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Salinity Discharge in the Glenelg Hopkins CMA Region

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Salinity Discharge in the Glenelg Hopkins CMA Region

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SUMMARY

The objective of this study was to determine the area, severity and location of secondary saline discharge in the Glenelg Hopkins CMA Region and present it in a map and database form.

Aerial photos were used for the location of saline sites and an extensive ground truthing program was carried out using the Inventory of Soil Conservation Needs (ISCON) techniques for the classification of salt severity.

This report summarises the extent and severity of salinity for all of the Land Management units within the Glenelg Hopkins CMA region. The region comprises of 2,660,780 ha of which 27,472 ha is saline, a total of 1.03% of the region. This varies across the LMU's from 0.02 % in the South West Sands to 5.8 % in the Wimmera Plains.

The majority of saline sites remain as class 1 severity rating. This is the least degraded of the 3 classes and indicates that there is a large opportunity to implement saline agronomy practices to achieve both economic and environmental benefits. Recent modelling work by SKM (Sinclair Knight Merz) has indicated that such remedial works may limit potential expansion of salt effected areas and/or stop their further degradation.

Land Management Unit	Total Area (ha)	Total area of salinity (ha)	Salinity %
Dundas Tablelands East	181,390.3	6,027.4	3.30
Dundas Tablelands West	224,148.4	3,935.3	1.75
Grampians	71,795.8	42.0	0.06
Grampian Slopes	36,258.5	82.6	0.20
Granite	52,966.4	171.8	0.30
Lakes and Dune Systems	1,5556.1	23.7	1.50
Merino Tablelands	99,040.3	239.0	0.20
Northern Alluvial Plains	92,917.7	2,899.8	3.00
Sedimentary Rises	92,216.0	465.1	0.50
South West Sands	435,448.6	107.9	0.02
Southern Alluvial Plains	48,589.1	550.4	1.10
Stony Rise & Scoria Cones	186,872.7	2,344.4	1.25
Steep Sedimentary Hills	33,148.1	149.0	0.45
Tertiary Gravels & Sands	25,520.0	63.7	0.25
Undulating Alluvial Plains	20,833.3	670.4	3.20
Volcanic Plains	894,739.7	8,349.6	0.90
Volcanic Rises	9,186.2	6.9	0.07
Weathered Limestone	148,567.9	1017.1	0.70
Wimmera Plains	5,584.6	326.0	5.80

CONTENTS

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INTRODUCTION

The Glenelg Region Salinity Forum was set up in 1991 to prepare a strategy to combat the problem of dryland salting in the region. Preliminary estimates of salinity were used to help formulate the strategy. Several studies have been carried out in the region in the past that involved the mapping and measurement of salinity. These are Fisher (1991), Whitworth (1991) and Jerinic & Dahlhaus (1994). By no means however, did they cover the whole of the Region. Due to the subjective nature of some of the salinity discharge estimates, it was decided in 1993 that a mapping program should begin to improve the accuracy of information. Land management units (LMU's) where the reliability of salinity discharge data was low were to be surveyed first. (Glenelg Salinity Forum, 1993).

Salinity discharge mapping reports to date include;

- More, Rosalind (July, 1994) *Salinity Discharge Mapping for the Merino Tablelands in the Glenelg Salinity Region*; DNRE.

- More, Rosalind (November, 1994) *Salinity Discharge Mapping for the Grampians Slopes in the Glenelg Salinity Region*; DNRE.

- Munro, Melinda (May, 1998) *Salinity Discharge Mapping for the South West Sands and Tertiary Gravel's and Sands in the Glenelg Salinity Region*; DNRE.

- Munro, Melinda (May, 1998) *Salinity Discharge Mapping for the Dundas Tablelands in the Glenelg Salinity Region*; DNRE.

- Munro, Melinda (June, 2000) *Salinity Discharge Mapping for the Volcanic Plains in the Glenelg-Hopkins CMA Region*; DNRE.

In 1999 the Glenelg Hopkins Catchment Management Authority was formed. The formation of this Authority resulted in the Glenelg Salinity Region being redefined to encompass a larger area to the north and east. This brought into place the new Glenelg Hopkins CMA Region as shown on page 29 of this report.

METHODOLOGY

Aerial Photographs

Coloured aerial photos of the area, taken in 1991-92 at an approximate scale of 1:25,000, were used in the study. Sites that were possibly saline were marked on plastic overlay material on the photos for field checking.

