

Corangamite Salinity Action Plan

Process for the initial selection and validation of target areas for salinity management.



Background report 2
February 2003

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Corangamite Salinity Action Plan (2005 – 2008)

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Cover Photo: Dryland salinity near Kuruc A Ruc Creek, Werneth. (P. Dahlhaus, August 2002)

Summary

This report documents the process for the **initial** selection and validation of target areas for salinity management in the Corangamite CMA second generation Salinity Action Plan.

The process is based on a framework containing three fundamental components, *viz*: landscape disaggregation to provide consistency in methods; salinity risk assessment based on a variety of asset classes; and an analysis of temporal changes or trends in salinity values.

The outcomes of two recently completed projects have been critical in the target area selection process: - the Groundwater Flow Systems (GFS) project and the Geospatial Salinity Hazard and Asset Risk Prediction (GSHARP) project. The GFS project has contributed an understanding of the applicability of various salinity management options in terms of their hydrological response. GSHARP has contributed a spatial picture of salinity hazard and where assets are at risk within the Corangamite region. Additional to these projects a method for determining target areas for salinity management to protect stream water quality is also documented.

Together these tools provide an objective, transparent and accountable method of determining the target areas for salinity management. The combined process will allow future iterations to be run with relative ease, as continuous improvements are made to the input data sets, the methods and the scientific conceptualisation of the salinity processes within the Corangamite region.

Although there are many knowledge gaps or omissions in the data sets and some of the salinity processes are speculative, the methodology is arguably a more important outcome than the selection of the target areas. Provided that the process is valid, the continuous improvement of data and knowledge in conjunction with regular monitoring and evaluation will provide the means to update the salinity target areas to maximise the investment benefit on an annual basis.

This initial process has resulted in 13 areas being delineated as interim target areas for salinity treatment. Validation of the assets at risk in these areas has been checked in the field. Discussions with the asset managers will further clarify the actual risk that salinity imposes on these assets and assist in developing appropriate management options. Further refinement of the target areas is an expected outcome of these discussions.

Table of Contents

SUMMARY	I
1	INTRODUCTION 1
2	THE GROUNDWATER FLOW SYSTEM PROJECT 2
3	THE GEOSPATIAL SALINITY HAZARD AND ASSET RISK PREDICTION (GSHARP) PROJECT6
3.1	Review of the GSHARP risk map 7
3.1.1	Immediate-term asset risk 7
3.1.2	Near-term asset risk 7
3.1.3	Near and far term asset risk 7
3.1.4	Far-term asset risk 7
4	VALIDATION AND EVALUATION OF GSHARP FOR ASSET RISK PRIORITY AREA SELECTION8
4.1	Validation of GSHARP outcomes 8
4.2	Conclusions on the GSHARP outcomes 8
4.2.1	Agricultural land assets 12
4.2.2	Environmental assets 13
4.2.3	Water resources 13
4.2.4	Culture and Heritage 13
4.2.5	Infrastructure and utilities 14
5	SELECTION OF TARGET AREAS FOR STREAM WATER QUALITY ASSET 15
6	DISCUSSION AND CONCLUSIONS 19
7	RECOMMENDATIONS 21
7.1	Groundwater Flow Systems 21
7.2	GSHARP and its successors 21
7.3	Trend analysis 22
7.4	Model enhancements 22
REFERENCES	23
APPENDIX A	– FIELD VALIDATION SHEETS 24

List of Figures

Figure 2.1	Responses of the groundwater flow systems to hydrologic change.	2
Figure 2.2	Groundwater flow systems of the Corangamite CMA region	5
Figure 4.1	Immediate-term asset risk scenario	9
Figure 4.2	Near-term asset risk scenario	10
Figure 4.3	Far-term asset risk scenario	11
Figure 4.4	GSHARP identification of agricultural land asset on the Mt Mercer – Dereel Rd	12
Figure 4.5	Examples of utility assets at risk	14
Figure 5.1	Bulk salinity hazard modelled in the GSHARP process.	16
Figure 5.3	Areas selected on the basis of risk to surface water quality assets	18
Figure 6.1	Interim target areas for salinity management	20

List of Tables

Table 2.1	Groundwater Flow Systems and their management implications.	2
Table 2.2	Applicability of salinity management options based on groundwater flow systems	4
Table 5.1	Linear trends in EC for five rivers with high salinities	15

1 Introduction

This report documents the process for the **initial** selection and validation of target areas for salinity management in the Corangamite Catchment Management Authority (CCMA) second generation Salinity Action Plan (SAP). The second generation plan is being developed in line with Victoria's Salinity Management Framework, "*Restoring our Catchments*" (NRE, 2002) which sets out broad and challenging targets for management of salinity across the state. The SAP will be incorporated into the broader Corangamite Regional Catchment Strategy (RCS), a draft version of which has been published (Thomas & Colliver, 2003).

Direction for the development of the Corangamite SAP is provided by *Guidelines for review and renewal of action plan/sub-strategies to the Regional Catchment Strategy* (Draft) (NRE 2002). The guidelines require that a sub-strategy to the RCS (such as the Corangamite SAP) should "...indicate the priority setting criteria and process used to prioritise different actions and how this addresses protection of identified assets, minimisation of risks to assets,...". This background report is intended to partly address that requirement.

The inaugural Corangamite Salinity Management Plan, "*Restoring the Balance*" (Nicholson *et al.*, 1992) identified high priority areas within the Corangamite Salinity Region on the basis of Land Management Units (LMUs). The LMUs were ranked according to two components; the assessment of the salinity problem and the likely adoption. The salinity problem assigned rating values to:

- Area of land affected by secondary salinisation
- The rate of expansion of secondary salinisation
- Net income generated from the land
- Environmental effects
- Off site effects
- Special issues

The Likely adoption was weighted according to

- Groundwater system
- Community support

The summed weights prioritised the LMUs and target areas - known as Hot Spots - were selected for treatment in the six highest ranked LMUs. The process has been documented in Background Report No.8 (Nicholson *et al.*, 1992) of the initial salinity management plan. Later amendments to the Hot Spots delineated additional management areas as "*supplementary treatment areas*". The treatment options and targets for the hot spots and supplementary treatment areas were last revised in August 2000 (Heislars & Pillai, 2000).

The process described in this report is an altogether different approach based on a risk management using an assessment of salinity hazard and risk to various classes of assets. This approach is in keeping with the current National and State guidelines.

2 The Groundwater Flow System project

The Groundwater Flow Systems (GFS) have been developed in the National Land and Water Audit (Audit) as a framework for dryland salinity management in Australia (NLWRA, 2001). They “...characterise similar landscapes in which similar groundwater processes contribute to similar salinity issues, and where similar salinity management options apply” (Coram et al., 2001).

In the Audit, GFSs are characterised by their hydrological responses and flow paths into local, intermediate and regional systems (Table 1).

Local Flow Systems	Intermediate Flow Systems	Regional Flow Systems
Groundwater flows over distances of less than 5 kilometres within the confines of sub-catchments.	Groundwater flows over distances of 5 to 30 kilometres and may occur across sub-catchment boundaries	Groundwater flow occurs over distances exceeding 50 kilometres at the scale of river basins.
Respond rapidly to increased groundwater recharge. Watertables rise rapidly and saline discharge typically occurs within 30 to 50 years of clearing native vegetation for agricultural development. These systems can also respond relatively rapidly to salinity management practices, and afford opportunities to mitigate salinity at farm scale.	Have a greater storage capacity and generally higher permeability than local systems. They take longer to ‘fill’ following increased recharge. Increased discharge typically occurs within 50 to 100 years of clearing native vegetation for agriculture. The extent and responsiveness of these groundwater systems present much greater challenges for dryland salinity management than local groundwater flow systems.	Have a high storage capacity and permeability. They take much longer to develop increased groundwater discharge than local or intermediate flow systems – probably more than 100 years after clearing native vegetation. The full extent of change may take thousands of years. The scale of regional systems is such that farm-based catchment management options are ineffective in re-establishing an acceptable water balance. These systems will require widespread community action and major land-use change to secure improvements in water balance.

Table 2.1 Groundwater Flow Systems and their management implications.

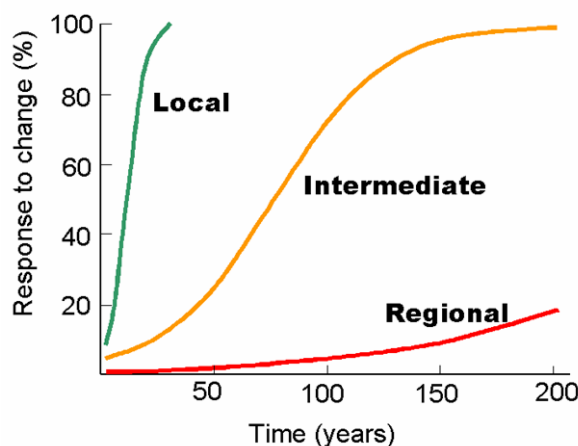


Figure 2.1
Responses of the groundwater flow systems to hydrologic change. This may influence salinity management options and investment.

The underlying assumption is that salinity is caused by increased recharge leading to rising groundwater tables, which have resulted from changes in land management over the past 200 years. While this may hold true for many Australian landscapes, the Audit's conceptual model does not hold for all areas of south west Victoria. In some areas such as the Western Victorian volcanic plains and the Heytesbury the groundwater tables have remained relatively unchanged over the past 200 years and other factors such as soil waterlogging and regolith hydrology are implicated in the spread of salinity (Dahlhaus & MacEwan, 1997).

