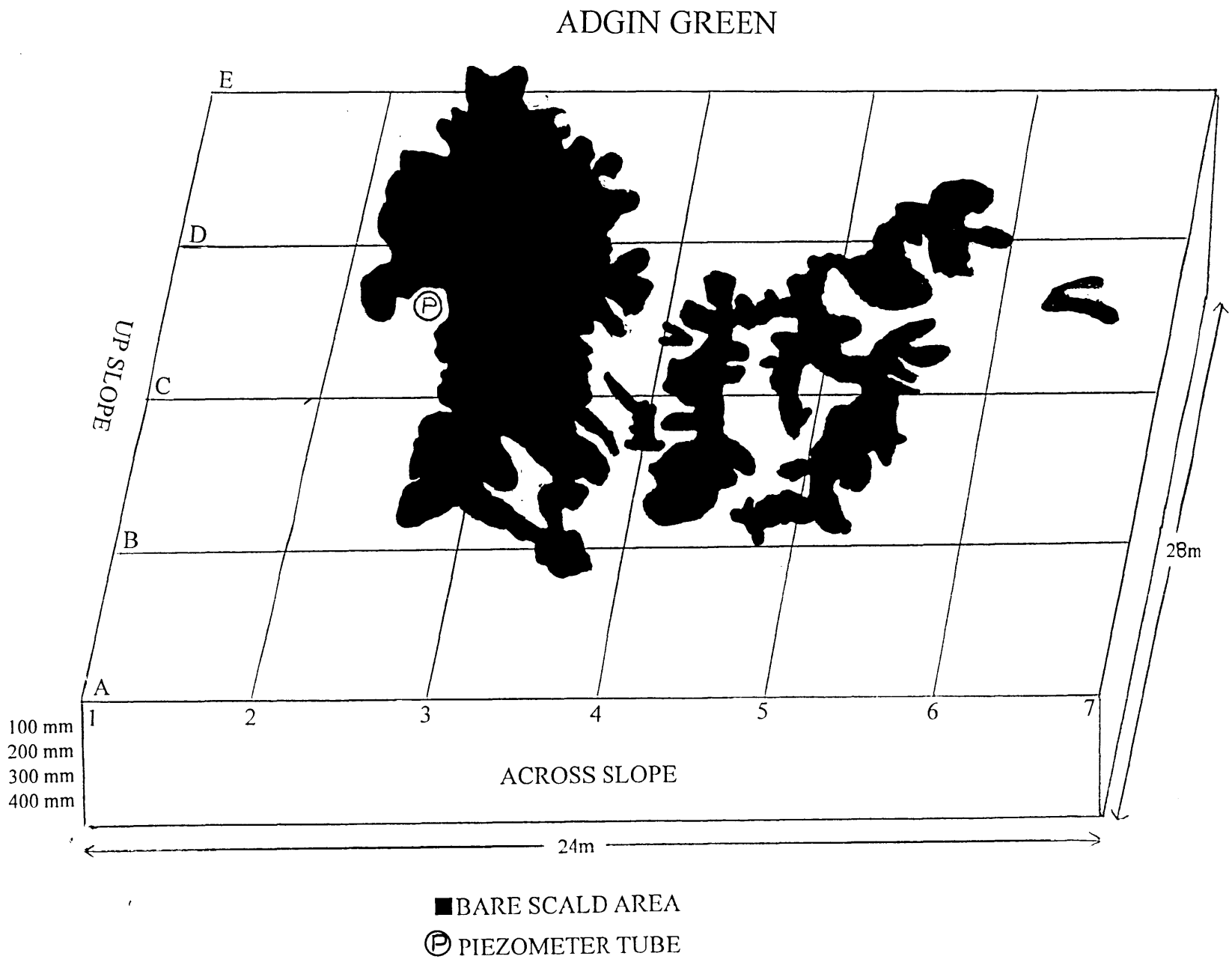

Figure 4.2 Diagrammatic representation of grid system on a scald at "Adgin Green", Uralla.