Field Assessment

Location of Possible Saline Sites

Extensive and detailed ground truthing for the positive identification of possible saline areas was carried out. The farmers who owned the land where each site fell were approached for permission to inspect the area.

Assessment of sites for Salinity Indicators

Each site was assessed in accordance with the Inventory of Soil Conservation Needs (ISCON) techniques description in detail by Matters (1987) and Matters & Bozon (1995). In brief, a site was inspected for the presence of three or four salt indicator species and other symptoms of salinity. These included the appearance of bare ground, ground water seepage, salt crystals and scalds, erosion as a result of deterioration in soil structure and deterioration or eventual death of trees. Each site was given a severity rating, low (Class 1), medium (Class 2) or severe (Class 3), with the presence of the more salt tolerant species and the increasing appearance of bare ground, salt and the other symptoms of salinity indicating a more severely affected area. Where the site was not purely one class, an estimate of the percentage of each class was made and the overall classification given as the one with the greatest percentage. In some cases it was difficult to tell whether the drainage line was salt affected or simply waterlogged. If two or more salt tolerant species were present the site was considered to be saline. (Matters 1987). The severity classes, C1, C2 & C3 are described below.

Defining and Recording Areas

Areas were marked directly onto the photo overlays. Where seeps were to small too be seen on the photo (for example 10m square) a point or dotted line was used to mark their position. Eg. Narrow drainage lines were marked with a dotted line onto photos.

Areas were assessed as being primary or secondary salting. Primary salinity is a natural occurrence and is often evident in the form of saline lakes and wetlands. Secondary salinity, on the other hand, is induced as a result of previous agricultural activities such as tree clearing and occurs due to a change in catchment water balance.

Additional information about position of salinity in the landscape, evidence of salinity and treatment of discharge was noted. Each site was given an individual identification number. One number was used for several areas if they were located close together and had similar severities of salting and class indicator species. All of the information for each site was recorded onto site assessment sheets.

Class	Severity of salting	Site characteristics
1	Low	- patchy growth in paddock - reduced vigour of crop or pasture - pastures thin or die out, replaced by more salt tolerant species - no salt crystals or bare patches seen
2	Medium	- species of higher salt tolerance replace C1 indicators - salt stress causes change in leaf shape & colour - salt stains & scalds may appear - bare areas up to 1 square metre
3	High	- only highly salt tolerant plants present - 2 or 3 species dominant - large areas of bare ground - trees may be dead or dying

Matters & Bozon (1995)

Maps and Database

Areas were transferred from the aerial photos onto 1:25000 map sheets using a Sketchmaster. Sites that could not be drawn onto the aerial photos because they were too small, and therefore shape not recorded, were marked as dots or dotted lines on the map sheets. Maps were then sent to Bendigo for digitising where area and coordinates were recorded. Additional site information from the site assessment sheets was then entered for inclusion on the statewide database. The database is stored at Hamilton NRE and Bendigo CLPR offices. The maps are held at the Hamilton NRE office.

Limitations of the Study

The mapping process, transferring and digitising of site detail has potential associated errors and should be taken into account when referring to areas quoted in this report.

Salt indicator species were identified though not recorded. The identification was only to identify if the site had a presence of two or more indicator species so as to classify the site as saline. Time constraints prevented a botanical survey from being carried out.

Salinity was not extensively searched for in forested areas. No saline sites were identified from aerial photos in forested areas. A systematic search of the entire forested area would be required to determine if salinity existed. This was not considered feasible given the inaccessibility of most of these areas. It was expected that the hydrology under large blocks of remnant vegetation would not have changed significantly enough to develop sites of secondary salinity.

The complete length of drainage lines was not surveyed, due to limited time. Drainage lines were checked for salinity at as many accessible crossings as possible. If a drainage line was saline along a number of lengths and at a number of checkpoints along its course, the whole drainage line was considered salt affected.