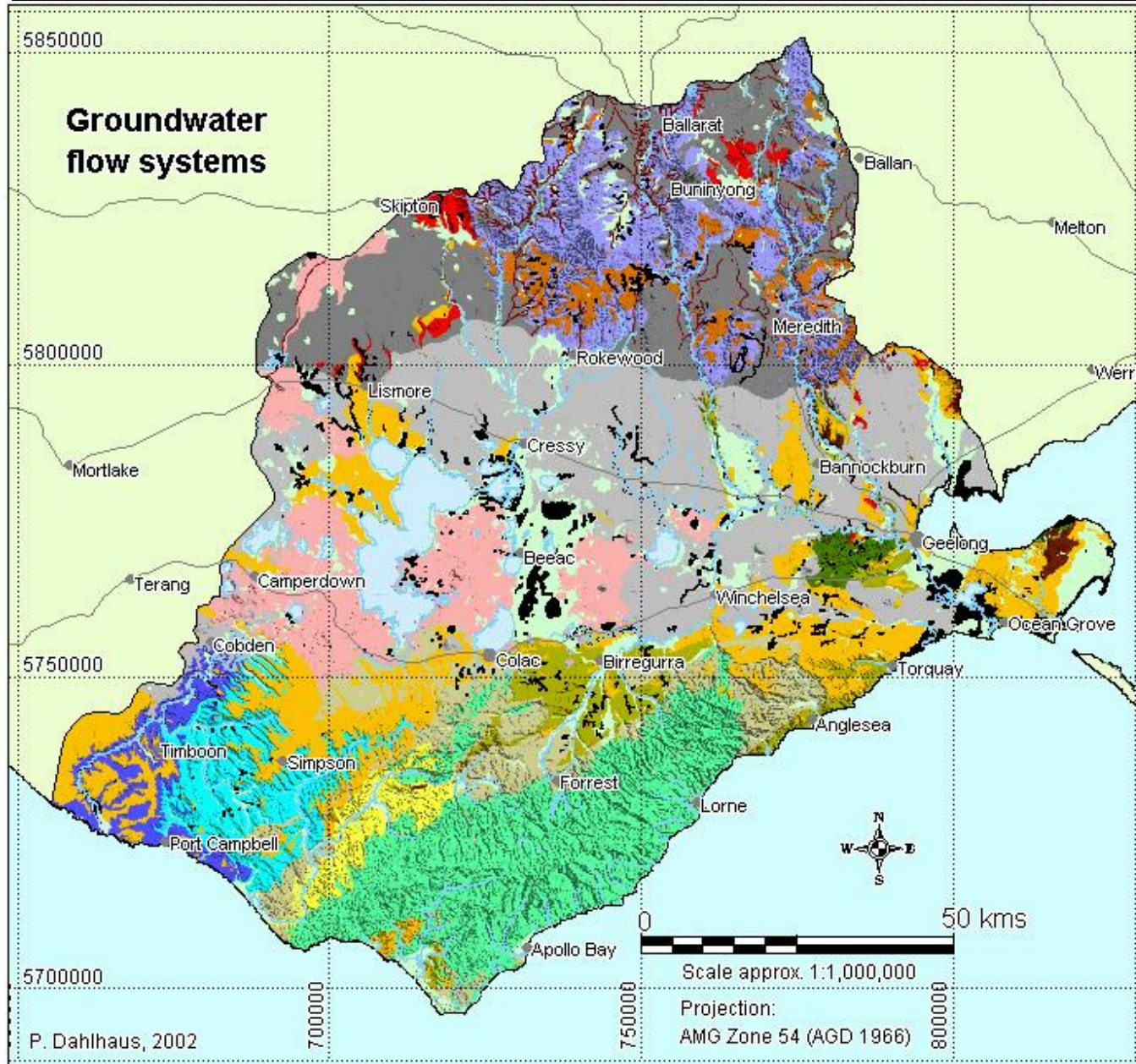
Seventeen GFSs were delineated in the CCMA on the basis of the consensus reached at a three-day GFS workshop held in Colac in November 2001, and subsequent discussions with regional experts. A report on the CCMA GFS was delivered in May 2002 and includes management options for each system (Dahlhaus *et al.*, 2002). This first attempt at delineating the GFS is a useful tool for salinity management, although subsequent revisions of the management plan should use a more rigorous three-dimensional hydrostratigraphic model that will be developed by current research projects.

The applicability of salinity management options based on groundwater flow systems is tabulated, and the spatial extent of the flow systems is illustrated, on the following pages. More detailed descriptions of the groundwater flow systems and the applicability of salinity management options can be found in the GFS report.

	Biological control of recharge			Engineering intervention		Productive use of saline land and water			
	Perennial pastures	Crop management	Trees/woody vegetation	Drainage	Groundwater pumping	Salt tolerant pastures	Halophytic vegetation	Saline aquiculture	Salt harvesting
GFS 1	Low - moderate	Low - moderate	Moderate	Low	Low - moderate	Moderate - high	Low	Low - moderate	Low
GFS 2	Inappropriate	Inappropriate	Inappropriate	Inappropriate	High				
GFS 3	Low		Low - moderate	Low	Low - moderate	Moderate	Low	Low - moderate	Low
GFS 4	Low		Low - moderate	Low - moderate	Low	High	Low	Low	Low
GFS 5	Low		Moderate	Low - moderate	Low	Moderate - high	Low	Low	Low
GFS 6	Low - moderate	Low - moderate	Low - moderate	Low	Low - moderate	Moderate	Low	Low - moderate	Low
GFS 7	Low - moderate		Low - moderate	Moderate - high	Low	Moderate - high	Low	Low	Low
GFS 10	Low - moderate	Low - moderate	Low - moderate	Low	Moderate - high	Moderate	Low	Moderate	Low
GFS 12	Low - moderate		High - Low	Low	Moderate	Moderate - high	Low	Moderate	Low
GFS 13	Low	Low	Low	Low	Moderate	High	Low	Moderate	Low
GFS 14	Low	Low	Low	Low	Moderate	High	Low	Moderate	Low
GFS 15	Low	Low	Low	Low	Moderate - high	Moderate - high	Low	Moderate - high	Low

Table 2.2 *Applicability of salinity management options based on groundwater flow systems*

Blue = local; orange =intermediate; pink = regional systems. Blank cells indicate that the management option is not applicable. GFSs with no salinity problems have been omitted.



Corangamite Catchment Management Authority

Groundwater Flow Systems

Local flow systems

- GFS 1 - Quaternary sediments
- GFS 2 - Scoria and stony rises
- GFS 3 - Highlands gravel caps
- GFS 4 - Heytesbury marls
- GFS 5 - Gerangamete marls
- GFS 6 - Otway Group (Barrabool Hills)
- GFS 7 - Granitic rocks
- GFS 8 - Older volcanics
- GFS 9 - Otway Group (Otway Ranges)

Intermediate flow systems

- GFS 10 - Pliocene sands
- GFS 11 - Wiridjil Gravels and equivalents
- GFS 12 - Palaeozoic sedimentary rocks
- GFS 13 - Central Highlands volcanic rocks

Regional flow systems

- GFS 14 - Volcanic Plains basalt
- GFS 15 - Deep Leads (mapped)
- GFS 15 - Deep Leads (inferred)
- GFS 16 - Port Campbell Limestone
- GFS 17 - Dilwyn Formation and equivalents

3 The Geospatial Salinity Hazard and Asset Risk Prediction (GSHARP) project

A Geospatial Salinity Hazard and Asset Risk Prediction (GSHARP) process has been developed by the Centre for Land Protection Research (CLPR), Natural Resources and Environment (NRE), Bendigo as a tool for geographically prioritising the salinity risk, as well as organising spatial information and expert knowledge for informing on-ground implementation decisions. The GSHARP method was derived from the Integrated Catchment Salinity Risk Prioritisation (ICSRP) method that had been used in the North Central CMA and Glenelg Hopkins CMA regions (Heislars & Brewin, 2003).

David Heislars, Senior Hydrogeologist, CLPR, undertook GSHARP modelling for the Corangamite CMA during 2002. The project was funded through the National Action Plan (NAP) foundation funding (knowledge gap filling) and has been reported separately by the CLPR (Heislars & Brewin, 2003). A committee comprising CCMA, and NRE representatives took responsibility for steering the project towards the goal of using GSHARP outcomes to select the initial priority areas for the CCMA SAP.

Ultimately, the GSHARP project provided:

1. A **salinity hazard map** for the CCMA region, derived by the addition of:
 - H 1.* Mapped area of land salinised
 - H 2.* Mapped line of salinisation along a watercourse
 - H 3.* Groundwater salinity rating
 - H 4.* Depth to watertable rating
 - H 5.* Flow weighted stream salinity rating
 - H 6.* Groundwater flow system rating
2. A **salinity risk map**, derived by summing the risk of salinity to the following assets:
 - A 1.* Infrastructure (roads, bridges, railway and towns)
 - A 2.* Utilities (electricity, gas, water, Telstra)
 - A 3.* Agricultural land
 - A 4.* Water reservoirs
 - A 5.* Environment (Public land, Victorian Rare or Threatened (VROT) species, Significant and/or Ramsar wetland)
 - A 6.* Cultural and Heritage (Aboriginal, historical, natural)

Details of the data quality and process have been reported in the final GSHARP report (Heislars & Brewin, 2003).