4.1.5 Soil Pit

A soil pit 4 metres by 2 metres wide by 2 metres deep was dug at the property "Wollun Station" to investigate the soil horizons below a scald area (Plate 4.3).

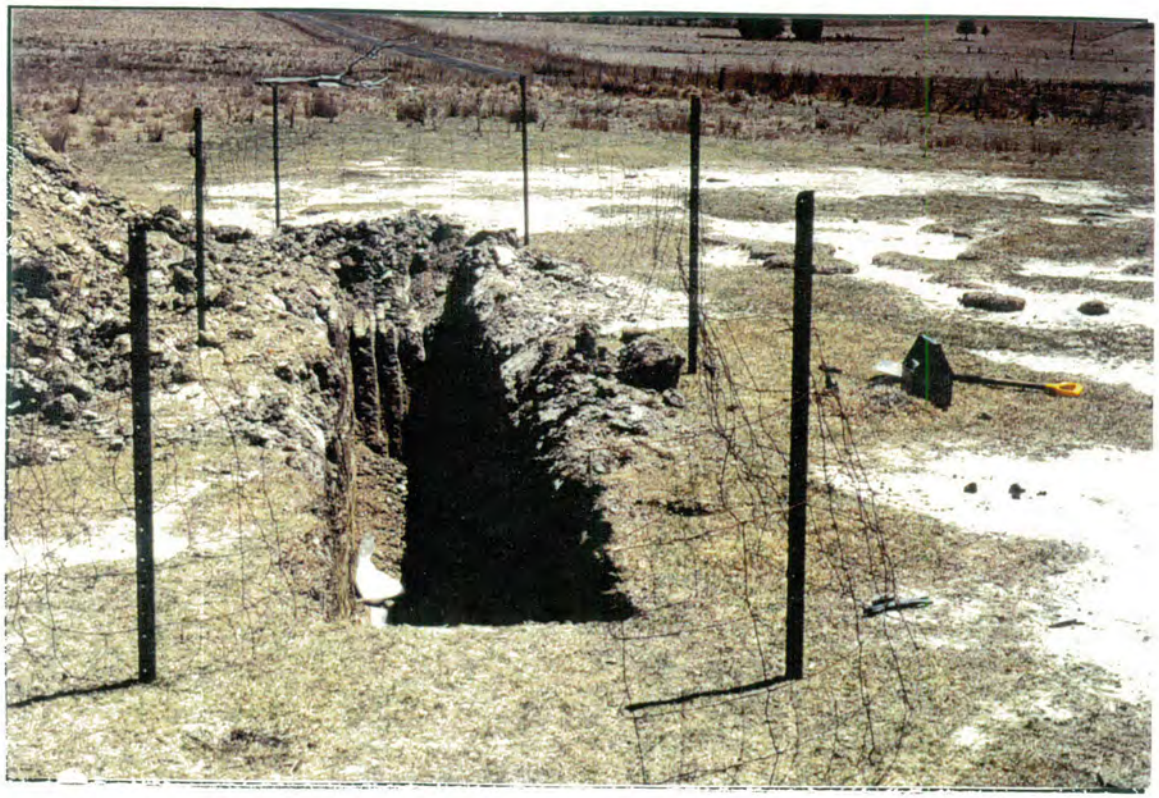

Plate 4.3 Soil pit dug at "Wollun Station", Wollun to investigate soil horizons (19/07/94).

4.1.6 Electromagnetic Induction Surveys

Two EM units were used for detailed and broadscale electromagnetic mapping of the experimental scald sites, the EM 38 and the EM 31. The EM38 operates at a frequency of 14.6 kHz and measures to depths of 0.75 metres and 1.5 metres (Plate 3.4). The EM31 operates at a frequency of 9.8 kHz and measures to depths of 3.0 metres and 6.0 metres (Plate 3.5) (Slavich 1990). The EM 31 was also mounted on a four-wheeled motorbike (Plate 3.6) allowing large areas of land to be surveyed relatively quickly at 5 metre depths. A soil core was taken at each of the 20 experimental sites where the EM31 and EM38 electromagnetic survey were carried out to make comparisons between soil core results and corresponding EM data. A hand auger was used to extract soil samples to a depth of 0.75 m and the samples mixed and a subsample taken to represent 0 - 0.75 m depth. The soil cores and the EM surveys were carried out on the same day to ensure uniformity in data collection to enable groundtruthing of the EM38 EC values by comparison with the EC of the soil.