Dundas Tablelands East

Total Area:	181,390.3 Ha (of LMU in GHCMA)
Area affected by saline discharge:	6,027.4 Ha (3.3 % of LMU)
Total area of Class 1 severity:	3,694.8 Ha (61.3% of the salinity)
Total area of Class 2 severity:	1,717.8 Ha (28.5% of the salinity)
Total area of Class 3 severity:	614.8 Ha (10.2% of the salinity)
Area of salinity remaining untreated to date:	4,171 Ha (69.2% of the salinity)

Hydrogeology, Landform and Soils

Deeply weathered rhyolite and rhyodacite has formed a gently dissected laterised tableland. Valleys are characteristically broad and flat-bottomed. An outlying area near Lake Bolac comprises Grampians Sandstone and Cambrian Greenstone with a weathered tertiary laterite capping. A large number of lakes and wetlands have developed in this area. Brown duplex soils occur in elevated positions, and yellow duplex soils in the valleys. Moderate to low recharge occurs across most of this LMU. Relatively higher rates of recharge probably occur on the lighter soils of the eastern margin of the Chatsworth/Lake Bolac outlier. Groundwater systems are local. Large areas of the flat-bottomed valleys are affected by relatively small rises in water tables and saline seeps extend up the sides of the valleys (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The majority of this LMU is used for agriculture. There is a large area of State Forest north of Balmoral, surrounding Rocklands Reservoir. Saline groundwater discharge from this LMU makes a significant contribution to salt loads in the Glenelg and Wannon Rivers, adversely affecting the environmental values of these streams (Glenelg Salinity Forum, 1993).

Dundas Tablelands West

Total Area:	224,148.4 Ha (of LMU in GHCMA)
Area affected by saline discharge:	3,935.3 Ha (1.75 % of LMU)
Total area of Class 1 severity:	3,089.2 Ha (78.5% of the salinity)
Total area of Class 2 severity:	806.7 Ha (20.5% of the salinity)
Total area of Class 3 severity:	39.4 Ha (1% of the salinity)
Area of salinity remaining untreated to date:	3,178 Ha (80.8% of the salinity)

Hydrogeology, Landform and Soils

Deeply weathered granite has formed a laterised plateau surface, which has been deeply dissected. The plateau surface is gently to moderately undulating. Valleys may be relatively deep and steep sided. The Unit supports a local groundwater system. Moderate to low recharge is distributed over most of the area. Salinity is a relatively severe problem. Soils are mainly red and brown duplex profiles on the plateau with yellow duplex on valley bottoms (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The majority of this Land Management Unit is used for agriculture. Wool production is the principal form of agriculture. Extensive clearing has resulted in a loss of most environmental values. Remnant grasslands and woodlands are subject to continued threats and require urgent protection. This LMU makes a significant contribution to salt loads in the Glenelg River (Glenelg Salinity Forum, 1993).

Grampians

Total Area:	71,795.8 Ha (of LMU in GHCMA)
Area affected by saline discharge:	42 Ha (0.06 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

The Grampians comprise north south aligned steep rocky ridges with a precipitous east face. Aquifers form in fractured rock; groundwater systems are intermediate between local and regional. There is some recharge of the aquifers of the adjacent colluvial slopes. Recharge rates are naturally high but removal of tree cover may increase recharge rates. Salinity is not considered to be a significant problem in this LMU. Soils are generally rocky and shallow although deeper profiles have formed on outlying areas north east of Glenthompson and near Woorndoo (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The majority of this LMU is public land forming the Grampians National Park. This is an area of outstanding environmental value supporting diverse forests, woodlands and heathlands. Agriculture is confined to the small outlying weathered areas. Water is harvested from catchments in this LMU to supply adjacent towns. The quality of water supplied is dependent on the maintenance of forest cover (Glenelg Salinity Forum, 1993).

Grampians Slopes

Total Area:	36,258.5 Ha (of LMU in GHCMA)
Area affected by saline discharge:	82.6 Ha (0.2 % of LMU)
Total area of Class 1 severity:	66.2 Ha (80.2% of the salinity)
Total area of Class 2 severity:	12.6 Ha (15.3% of the salinity)
Total area of Class 3 severity:	3.8 Ha (4.5% of the salinity)
Area of salinity remaining untreated to date:	79.3 Ha (96% of the salinity)

Hydrogeology, Landform and Soils

Sediments eroding from the steep Grampians ranges have formed deep deposits of unconsolidated sands on the foothills of the Grampians. These form steep to gentle slopes. Deep acid uniform sandy soil profiles have developed. These have low fertility levels. Local groundwater systems form in unconsolidated sediments. Highest recharge is likely to occur on the upper slopes where the colluvium contacts the Grampians bedrock. Recharge rates are generally high however, and groundwater levels are rising rapidly following clearing. There is some evidence that recharge in this LMU contributes water to the adjacent Northern Alluvial Plains (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Most of this LMU remains uncleared and much of this forested land is reserved in the Grampians National Park. Environmental values here are high. Significant areas of remnant native vegetation also occur on freehold land in the Victoria Valley. Remaining areas are cleared for agriculture. Fine wool production is a significant enterprise in the Victoria Valley (Glenelg Salinity Forum, 1993).