The resulting maps were presented to the CCMA SALMIC meeting in October (Meeting No.26). In relation to the salinity risk map, there was some discussion about the relative value given to the weightings, especially since all assets were given the same weightings. For example, an urban water reservoir, Ramsar wetland of international importance, telephone exchange, unsealed rural road, agricultural land, aboriginal midden and state forest were all given equal value. The SALMIC requested the GSHARP steering committee to re-evaluate the weightings with a view to refining the risk map.

3.1 Review of the GSHARP risk map

The GSHARP steering committee met with CLPR project officers on 14th November 2002 to review the risk map. In the absence of any objective guidelines on the relative importance of assets, the GSHARP steering committee decided (after much discussion) to rely on the general importance given to assets through the community workshops on the CCMA Regional Catchment Strategy (Thomas & Colliver, 2002). Members of the committee each ranked the assets in order of perceived importance and the summed rankings generally resolved into a four-tier structure as follows:

- Water resources assets = 4
- Agricultural Land assets = 3
- Environment assets = 3
- Infrastructure assets = 2
- Cultural and Heritage assets = 1
- Utilities assets = 1

The rankings take into account the relative risk to the assets. For example, many utilities (eg. gas pipelines, Telstra cables, etc.) are designed to withstand aggressive salt conditions in the ground, and the salinity threat to a Natural Heritage asset (eg. a road cutting listed as a geological feature of the National Estate) may not be as urgent.

The resultant amended risk maps depicted four scenarios:

3.1.1 Immediate-term asset risk

For the immediate-term asset risk map a 1 kilometre by 1 kilometre cell is summed according to the ranking of asset intersections with mapped salinity, other than Ramsar wetlands and water supply reservoirs which are ranked on their occurrence within a 'hazardous' GFS and Towns, Public Land and Victorian Rare or Threatened Species (VROTS) which are ranked on their intersection with shallow watertables (less than or equal to 2 metres below the natural surface).

3.1.2 Near-term asset risk

The near-term risk is determined using the intersection of all assets with shallow watertables (less than or equal to 2 metres below the natural surface). A cell is ranked (with the same weightings as above) according to whether the asset (road or wetland, etc.) is underlain by shallow watertables.

3.1.3 Near and far term asset risk

The near and far term asset risk is determined using watertables less than or equal to 5 metres below ground to predict the intersections with the asset. These predictions are speculative as the depth-to-watertable data set is less accurate.

3.1.4 Far-term asset risk

The far-term asset risk is determined using water-tables between 2 and 5 metres depth. This prediction is highly speculative and will need further refinement as more accurate datasets are derived.

4 Validation and evaluation of GSHARP for asset risk priority area selection

Three of these – immediate-, near- and far-term risk – were used to delineate the initial priority areas where assets were at risk. The priority regions were chosen at a meeting of the SAP consultant team on November 21st 2002. The maps and asset risk priority regions are shown on the following three pages (Figures 4.1, 4.2 & 4.3). The selection process and outcomes were presented to the SALMIC for ratification on December 13th 2002.

4.1 Validation of GSHARP outcomes

The areas were selected on the basis of a grouping of cells with higher scores in the immediate-term. These areas were then queried to determine specifically which assets are at risk. Unfortunately, data exchange protocols, confidentiality and copyright issues prevented the original GSHARP data sets being available. However, the gridded (or rasterised) data were supplied and separate maps were generated for each priority area for on-ground validation of the asset risk.

Each area was field-checked to validate that risk to assets could be determined on ground. The data and results of this process are appended (Appendix 1).

4.2 Conclusions on the GSHARP outcomes

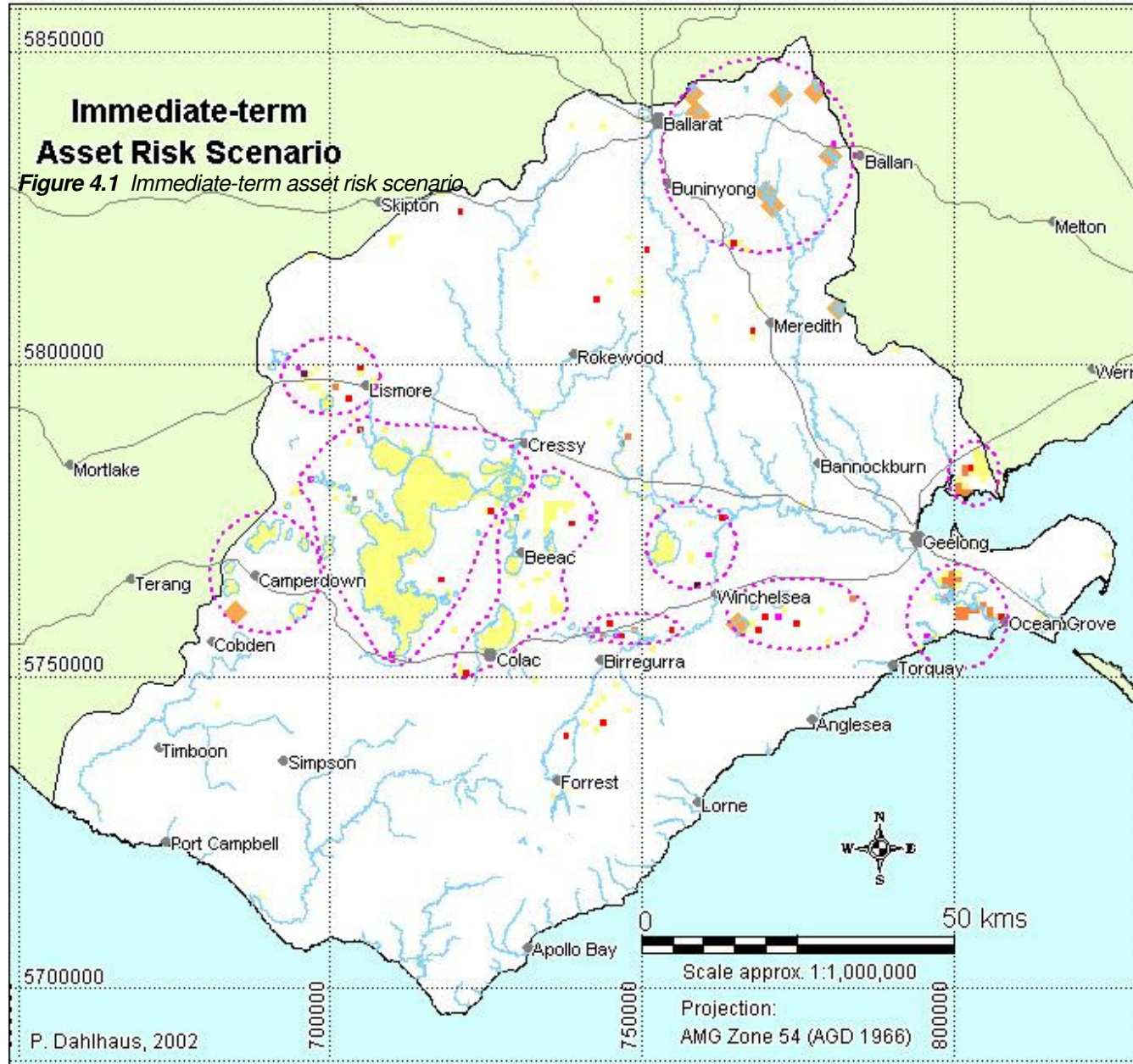
In general, the GSHARP process has successfully identified the broad areas where assets are at risk of salinity. On the **positive** side, GSHARP has

1. Provided an objective, transparent and accountable process for the identification of areas where assets are at risk from salinity. The process is flexible enough to incorporate improvements to both data quality and method, and continuous improvement will make future iterations of the salinity risk prioritisation more accurate.
2. Incorporated assets that were not considered in previous salinity “hot spot” selection. These include infrastructure, utility, cultural and heritage assets. As more assets are identified they can be easily added to the GSHARP asset register.
3. Attempted to predict the salinity risk into the future with the immediate-term, near-term and far-term risk scenarios.
4. Identified the risk to infrastructure and utilities reasonably well.

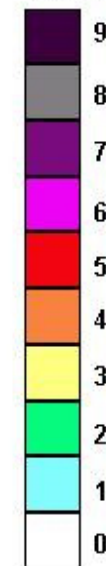
On the **negative** side, GSHARP has:

1. Poorly identified the risk to agricultural land, environmental assets and cultural and heritage assets.
2. Not identified the risk to water quality, either in urban water supply reservoirs or in surface water bodies, including rivers and streams.
3. Been severely limited in accuracy by the quality of the input data. This is particularly true for the layers used to determine the salinity hazard rating, all of which are incomplete, inaccurate or not entirely suited to the purpose. The asset layers are also restricted by their incompleteness.

Specific details and examples are provided in the following sections.