Plate 4.4 Electromagnetic survey of a scald site at "Glendella"using the hand held EM38 unit following set distances along a transect measuring at 0.75 and 1.5 m depths (08/07/95).

Plate 4.5 Electromagnetic survey of a scald site at "Glendella"using the EM31 unit following set distances along a transect and measuring at 3.0 and 6.0 m depths (08/07/95).

Plate 4.6 Electromagnetic survey of a scald site at "Buri West"using the EM31 unit which was mounted on a 4WD bike to survey larger areas at 5.0 m depth (12/07/95).

4.2 Scald Amelioration

Five replicated experimental treatments including ponding, reverse interception drains and two chemical ameliorants as well as untreated control sites were set up in November 1993 (Table 4.1). The success of the treatments was gauged by the return of vegetative cover to bare areas and changes in water infiltration rates measured using a disc permeameter. Soil cores were removed prior to and after completion of the treatment period and comparisons made of exchangeable sodium, calcium, potassium, magnesium, pH, ESP and SAR.

Table 4.1 Summary of treatments and properties in the Harhnam and Bozo landcare groups. (An * indicates those experimental sites with piezometers).

	No.	Ponding	No.	Reverse Interception Drains	No.	Chemical Ameliorates (Gypsum & Epsomite)	No.	Controls
Properties	*19	Adgin Green	16	Lakview	1	Church Gully	*25	Maryland
	42	Blaxland (road)	40	Maryland	*11	Maryland	*47	Glendella
	*38	Wilgar	44	Glendella	*3	Wollun Station	*50	Wilgar
	24	Wollun Station	*46	Acton	*9	Buri West	*45	The Glen
	*37	Blaxland (cherrytree)	*14	Bergen Op Zoom	39	Wilgar	*5	Ingleholme

4.2.1 Ponds

Each pond consisted of a semi-circular contour bank built with a D5 bulldozer (Plate 4.7 & 4.8). Ponding treatments were installed at "Blaxland (cherrytree)", "Blaxland (road)",Wollun Station", "Adgin Green" and "Wilgar" (Table 4.1). When it rained water flowed across the scald and into the depression (Fig 4.3). A 50 mm diameter PVC pipe was installed at the base of the contour bank to drain water from the ponded area. The outside end of the pipe had a screw on PVC attachment which could be removed when drainage of the pond was required. Water samples were collected from each pond when it filled and then, after sampling, it would be drained. Problems emerged with the drainage pipe as not all the water could be removed and so a 3 inch (75 mm) flood lifter pump was used to pump the remaining water out to ensure the ponds were dry between successive rainfall events. The water samples taken from each pond were analysed for soluble sodium, TDS (total dissolved salts), pH and SAR by Lanfax Laboratories, Armidale. The volume of water removed from each pond was estimated each time it was pumped out by multiplying the time in minutes it took to pump the pond dry by the number of litres of water the pump removed per minute. The sodium and TDS results were converted to kilograms of sodium and TDS per pumping per dam to take into account the different volumes of water pumped per sampling per dam.

Plate 4.7 Pond installation at "Adgin Green", Uralla (25/11/93).

Plate 4.8 Completed pond at "Adgin Green", Uralla (25/11/93).