Granite

Total Area:	52,966.4 Ha (of LMU in GHCMA)
Area affected by saline discharge:	171.8 Ha (0.3 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

Massive granite bedrock forms areas of rolling hills and plains with many rocky outcrops. Occurrences of this LMU include the Victoria Valley, an area south of Glenthompson and in the north East of the Region. Groundwater systems are local, forming in fractured rock. The fracture network is generally limited and groundwater volumes are low. High recharge is likely to be associated with rocky outcropping's. Brown duplex soil profiles are common in elevated positions and yellow duplex profiles form in depressions. Soils associated with rocky outcrops are skeletal (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Large areas of the northeastern occurrences of this LMU remain as public land, reserved as State Park or State Forest. Cleared areas are used mostly for wool production (Glenelg Salinity Forum, 1993).

Lakes and Dunes System

Total Area:	1,556.1 Ha (of LMU in GHCMA)
Area affected by saline discharge:	23.7 Ha (1.5 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

For the most part, the unit is characterised by flat to gently undulating plains, with swamps, lakes and undulating lunettes. Grey uniform cracking clays and black duplex soils occur on low-lying plains. Calcareous uniform cracking clays are common on clay lunettes while gradational sandy loams are generally associated with sand lunettes. (KEVIN, 1993)

Land Use and Environmental Values

Cropping is common on lunettes, while sheep and dairy cattle grazing occur in remaining areas. (KEVIN, 1993)

Merino Tablelands

Total Area:	99,040.3 Ha (of LMU in GHCMA)
Area affected by saline discharge:	239 Ha (0.2 % of LMU)
Total area of Class 1 severity:	204.6 Ha (85.6% of the salinity)
Total area of Class 2 severity:	34.4 Ha (14.4% of the salinity)
Total area of Class 3 severity:	0 Ha
Area of salinity remaining untreated to date:	209.1 Ha (87.5% of the salinity)

Hydrogeology, Landform and Soils

Tertiary laterite caps soft calcareous mesozolic sediments although little of the original laterised plateau surface now remains. Groundwater systems are local with aquifers forming in weathered rock. Highest rates of groundwater recharge are likely to be in the upper parts of the landscape, just below remnant laterite capping. The soft underlying rocks have eroded rapidly once the laterite capping has been cut through, leading to long, steep, convex slopes which are susceptible to mass soil movements. Brown gradational soils are common on hill tops and deep uniform profiles occur on valley bottoms. (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The native vegetation of the Merino Tablelands was mainly grassland. These have been heavily modified since settlement and remnants are now rare and valuable. A post war soldier settlement scheme lead to the development of dairying in this LMU but the area is now used predominantly for sheep grazing (Glenelg Salinity Forum, 1993).

Northern Alluvial Plains

Total Area:	92,917.7 Ha (of LMU in GHCMA)
Area affected by saline discharge:	2,899.8 Ha (3 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

Unconsolidated alluvial sediments have formed flat to slightly undulating plains. Groundwater flows are regional and are likely to be supplemented by aquifers in the adjacent sedimentary LMU's. Drainage on the flat plains is restricted leading to the development of extensive lake and wetland systems and causing widespread waterlogging problems for agriculture. Recharge is wide spread. Highest recharge is likely to be through sandy soil profiles associated with relict waterbodies. Soils are mostly yellow and brown duplex profiles. Some are gilgaed (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The lakes and wetlands associated with this LMU often have high environmental values. Much of the woodland and grassland vegetation originally present on the plains has been cleared. Remnants are mostly associated with publicly owned wetlands. The major agricultural enterprise is sheep grazing. Cereal cropping is also common where waterlogging problems have been overcome (Glenelg Salinity Forum, 1993).