Score



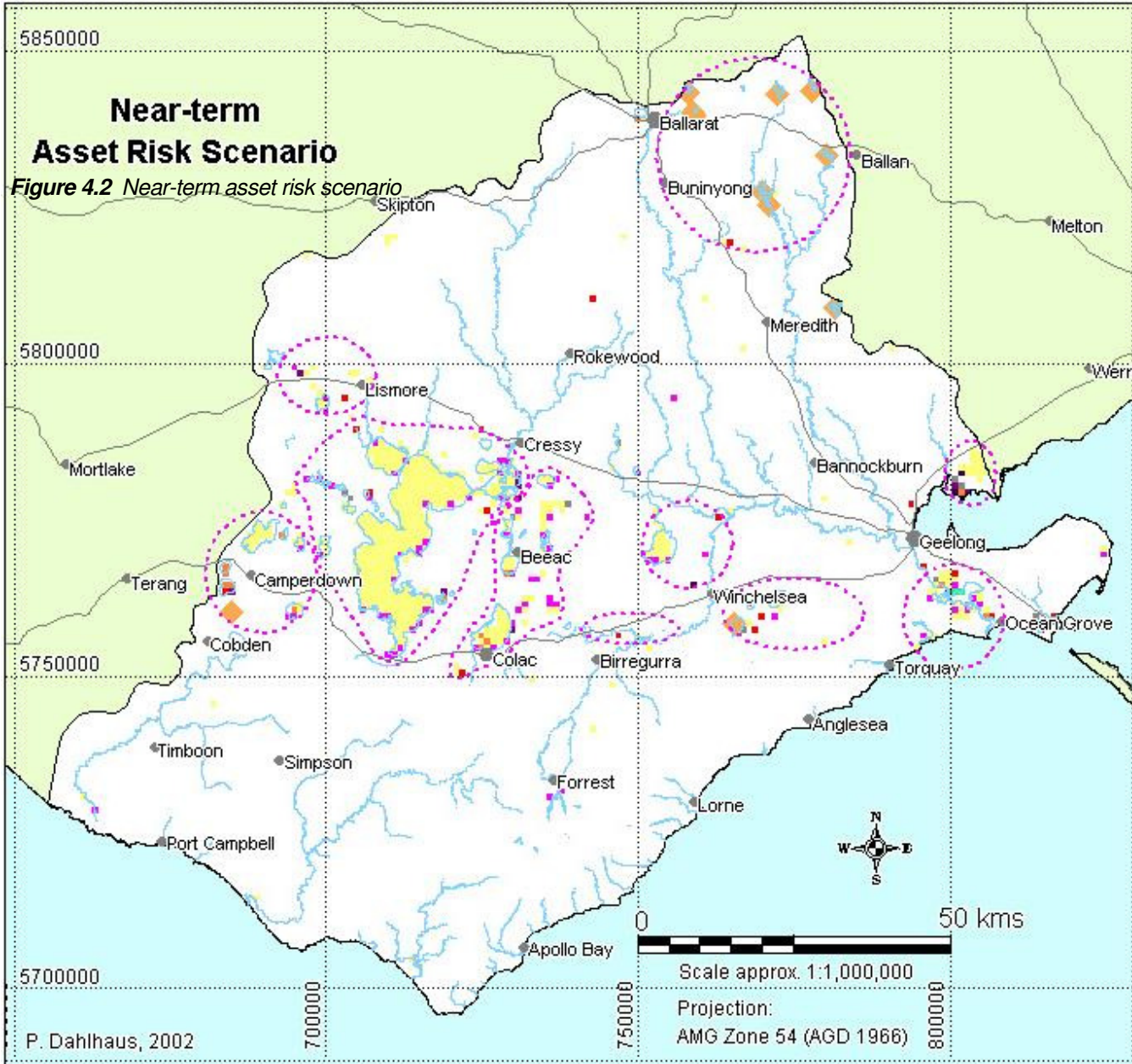
**Immediate-term
Asset Risk
Scenario**

Weighted as;

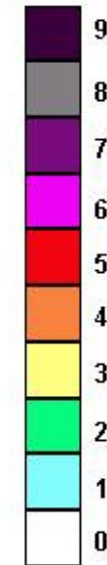
Water resources = 4
Agricultural Land = 3
Environment = 3
Infrastructure = 2
Culture & Heritage = 1
Utilities = 1



Area representing
a cluster of assets
currently at risk.



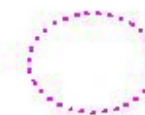
Score



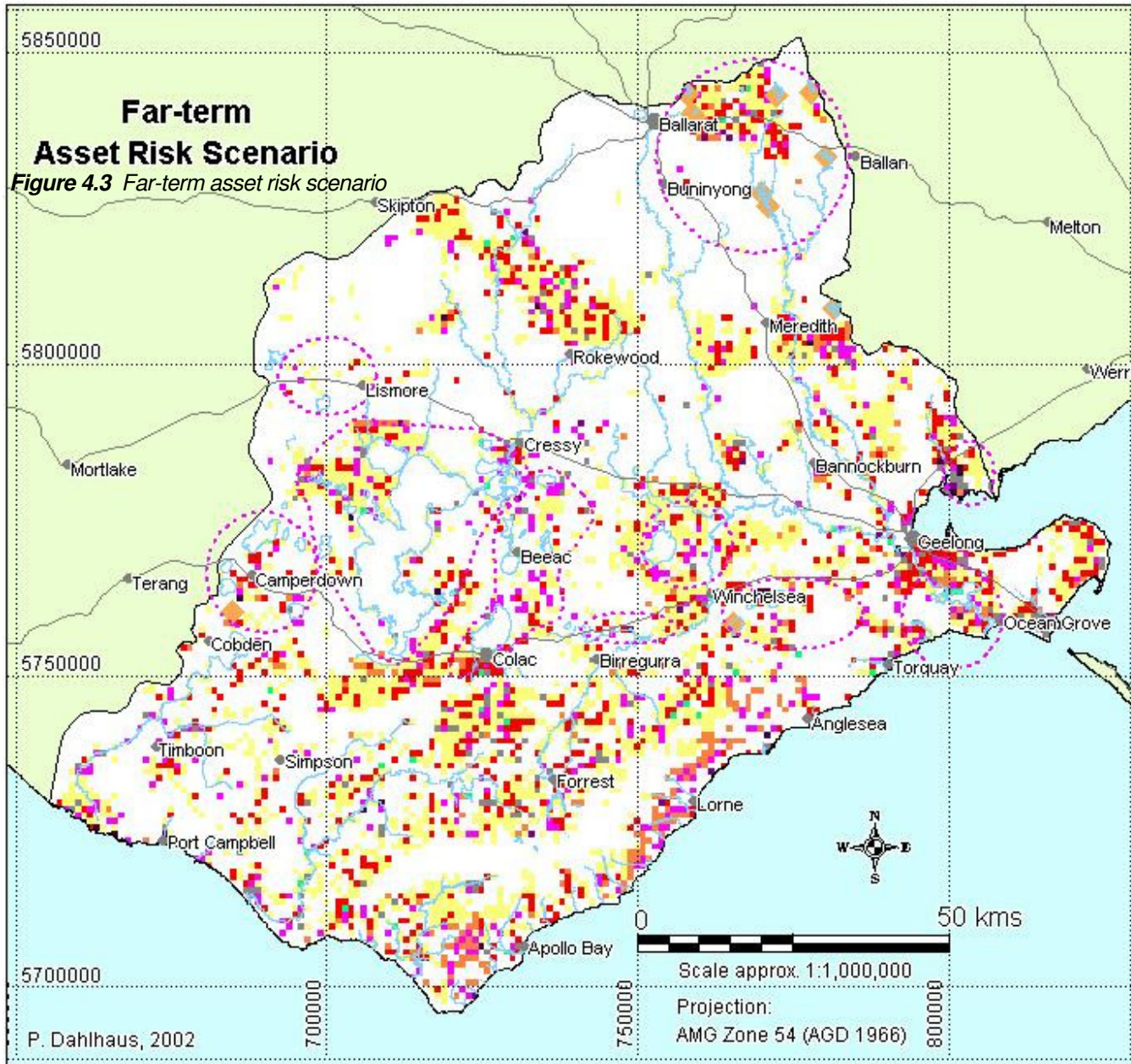
**Near-term
Asset Risk
Scenario**

Weighted as;

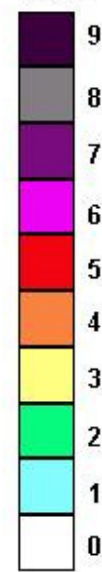
- Water resources = 4
- Agricultural Land = 3
- Environment = 3
- Infrastructure = 2
- Culture & Heritage = 1
- Utilities = 1



Area representing
a cluster of assets
currently at risk.



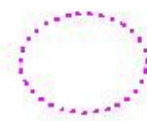
Score



Far-term Asset Risk Scenario

Weighted as;

- Water resources = 4
- Agricultural Land = 3
- Environment = 3
- Infrastructure = 2
- Culture & Heritage = 1
- Utilities = 1



Area representing a cluster of assets currently at risk.

4.2.1 Agricultural land assets

In general, the GSHARP has limitations in identifying the salinity risk to agricultural land. In particular, the following shortcomings were noted:

1. All agricultural land has equal asset value whereas, cropping land with krasnozem soils and groundwater irrigation allocations around Alvie and Warrion, or Bungaree and Wallace would widely be regarded as more valuable agricultural land assets than the grazing country of Grenville and Pittong. Although a process for determining the value needs to be decided (is it the real-estate value, or the productivity value, for example) the risk should ultimately be weighted according to the agreed asset value.
2. The scale of the saline land in relation to the scale of the farm is not taken into account. In fact, ten hectares of salinised farmland is a much greater problem on the smaller dairy farms in the Heytesbury than on the larger mixed farms of the Mt Mercer district.
3. The method used averages the salinity risk such that significant areas of salinised land may be excluded. Initially the salinised land is averaged over the area of a 250 metre by 250 metre grid cell (6.25 hectares). This omits areas of less than 3 hectares (i.e. less than half the cell). These cells are then summed as one kilometre by one kilometre cells. Effectively, a cell does not score highly if it is intersected by narrow linear discharge area, or an area less than about 50 hectares over the 100 hectares of each cell. This point is demonstrated by Figure 4.4 below.