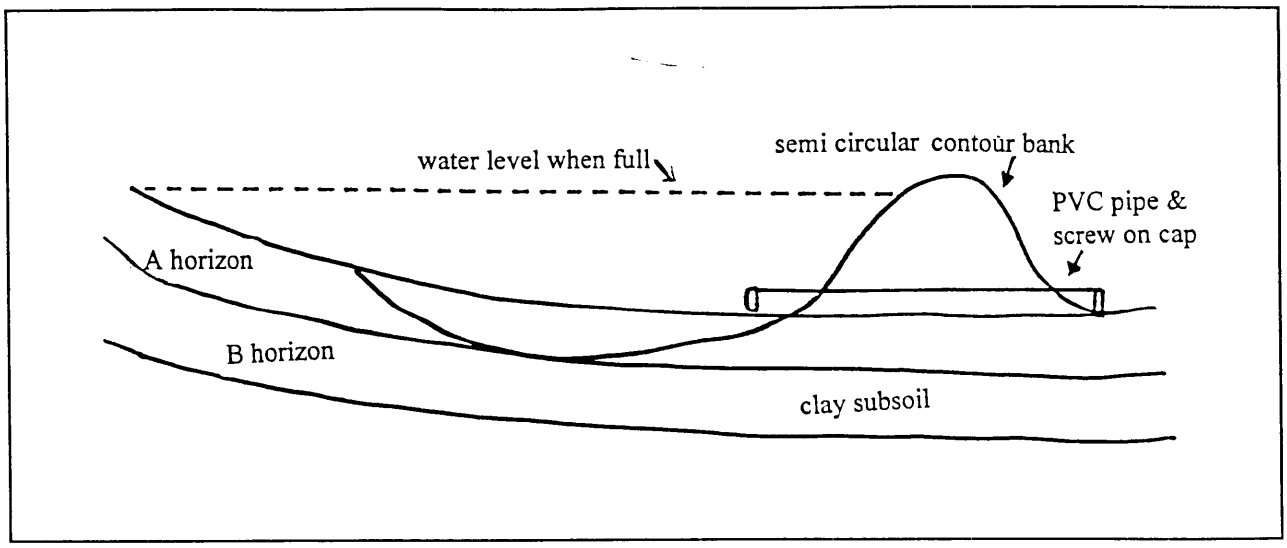

Figure 4.3 Diagrammatic representation of ponding system.

4.2.2 Reverse Interception Drains

Reverse interception drains were installed on 5 replicate scalds using a D5 bulldozer and an excavator to produce a drain which penetrated below the surface of the B horizon. The spoil from the drain was used to form a contour bank up slope from the scald (Fig. 4.4) (Plates 4.9 & 4.10). Four drains located at the properties "Acton", "Glendella", "Lakeview" and "Adgin Green" were designed to lead drainage water to a definite disposal point in the paddock away from the scald while the fifth drain at "Maryland" (Table 4.1) directed water to a local creek. Drains were relatively shallow because the A horizon was only about 100 mm deep in each case.