Sedimentary Rises

Total Area:	92,216 Ha (of LMU in GHCMA)
Area affected by saline discharge:	465.1 Ha (0.5 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

This LMU comprises Ordovician meta-sediments with small areas of Cambrian greenstone. Both parent materials support local groundwater systems in fractured bedrock. There may be some movement of groundwater from this LMU into the adjacent Northern Alluvial Plains. Low undulating hills support red and brown duplex soils occurring on the midslopes and uniform and gradational profiles on the upper slopes and ridges. Yellow duplex profiles are common on the lower slopes. Recharge is high on the upper slopes and ridges and moderate to low on the midslopes (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Much of the native vegetation has been cleared from this LMU. Saline discharge from this LMU is likely to be a significant contributor to salt loads in the Hopkins River causing consequent environmental damage. Agricultural land use is principally sheep grazing but cereal cropping is also commonly practised (Glenelg Salinity Forum, 1993).

South West Sands

Total Area:	435,448.6 Ha (of LMU in GHCMA)
Area affected by saline discharge:	107.9 Ha (0.02 % of LMU)
Total area of Class 1 severity:	84.3 Ha (78.1% of the salinity)
Total area of Class 2 severity:	22.5 Ha (20.9% of the salinity)
Total area of Class 3 severity:	1.1 Ha (1%of the salinity)
Area of salinity remaining untreated to date:	106.2 Ha (98.4% of the salinity)

Hydrogeology, Landform and Soils

Windblown sands have formed a thin veneer over older marine sediments. Linear calcareous and siliceous dune systems have developed. Both regional and perched local groundwater systems occur. Soils profiles are mostly sandy and uniform. Extensive areas are poorly drained leading to the formation of wetland systems (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

A relatively large proportion of this LMU remains in public ownership. Much of this has been retained as native forest, woodlands and wetlands. A substantial area in the south of this LMU, near Portland, is used for pine plantations. Overall environmental values of this LMU are high. (Glenelg Salinity Forum, 1993). Sheep and cattle grazing are the major agricultural land use. Privately owned pine plantations and more recently eucalypt plantations are now a very common site on the landscape.

Southern Alluvial Plains

Total Area:	48,589.1 Ha (of LMU in GHCMA)
Area affected by saline discharge:	550.4 Ha (1.1 % of LMU)
Total area of Class 1 severity:	173.4 Ha (31.5% of the salinity)
Total area of Class 2 severity:	362.7 Ha (65.9% of the salinity)
Total area of Class 3 severity:	14.3 Ha (2.6% of the salinity)

** Treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

Unconsolidated alluvial sediments have formed flat to slightly undulating plains along the course of southward flowing rivers. Groundwater systems are likely are likely to be intermediate and linked with the systems of the adjacent Weathered Limestone. Recharge probably occurs through the sandier parts of this unit and in old stream channels. Rapid lateral drainage has been implicated as a cause of salinisation in alluvial areas where saline river flows occur. Soils are mostly yellow duplex (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The majority of this LMU has been cleared for agriculture. Dairying is an important industry reflecting the relatively high rainfall this LMU receives. Costal wetlands retain high environment values (Glenelg Salinity Forum, 1993).

Stony Rises and Scoria Cones

Total Area:	186,872.7 Ha (of LMU in GHCMA)
Area affected by saline discharge:	2,344.4 Ha (1.25 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

A second, more recent phase of volcanic activity resulted in the formation of rocky basalt flows and isolated elevated scoria cones. The stony rises comprise slightly elevated, undulating stony plains with interrupted drainage forming wetlands. The scoria cones are characteristically conical and steep sided, rising up to 200 metre above the surrounding plains. Aquifers form in the fractured rock of the stony rises and scoria cones. Groundwater systems are primarily local and groundwater salinities are relatively low. It is likely that aquifers in this LMU are a significant source of recharge for the aquifers of Volcanic Plains. Soils are mostly stony loams, and organic and peaty loams in association with the areas of poor drainage. Deep red profiles form on the scoria cones (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The high proportion of stone in the stony rises makes cultivation difficult and limits agricultural production. In these areas, sheep grazing is the major agricultural enterprises. Skeletal soils and a very high proportion of free rock have prevented agricultural development altogether in the vicinity of the most recent eruption points. Some land in these areas has been retained in public ownership and includes Mt. Eccles and Mt. Napier State Parks. The scoria cones typically support deeper and relatively fertile soil profiles. Horticulture, particularly potato growing, is a common land use on the scoria cone in the higher rainfall southern areas (Glenelg Salinity Forum, 1993).