Figure 4.4 (a) Area of salinised agricultural land on the Mt Mercer - Dereel Rd. The area photographed (on the south side of the road) has not been mapped.

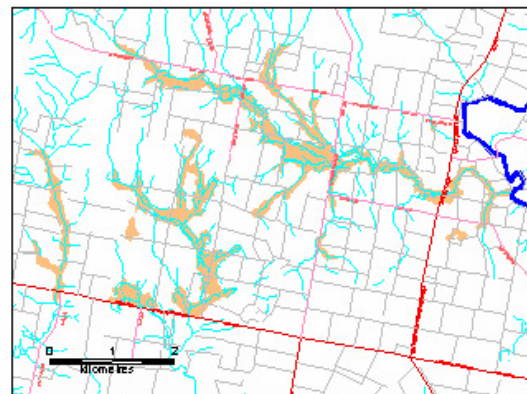


Figure 4.4 (b) Mapped salinity

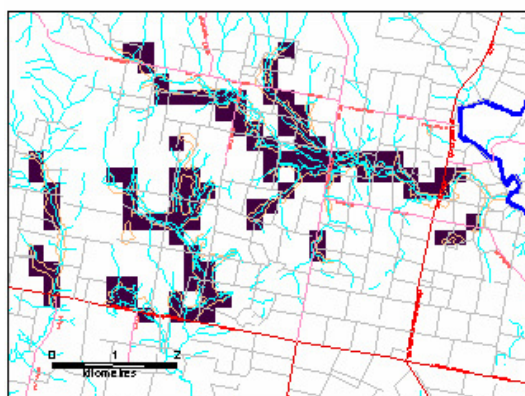


Figure 4.4 (c) Agricultural land asset grid intersections (250 m grid cell)

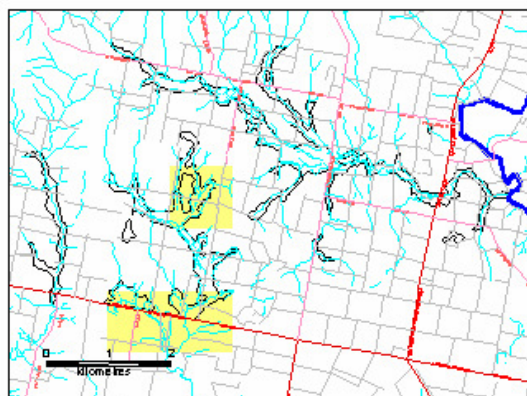


Figure 4.4 (d) Final salinity risk (1 km grid cells)

Figure 4.4 GSHARP identification of agricultural land asset on the Mt Mercer – Dereel Rd

4.2.2 *Environmental assets*

Environmental assets were considered in three categories; Public Land, VROTS and Ramsar and significant wetlands. The inclusion of environmental assets is a significant addition to the salinity management plan, however limitations in using GSHARP to identify the salinity risk to environmental assets are:

1. The data sets used do not discriminate between environmental assets and public assets. For example, Public Land may vary from a flora reserve (high environmental value) to a football oval (low environmental value). Similarly, the VROTS may vary from halophytic vegetation in primary saline areas to salt-sensitive species in secondary discharge sites to migratory mammals largely unaffected by salinity.
2. A Ramsar or significant wetland is identified 'at risk' if it occurs in a 'hazardous' GFS. This argument is false for many of the wetlands of the Volcanic Plains basalt GFS, since their environmental value lies in their primary saline origins. Estuarine saline wetlands were generally omitted because they have not been mapped.
3. VROTS and Public land are deemed 'at risk' if they are underlain by a shallow watertable. However, if the salinity of the groundwater is relatively low, the asset may not be at risk at all. A large fresh-water lake fed by groundwater discharge which is also a Public Land reserve (eg some of the lakes around Camperdown) is falsely identified 'at risk'. This flaw in logic is particularly evident in the far-term asset risk scenario map, which falsely identifies the Otway coast as being 'at risk' because the Public Land is underlain by (fresh) groundwater at a depth of five metres.
4. Significant stands of remnant vegetation and ecological vegetation classes (EVCs) are not currently included in the process. Encroaching salinity may be a threat to both, and may include threats to indigenous fauna if their habitat was degraded.

4.2.3 *Water resources*

The GSHARP process identified the risk to water supply reservoirs by their occurrence within a 'hazardous' GFS. However, water supply reservoirs typically harvest their water from surface runoff, or are filled via aqueducts, and are often located at high points in the landscape. Few are considered 'at risk' due to saline groundwater input.

The salinity risk to water resources other than urban supply reservoirs – lakes, rivers and streams – is not assessed by the current GSHARP process. Yet these surface water resources are used for irrigation and recreation, and their environmental values are highly valued within the CCMA community. The current inability to identify the salinity risk to these water resources is seen a major flaw in the GSHARP process and requires urgent attention before the next iteration.

4.2.4 *Culture and Heritage*

The ability of the GSHARP process to identify the risk to cultural and heritage assets was severely limited by the paucity of quality data, the restrictions on the data access and the lack of information about the specific sites. This is partly due to the confidentiality of archaeological site locations. Some registered heritage sites, such as the Cheetham Saltworks at Point Henry were not identified because the sites had not been included in the salinity mapping.

Additionally, natural heritage sites were equated with Public Land, resulting in asset misidentification and the omission of assets such as sites of geological and geomorphological significance.

4.2.5 Infrastructure and utilities

In general, the GSHARP process identified the risk to infrastructure and utilities accurately. Field checking was required to ascertain if the asset was in the discharge area (Figure 4.5).

Right: A water main transecting salinised land (class one salinity) north east of Camperdown.



Above: Road, gas pipeline and agricultural land intersects with saline land west of Ballan.

Figure 4.5 *Examples of utility assets at risk*

5 Selection of target areas for stream water quality asset

The GSHARP project has provided the basis for rational and objective selection of ten areas where clusters of assets are identified as being at higher immediate risk of salinity processes (Figure 4.1). However, the salinity risk to surface water quality has not been adequately identified through the GSHARP process. This has been highlighted by the SALMIC at the December 13th 2002 meeting and by NRE staff at a meeting on February 10th 2003. To address this gap, a method based on the GSHARP hazard mapping, modelling of stream salinity trends, and the groundwater flow systems has been used.

The GSHARP hazard identification process has identified several catchments within the CCMA that have high flow weighted stream salinities (Figure 5.1). The most obvious catchments are those of the Woody Yaloak River, Leigh River, Moorabool River, Birregurra Creek and Thompson Creek. Since the pre-1800 salinity values for these waterways is not known, it is uncertain if the streams are 'at risk' based solely on their flow weighted salinities. Indeed, if the streams were saline in their 'natural states' (i.e. before widespread land-use change), it could be argued that acting to decrease the water salinity may jeopardise the biodiversity asset, if indigenous halophilous flora and fauna were adversely affected.

The monitoring record for some of the waterways provides the opportunity for an analysis of trends in the Electrical Conductivity (EC) measured at the stream gauging stations each month over the past 26 years. The CSIRO have developed a method for stream salinity analysis using a semi-parametric method based on the Generalised Additive Model (GAM) (Morton, 1997). Morton's semi-parametric analysis provides linear and non-linear trends in EC which are independent of flow and season, or more basically, the results indicate the underlying EC trend due to changes in baseflow contribution.

At this stage, trends in the EC for stream water at five gauging stations have been analysed. The results for the linear component are tabulated below and the non-linear trends have been graphically represented in Figure 5.2.

Station number	Station name	Geometric Mean EC ($\mu\text{S}/\text{cm}$)	EC trend ($\mu\text{S}/\text{cm}/\text{yr}$)
232202	Moorabool River at Batesford	1459	18.7
233200	Barwon River at Pollocksford	2015	-33.6
233211	Birregurra Creek at Ricketts Marsh	10420	-156.1
233215	Leigh River at Mount Mercer	1146	-1.4
234201	Woody Yaloak River at Cressy	5105	5.0

Table 5.1 Linear trends in EC for five rivers with high salinities

Of these, only the Moorabool and the Woody Yaloak show increasing trends over the 26 year monitoring period. The analysis of the remaining 34 gauged rivers and streams in the CCMA region is being undertaken during the next few months as a part of a PhD research project (Dahlhaus *et al.*, in prep).

It is logical that efforts at mitigating the salinity loads of both the Woody Yaloak and the Moorabool rivers should continue in order to protect the water quality asset and associated beneficial uses and biodiversity of the rivers. Until further research is completed it is not known if the decreasing salinities in other streams poses a risk to the environmental and biodiversity assets.