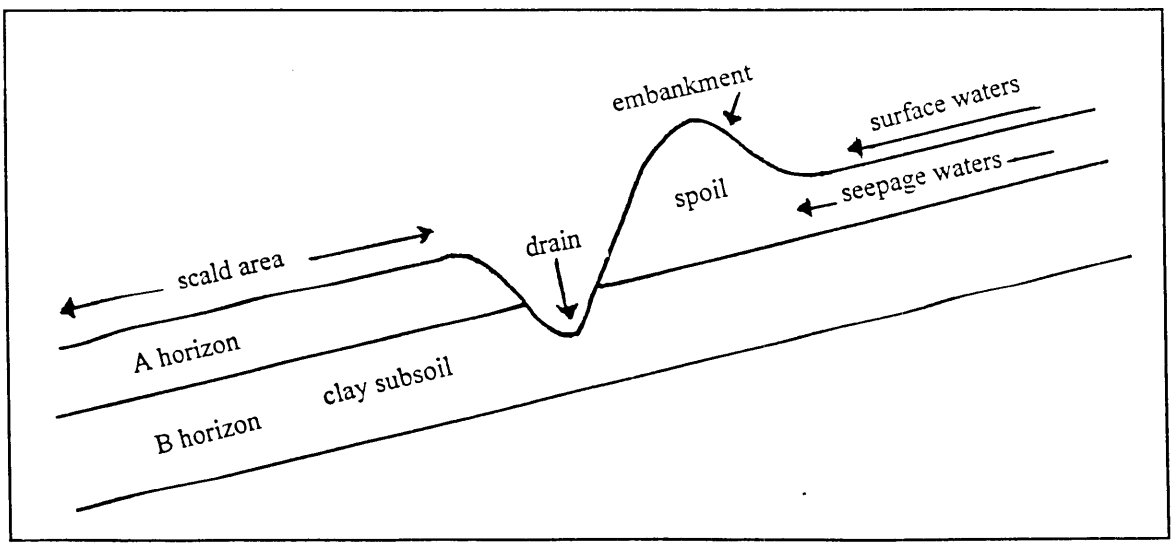

Figure 4.4 Reverse interception drain general design.

Plate 4.9 Construction of a reverse interception drain at "Lakeview", Uralla (26/11/93).

Plate 4.10 Completed reverse interception drain at "Lakeview", Uralla (26/11/93).

4.2.3 Chemical Ameliorant Trials

Chemical ameliorants were added at each of five sites inside 1 m diameter 400 mm deep steel rings designed to restrict the chemicals to a known area. One ring was used for gypsum (calcium sulphate) and one for epsomite (magnesium sulphate) and each site had the respective chemical treatment applied at the rate of five tonnes per hectare. Plates 4.11 , 4.12 and 4.13 show how the rings were positioned in the field so as not to disturb the soil profile. The chemical ameliorant treatments were applied at "Buri West", "Wilgar", "Church Gully", "Blaxland" and "Wollun Station" (Table 4.1). Soil cores extracted from the rings prior to and after the treatments were completed, were analysed to measure any changes in the chemical composition of the soil due to the application of the gypsum and epsomite

Plate 4.11 Installation of 1 m diameter steel rings for chemical ameliorant trials (30/11/93).

Plate 4.12 Steel ring positioned prior to backfilling the soil outside (30/11/93).

Plate 4.13 Steel ring in position for chemical ameliorant trials at "Buri West"(30/11/93).

4.2.4 Control Sites

A scald on each of the five properties "Maryland", "Ingleholme", "Glendella", "Wilgar" and "The Glen" (Table 4.1) was chosen as an untreated control and analysed as for the treated scalds. Soil cores were extracted and a series of infiltration tests were completed for comparison with the treated scalds. Observations were made on any changes to these scalds during the experimental period.

4.2.5 Fencing

It was necessary to exclude stock from the ponding and chemical ameliorant trials to prevent interference with the treatments. Hingelock with a strand of barbed wire on the top was used for this purpose (Plate 4.14). The reverse interception drains and the control scalds were not fenced as stock could do no damage to the drainage system. Observations were made on any effects of the fencing on untreated scalds inside and outside the fences.

Plate 4.14 Fenced off chemical ameliorant trail at "Wollun Station", Wollun (20/12/93).

4.2.6 Soil Cores for Analyses

The 20 experimental soil cores were removed and analysed for exchangeable sodium, calcium, magnesium, potassium, pH, ESP and SAR before the implementation of experimental treatments. After the experimental period a second series of cores were taken for comparison of initial and final results.

4.2.7 Infiltration Measurements

A series of infiltration tests were conducted on the 20 treatment scalds to monitor changes in infiltration rates using a disc permeameter (Plate 4.15).This equipment supplied water to the soil under a small, adjustable positive head of 2 mm. The flow of water was then measured over time and the volumetric infiltration through the soil profile was subsequently calculated.

Plate 4.15 Disc permeameter used to measure water infiltration rate at scald sites.

4.2.8 Statistical Analysis of Results

An analysis of variance (AOV) was applied to the treatment data using the software package Quartro 6.0. Cochran's C test (Appendix C) was used to determine variance homogeneity and means were separated using Scheffe's test (Feldman *et al.* 1987).