Steep Sedimentary Hills

Total Area:	33,148.1 Ha (of LMU in GHCMA)
Area affected by saline discharge:	149 Ha (0.45 % of LMU)

**Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

Fresh Ordovician meta-sediments form fractured rock aquifers with very high rates of recharge in the upper parts of the landscape. Groundwater systems are local. Landforms range from moderate rolling to steep hills. Skeletal gradational and uniform soil profiles on the upper slopes and crests have low moisture storage capabilities and allow high rates of recharge. Mid slope duplex profiles allow moderate rates of recharge (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Some remnant forest cover remains on the upper parts of the landscapes and on public land in the vicinity of Ararat. The LMU is otherwise cleared and used for sheep grazing. Salt loads from this LMU are likely to contribute to salinity in the Hopkins River (Glenelg Salinity Forum, 1993).

Tertiary Gravels and Sands

Total Area:	25,520 Ha (of LMU in GHCMA)
Area affected by saline discharge:	63.7 Ha (0.25 % of LMU)
Total area of Class 1 severity:	58.6 Ha (92% of the salinity)
Total area of Class 2 severity:	1.6 Ha (2.5% of the salinity)
Total area of Class 3 severity:	3.5 Ha (5.5% of the salinity)
Area of salinity remaining untreated to date:	61.1 Ha (96% of the salinity)

Hydrogeology, Landform and Soils

Unconsolidated tertiary sands and minor gravels with high permeability probably support a regional groundwater system. These areas are believed to be the uptake areas for the deep confined aquifer systems in the south west of the Region. Landform is mostly gentle slopes off western margins of the Dundas Tablelands. Soils are mostly uniform sandy profiles (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

The majority of this LMU has been cleared, principally for sheep grazing. Part of the LMU remains as forested public land, mostly reserved as State Forest (Glenelg Salinity Forum, 1993).

Undulating Alluvial Plains

Total Area:	20,833.3 Ha (of LMU in GHCMA)
Area affected by saline discharge:	670.4 Ha (3.2 % of LMU)

**Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

This LMU consists of flat to undulating plains and some playa lunette complexes with grey self-mulching clays and red and yellow duplex soils. The geology is river deposited Shepparton and Coonambidgal formation clay, sand and fine gravels. Predominant vegetation is open forest of Grey Box, Yellow Gum and Red Gum. Closed forest of Brown Stringybark and Messmates and shrublands of Samphire and Beaded Glasswort. (Wimmera Catchment Co-ordinating Group, 1992)

Land Use and Environmental Values

Sheep grazing is the predominant agricultural land use, which is combined with cereal cropping in the drier northern parts of the LMU. Rare and threatened flora occurs at Darragan Swamp, Jallumba Swamp and Natimuk Lake. The Chain of Lakes, Heard Lake and Lake Wyn Wyn has high value for the conservation of migratory wading birds. (Wimmera Catchment Co-ordinating Group, 1992)

Volcanic Plains

Total Area:	894,739.7 Ha (of LMU in GHCMA)
Area affected by saline discharge:	8,349.6 Ha (0.9 % of LMU)
Total area of Class 1 severity:	6,871.7 Ha (82.3% of the salinity)
Total area of Class 2 severity:	1,369.4 Ha (16.4 %of the salinity)
Total area of Class 3 severity:	108.5 Ha (1.3 %of the salinity)

** Treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

This LMU comprises extensive Pliocene basalt plains overlaying Tertiary and Mesozoic sediments. The dominant landform is a rolling plain. In places, the basalt capping has been eroded, exposing the underlying sediments and forming characteristic U shaped valleys. Aquifers form in the underling sediments. Groundwater flows are regional. High recharge is confined to the vicinity of eruption points and medium recharge is believed to occur over almost the entire remainder of the LMU. Soils are mostly dark duplex and gilgaed. Some deep gradational profiles occur and red duplex soils occur on older flows in elevated positions (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Sheep grazing is the predominant agricultural land use, which is combined with cereal cropping in the drier northern parts of the LMU. Dairying is relatively more common in the higher rainfall southern parts. The poor drainage characteristic of this LMU has lead to the development of extensive wetland systems, many of which have significant environment values. The original native grasslands and woodlands, which were once common on the plains, have been substantially cleared (Glenelg Salinity Forum, 1993).