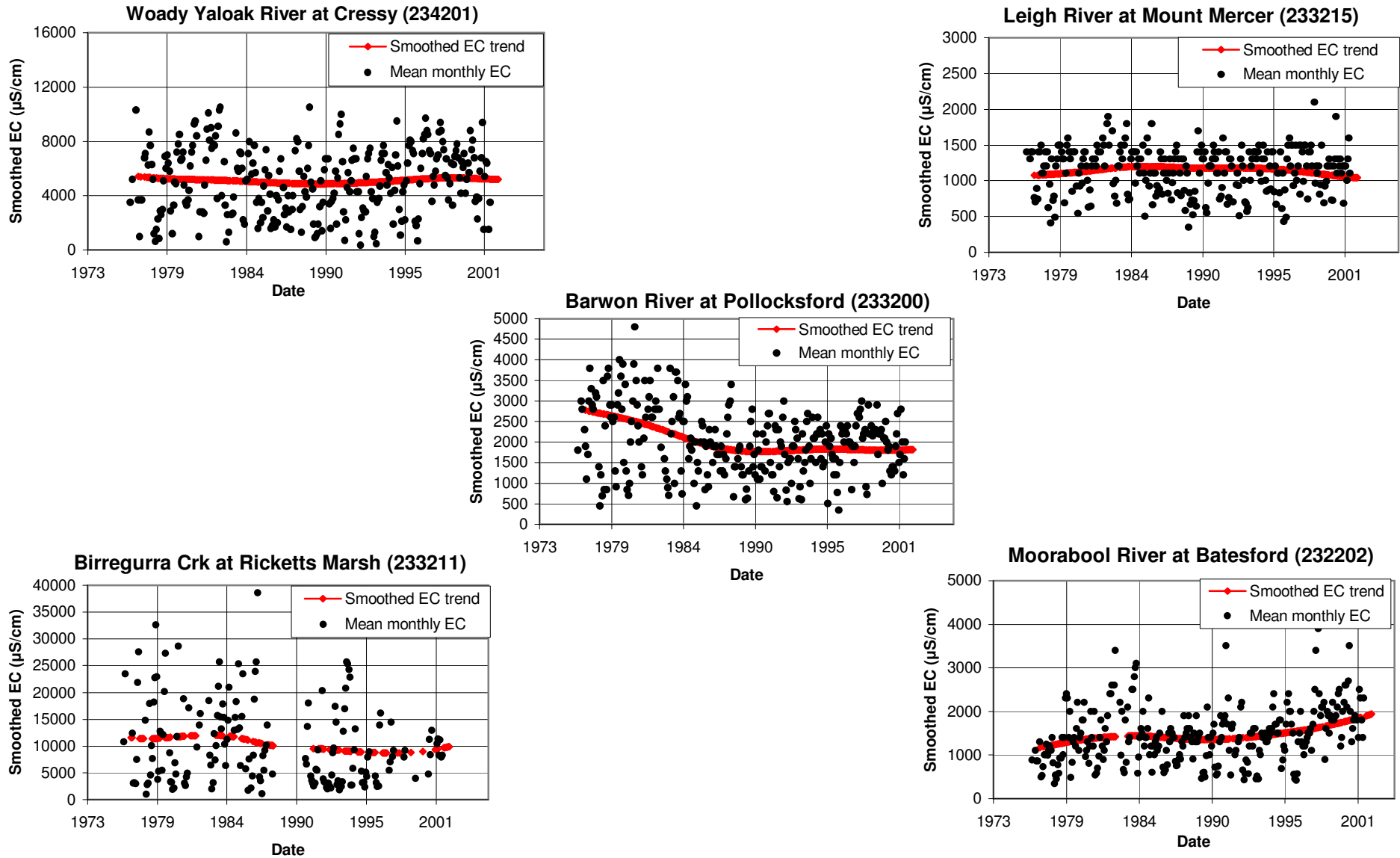


Figure 5.2 Non-linear EC trend analyses of five rivers with high salinities

In the short term, the causes of changes in stream salinities remain speculative. In particular, the contribution of salt added through surface wash-off compared to the contribution made by baseflow is unknown, as are the historic salinity loads in the streams. Since the modelling method removes the effects of stream-flow and climate, the trends in stream salinity should solely represent changes to the groundwater baseflow component. However, a complete analysis of the non-linear stream salinity trends in conjunction with an analysis of the appropriate bore hydrograph records would be required to definitively draw conclusions about the causes. Such an analysis will not be concluded for several months.

Although unproven, the most likely GFS contributing to the increasing stream salinity trends in the Moorabool and the Woody Yaloak rivers are the Palaeozoic sedimentary rocks, the Highland gravel caps and the granitic rocks. On the basis of the mapped salinity, the suspect GFS and catchment boundaries of the Woody Yaloak and Moorabool rivers, three target areas have been added (Figure 5.3). The areas have been nominated as Meredith (for the Moorabool River), Pittong and Illabarook (for the Woody Yaloak River).

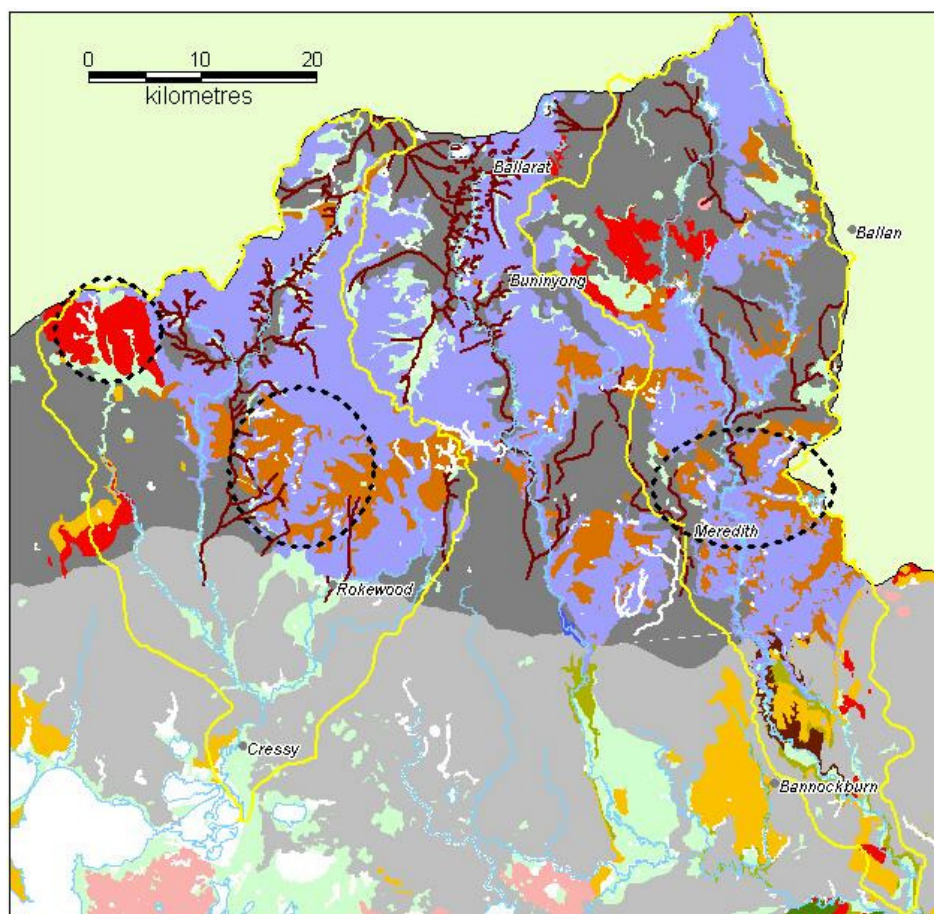


Figure 5.3 Areas selected on the basis of risk to surface water quality assets

The approximate boundaries of the selected areas are shown by the black dotted lines. The Catchments for the Woody Yaloak and Moorabool Rivers are outlined in yellow. The mapped salinity is shown in white. The groundwater flow systems are shown by the various colours. The target areas have been selected on the basis of 1) the trends in surface water salinity, 2) the most likely groundwater flow systems to be contributing salt, and 3) the areas where salinity has been mapped.

6 Discussion and Conclusions

The process for selecting target areas for salinity management outlined in this report is an attempt at an objective, transparent, accountable method based soundly on the factual evidence and current scientific knowledge. Although imperfect, it provides the foundation for future iterations of targeting investment into priority treatment areas, based on risk assessment and asset protection. As data sets improve and methods are refined, the process can be easily adapted to include the updated information and knowledge.

A variety of methods have been used in Australia to assess dryland salinity risk. A review by CSIRO (Gilfedder & Walker, 2001) categorized these into:

1. *Composite index methods*, which assign weights to various data layers. The weights are usually based on empirical judgment and summed to produce a risk map.
2. *Strongly inverse methods*, which use the distribution of salinised areas to build decision trees or expert methods to assess the risk of further salinisation.
3. *Trend based methods*, which use historical trends in land, stream or groundwater salinities to forecast future development of salinity in a region.

The authors concluded that a suitable approach to risk assessment should include:

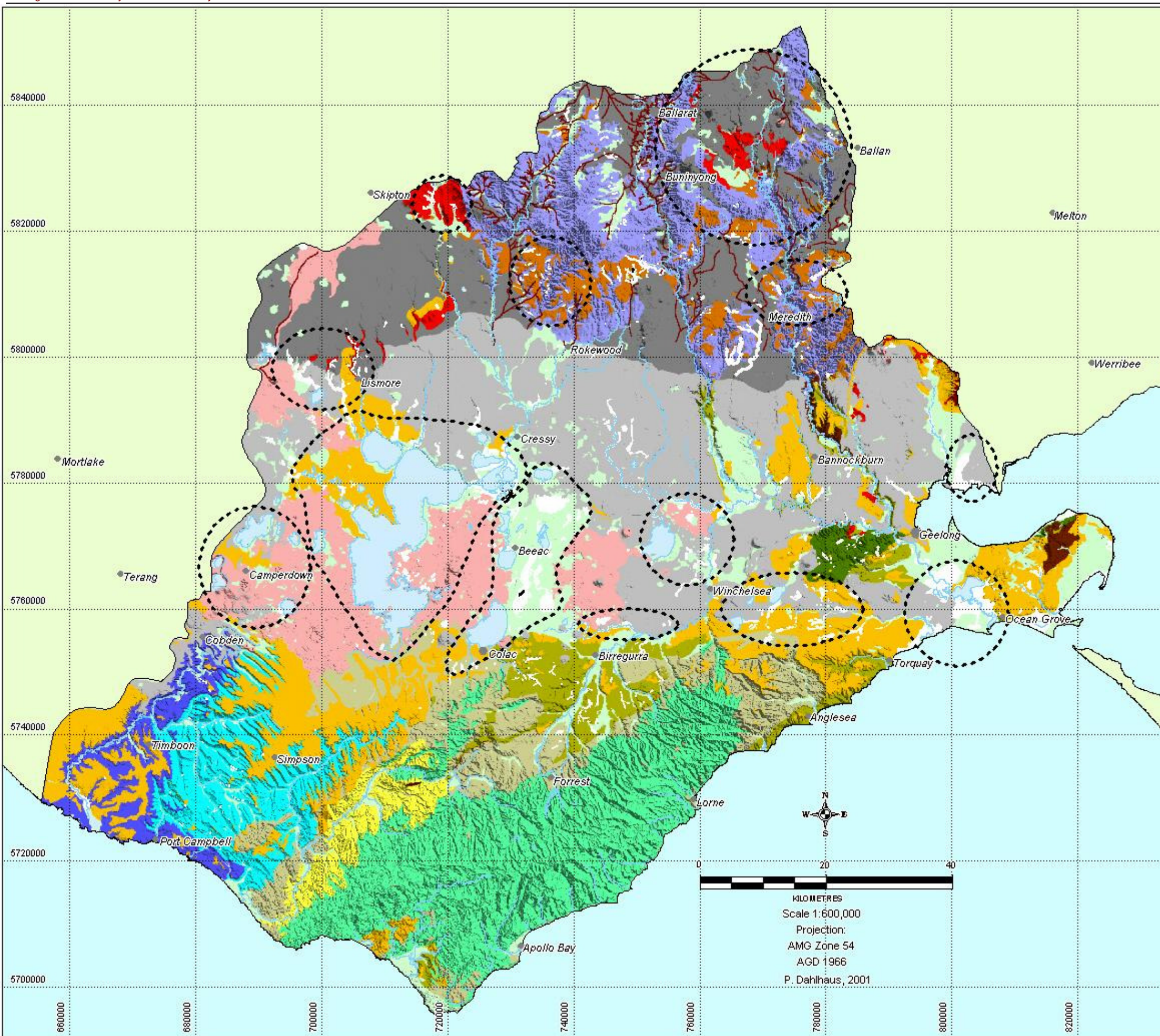
- Landscape disaggregation to provide consistency in methods
- Salinity risk assessment based on a range of approaches to target key processes within a landscape element
- Temporal change to allow predictions which can relate to the lead-time required for management intervention.

The process used in this report has all three fundamental components:

1. Catchment characterisation based on groundwater flow systems, as a logical method of landscape disaggregation. The GFS method follows the National framework for characterising similar landscapes with similar salinity processes where similar management options apply.
2. Identification of assets at risk due to salinity. The GSHARP method uses a classic risk-based approach based on the salinity hazard intersected with five asset categories. The method combines elements of composite index methods (by assigning weights or ranges to various categories) and the strongly inverse methods (by using the mapped salinity for asset intersections).
3. Identification of trends in salinity. The semi-parametric method of determining salinity trends of surface water resources provides a measure of change in a sub-catchment, independent of flow volume and climate.

Together these steps form the framework for determining the priority target areas for salinity management.

The process has delineated 13 areas for further investigation and development of management strategies and targets for the initial year of the salinity management plan (Figure 6.1). Discussions with asset managers will clarify the nature of the risk to assets, the possible approaches to salinity management (including cost-sharing arrangements), the appropriate targets (including likelihood of adoption and required incentives, and the likely timeframe for the implementation of treatment.



Corangamite
Catchment
Management
Authority

**Interim target areas,
mapped salinity,
Groundwater
Flow Systems
and terrain model**

Interim Salinity
Management
Target areas

Groundwater Flow systems

Local flow systems

- Quaternary sediments
- Scoria cones and stony rises
- Highlands gravel caps
- Heytesbury marls
- Gerangamete marls
- Otway Group - Barrabool Hills
- Granitic rocks
- Older volcanics
- Otway Group - Otway Ranges

Intermediate flow systems

- Pliocene sands
- Wridjil Gravels
- Palaeozoic sedimentary rocks
- Central Highlands volcanics

Regional flow systems

- Volcanic plains basalt
- Deep Leads
- Port Campbell Limestone
- Dilwyn Formation

Mapped salinity (white)

Elevation data model uses 20 m grid cells
source data is 10 m contours from VicMap
1:25,000 topographic maps. Data processing
by Tony Davidson, May 2001.

Image illumination:
Azimuth 45 degrees, inclination 45 degrees.
Vertical exaggeration x10 normal scale.
Image processing by Peter Dahlhaus.
Peter Dahlhaus - PhD project, 2001.

7 Recommendations

The following recommendations are made to improve on the three components of the selection process in the short-term (i.e. over the next one or two year timeframe).

7.1 Groundwater Flow Systems

Of the recommendations included in the groundwater flow systems report (Dahlhaus *et al.*, 2002), two are particularly applicable to the improvement of the selection of target areas for salinity management. These are:

- Priority should be given to research projects that can scientifically validate the assumed GFS for the CCMA region. Local GFS (i.e. highly responsive systems) with a significant salinity risk (eg. GFS 3 – Highlands gravel caps) should be targets for immediate research aimed at proving the conceptual model and improving the confidence in the management options. Funding and commitment for long-term projects involving team research (eg. CSIRO, CRCs, Universities and Government research bodies) should be sought to improve the understanding of more complex systems and their role in salinity processes.

In particular, GFS 14 - the volcanic plains basalt - requires research to disaggregate the larger “regional” flow system into regions or even more localised areas. This may provide the ability to manipulate ‘individual’ flow systems with appropriate targeted management, rather than the generic “discharge management” option. This flow system contains all of the regions highly-valued environmental assets.

- Scenario modelling for those systems with robust conceptual models (i.e. those GFS with a higher degree of confidence) would be useful to validate the assumed response of the suggested management options.

7.2 GSHARP and its successors

The GSHARP project represents the genesis of a process that may continuously evolve into a useful hazard assessment and risk assessment tool. Current research (eg. PhD research) aims to make significant improvements on the process by applying the generic methods of the Australian/New Zealand Standard on Risk Management AS/NZS 4360:1999 (SAA, 1999). In the short-term, substantial improvements can be made to the process by updating and upgrading the asset register to include:

- different classes of agricultural land, perhaps classed by value or productivity
- appropriately discriminated environmental layers, such as greater discrimination of VROT species at risk of salinity; ranking the significance of remnant vegetation and habitat; ranking for Public Land assets; and ranking the sensitivity of Ramsar and significant wetlands to changes in salinity (either increase or decrease)
- discrimination of cultural and heritage assets into classes based on their actual risk to salinity hazards, and inclusion of appropriate heritage assets, other than using one class of Public Land
- addition of all known utility and infrastructure assets such as all power lines, buildings, bridges, weirs, etc. to the existing database
- inclusion of municipal planning overlays and planning strategies to assess the risk of salinity to existing or planned subdivisions
- include the surface water quality asset in the register, perhaps by using the index of stream condition or other appropriate layer

7.3 Trend analysis

Improvements can be made to the trend analysis by:

- Completing a trend analysis on all 39 streams in the CCMA with sufficient length of record in the gauging station data
- Completing a trend analysis on all bore monitoring records (water levels, and salinity where known) to compare with the surface water analyses

7.4 Model enhancements

As more knowledge is gained from the projects currently in progress, the conceptual models and understanding of the salinity processes will be revised. In particular, current projects such as the Corangamite drainage scheme review, the research and development compendium, the regional knowledge network, the wetlands inventory and the groundwater monitoring guidelines and review all have the capacity to add an immense volume of knowledge and data to the salinity plan. Subsequent iterations of this target selection process will need to include those data and integrate the concepts.

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Appendix A – Field validation sheets

Note: The field checking sheets were based on the information supplied by the ICSRP method, later modified to GSHARP. These appendices include the immediate risk scenario maps and the field validation sheets. The full data set (over 200 maps) has not been included and is available from the Corangamite CMA on CD ROM.

[1 - Lara](#)

[2 - Geelong \(Lake Connewarre\)](#)

[3 - Modewarre](#)

[4 - Gordon – Lal Lal](#)

[5 - Murdeduke](#)

[6 - Warncoort](#)

[7 - Weering – Colac](#)

[8 - Corangamite](#)

[9 - Derrinallum](#)

[10 - Camperdown](#)

Second generation salinity action plan Integrated Catchment Salinity Risk Prioritisation (ICSRP) Validation of priority areas

Location No. 1
Location title: Lara
Name of assessor: *Graeme Anderson*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities		Electricity		2°Salt ~50m	Check ²
		Gas		2°Salt ~50m	
		Water		2°Salt ~50m	
		Telstra		2°Salt ~50m	
Agricultural land		Land		2°Salt ~50m	True ³
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁴
		VROTS	✓	WT = <2m	True ⁴
		Ramsar / signif wetlands	✓	GFS >=3	True ⁴
Cultural & heritage	✓	Aboriginal	?	Salt ~50m	True ⁵
		Historic	?	Salt ~50m	
		Natural	?	Public Land	

Comment or observations

Cultural & Heritage = c_nre1
VROT = both Flora and Fauna
Both Ramsar & Significant Wetland

General Comments: The majority of this area contains the Avalon saltworks/evaporation basins. The areas to the south are the extremely high environmental value coastal/estuarine systems. Little to no agricultural land threatened at present, issues with management of grazed saline land adjoining environmental areas. Avalon airport and nearby Lara, Melbourne-Geelong Rd etc high infrastructure/utility region.