Volcanic Rises

Total Area:	9,186.2 Ha (of LMU in GHCMA)
Area affected by saline discharge:	6.9 Ha (0.07 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

The GHCMA boundary passes through this LMU, its total area being 70,150 ha. The Volcanic Rises consist of gently undulating rises with scattered prominent volcanic cones. (KEVIN, 1993)

Shallow uniform and gradational soils occur on the rocky crests of cones, stony rises and scarps. Red and brown gradational soils occur on well-drained slopes and grey cracking clays, yellow duplex and brown duplex soils occur in poorly drained flats and depressions (Schoknecht 1988).

Land Use

The main land use is sheep grazing, with minor cropping on well-drained rock free areas. (KEVIN, 1993)

Weathered Limestone

Total Area:	148,567.9 Ha (of LMU in GHCMA)
Area affected by saline discharge:	1,017.1 Ha (0.7 % of LMU)

** Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

Highly weathered calcareous Miocene sediments form the underlying geology of this LMU. These weathered sediments support local and intermediate groundwater systems. Uniform sandy soil profiles have developed but calcareous uniform profiles occur in the vicinity of true limestone. Landforms are flat to undulating. The proximity of the coast with resulting high cyclic salt load may make some areas susceptible to salinity problems (Glenelg Salinity Forum, 1993).

Land Use and Environmental Values

Rainfall is relatively high throughout this LMU and soils relatively fertile. Dairying is a significant land use throughout the LMU but especially on the plains east of Warrnambool. The agricultural productivity of the LMU has lead to extensive agricultural development. Undisturbed native environmental value of the LMU is relatively low (Glenelg Salinity Forum, 1993).

Wimmera Plains

Total Area:	5,584.6 Ha (of LMU in GHCMA)
Area affected by saline discharge:	326 Ha (5.8 % of LMU)

**Class and treatment details are unavailable due to changes in mapping techniques*

Hydrogeology, Landform and Soils

This LMU has gently undulating to flat plains; occasional NW-SE undulations reflect the underlying Tertiary geology, which consists of Woorinen Formation clays over Parilla Sand. The predominant soil types are grey self-mulching and brown cracking clays and some red duplex. Predominant native vegetation is open forest with Black Box, Buloke, Yellow Gum and Grey Box. (Wimmera Catchment Co-ordinating Group, 1992)

Land Use and Environmental Values

Sheep grazing is the predominant agricultural land use, which is combined with cereal cropping in the drier northern parts of the LMU. (Wimmera Catchment Co-ordinating Group, 1992)

DISCUSSION

The objective of the Salinity Discharge Mapping project was to produce accurate information on the extent and severity of dryland salinity in the region and to record this information on 1:25 000 mapsheets.

A mapping scale of 1:25 000 offers several advantages. It provides sufficient detail to be useful to landholders and government agencies to plan and monitor the effectiveness of on-ground works at farm scale. This dryland salinity data is stored in mapsheet form at the Hamilton NRE office and as a separate layer on the NRE corporate Geographic Information System.

This project was run throughout the state of Victoria. This report is relevant to the Glenelg Hopkins CMA region only. The region comprises of 2,660,780 ha, of which 27,472 ha is salt affected. This equates to 1.03 % of the region. The majority of sites is of a class 1 (82.3%) severity rating; however, class 2 (16.4%) and 3 (1.3%) sites do exist in most land management units.

Although data on the number of sites that had been treated with some form of control method were limited, it was found that on average 88% of the saline affected area remains untreated.

Any treatment that had been implemented on saline sites had been focused on the discharge site with few attempts at recharge control. The most frequently observed attempts at discharge control were fencing of the site to exclude all stock. This then in turn allowed for the planting of trees, sowing of salt tolerant perennial pastures and the strategic grazing of the site.

To better understand salinity and the complex catchment processes that affect it a number of projects have been undertaken within the region. A locally driven project, EM31 or electromagnetic (EM) hazard mapping is a new technique used to map apparent electrical conductivity of the soil. This project unlike the salinity discharge mapping is able to give an idea of potential salinity problem areas.

The electromagnetic current the soil conducts can be related to the amount of salt present. This EM technology is being used to aid in dryland salinity management at a farm and sub-catchment level. The equipment used is an EM31 meter and GPS equipment mounted on a 4WD motor bike. The EM31 measures soil conductivity down to approximately 6 metres. An advantage of using this instrument is it is versatile and quick to carry out a survey without ground disturbance. EM values are plotted to produce maps that give an idea of potential salinity problem areas. Where salinity is already a problem EM maps give an idea of the severity and potential spread. EM31 hazard surveys are currently being conducted throughout the Glenelg Hopkins Region.

A second component to the 1:25 000 state wide discharge mapping is the long term monitoring of discharge sites. The discharge site monitoring establishes a network of strategic salinity monitoring sites across Victoria. This project aims to complement the first component.

These sites are monitored at relatively large scales and reassessed every three to five years to provide reliable data about the rate of change of the area and severity of salinity in a catchment, and the effectiveness of control options in high recharge zones. It is envisaged that this monitoring program will continue for a period of 20 – 30 years.

There are 6 of these sites in this region. These are:
A pair of treated and untreated sites at Mirranatwa on the Granite Land Management Unit.
A pair of treated and untreated sites at Bulart on the Dundas East Land Management Unit.
A site at Willaura on the Northern Alluvial Land Management Unit.
A site at Hamilton North on the Volcanic Plains Land Management Unit.

The initial survey at a monitoring site aims to set a benchmark. Follow up surveys are carried out to identify any change in the extent and severity of soil salinity. In the establishment phase three techniques are employed for documenting salinity levels at each discharge monitoring site:

1. Vegetation assessment.
2. Electromagnetic induction (EMI) survey using an EM38 instrument.
3. Soil sampling.

In addition, groundwater observation bores are installed if required and background data such as geology, climatic, land use, land management, site history and a photographic record are collected.

The minimum data to be gathered for reassessments are:

1. Repeat either or both the vegetation assessment and the EM38 survey. The decision to use either or both of these techniques will depend on the physical characteristics and the land use of the site.
2. Continuous monitoring of the piezometers.
3. Continuous collection of rainfall/climate data.
4. Update the site photographic record.
5. Update land management practices record.
6. Update land use record.

This is the minimum data set, however other site data may be reassessed if required. Site maps showing the pattern and extent of soil salinity inferred from vegetation cover, physical conditions and EMI data are used to create a picture of salinity at a site at the time of assessment. Soil salinity trends are developed by collating this data. When long term soil salinity trends have been established, the aim is to determine how these changes relate to any recorded variation in groundwater levels, climate, land use or land management practices.

To date, the pair of sites at Bulart and at Mirranatwa was established in 1995 and was reassessed in late 1998. The sites at Willaura and Hamilton north were established in early 1997 and are due for reassessment in 2001. At this stage it is hard to present any meaningful trend information. A report is in preparation.

Another long term study undertaken in the Glenthompson district (50 km east of Hamilton) within the Glenelg Hopkins CMA region was the South West Victoria Water Balance Modelling Project. This project aim was to increase the understanding of salinity processes and management options. The opportunity arose to examine three adjacent catchments which had three different management options applied.

The findings suggested that discharge area treatment would be an effective salinity management option in landscapes where groundwater flow is primarily vertical. The effect of treatment on ridges and slopes did not translate to a lowering of the water table on the valley floors. Even with tree plantations on the slopes and ridges, the model predicted no significant lowering of the water table on the valley floor if it remained untreated. However treating the valley floor with a salt tolerant perennial pasture (eg. Tall wheatgrass) resulted in the water table falling by about 2 m over 50 years. Establishment of tall wheatgrass in groundwater discharge areas also has the potential to

increase stocking rates from about 1 to over 7 sheep/ha. Winter cropping was predicted to have a similar water balance (evaporation and recharge) to annual pasture. (Wagg, 1999)

This assessment is not representative of the entire region; there is significant evidence of substantial lateral flow across the remainder of the region. In these areas it would be equally significant to reduce recharge and watertables on the rises with higher water using vegetation. There is obviously a longer response time in treating the upper landscape area but this combined with treatment of the low lying and discharge area would form a complete treatment regime.

Large areas of this region as shown in this report are suffering from salt damage, threatening our environmental values and profit margins. Beneficial species have been replaced by less productive salt-tolerant plants such as spiny rush and sea barley grass. In some places all plant cover has gone and soils are bare and exposed to erosion. As the production of these areas are already greatly reduced any treatment implemented has the potential to reduce erosion and significantly increase production, turning wasteland into highly productive land.

We all need to be alerted to the salinity issues and its ever increasing invasion on our landscape and to our opportunity for input and involvement.

For more detailed results from dryland salinity demonstration areas and assistance with salting problems, please contact the NRE Customer Service Centre on 136 186 or view www.nre.vic.gov.au for the Notes series.

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