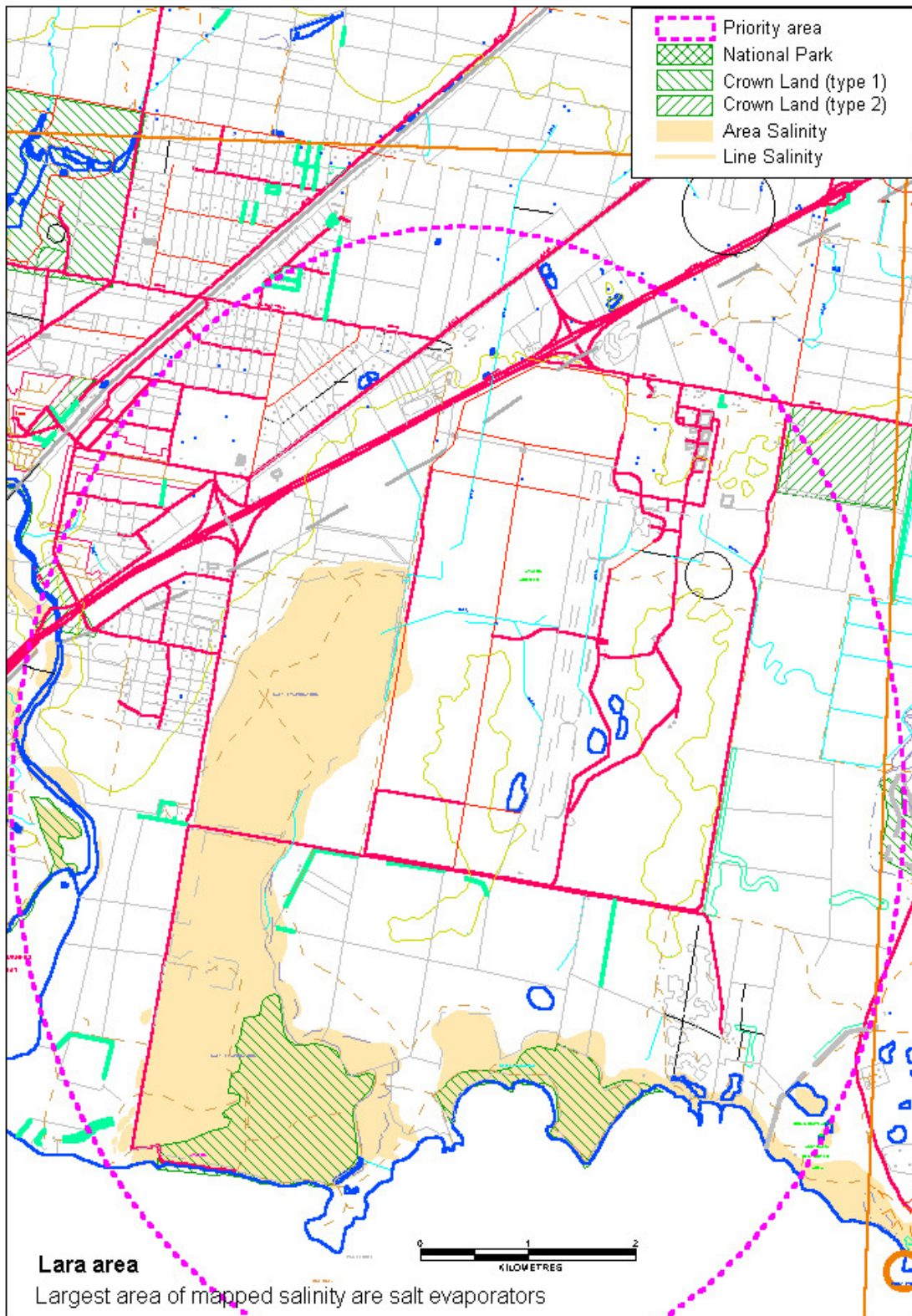
¹ Minor road intersected, unable to verify. Main Road to Avalon Beach not intersected even though it passes on edge of saltworks. Melbourne Freeway and Railway pass over Hovells Creek not intersected.

² No intersections with utilities shown. With nearby Lara and hobby farms suggest there may be some utility risk.

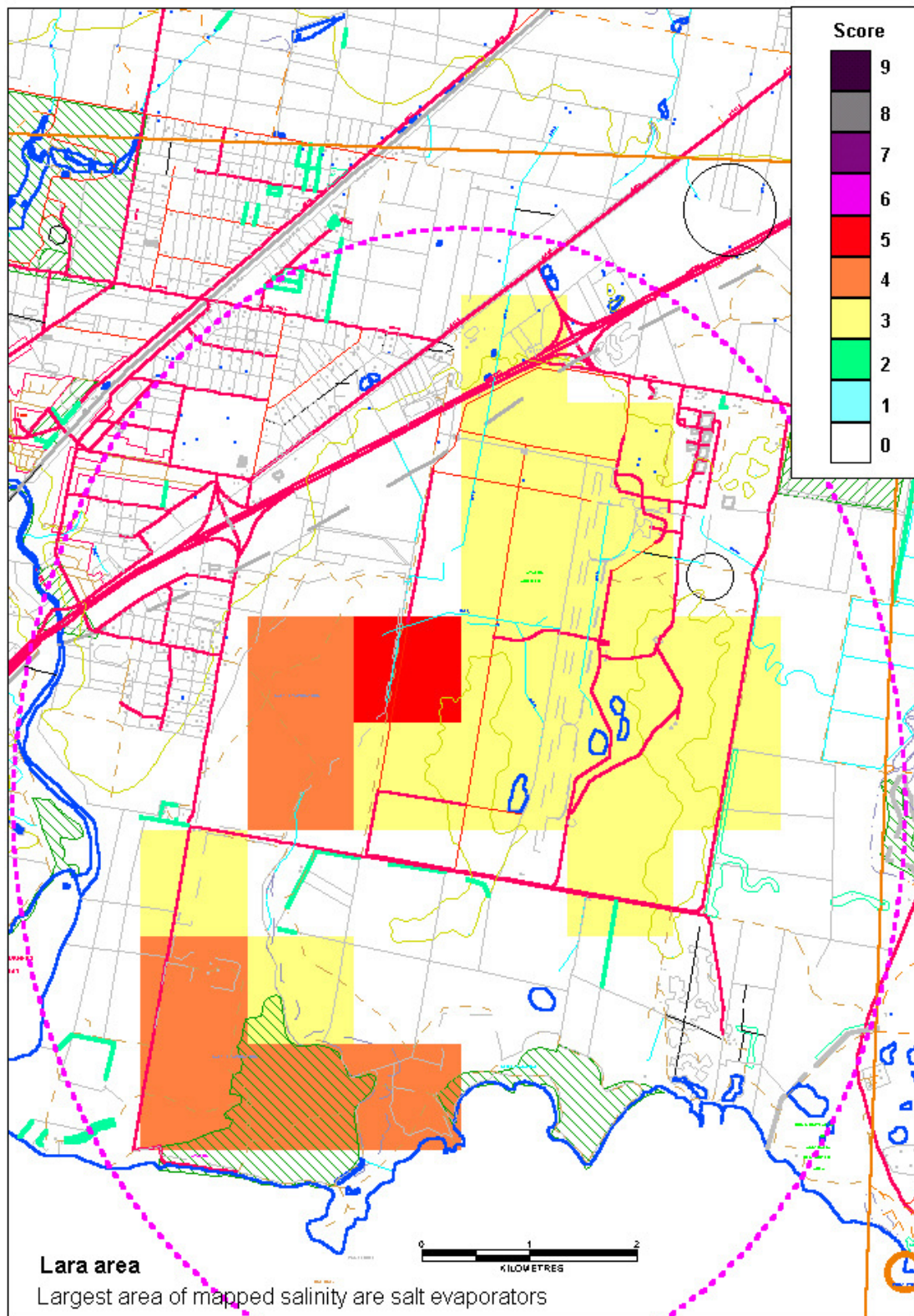
³ No agricultural land intersected. Majority of salinity recorded is Avalon Saltworks. Primary salinity exists along coastal/estuarine.

⁴ The Hovells Ck estuary and coastal strip is regarded as a major environmental asset with Ramsar wetlands, Public land and VROTS. The maps show the entire Avalon Airport as being intersected, with further investigation required to verify for airport. Flora staff unsure.

⁵ Coastal strip intersected as expected for cultural significance.



Immediate-term Asset Risk Scenario



Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 2
Location title: Geelong area (Lake Connewarre)
Name of assessor: *Graeme Anderson*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities		Electricity		2°Salt ~50m	False? ²
		Gas		2°Salt ~50m	
		Water		2°Salt ~50m	False? ²
		Telstra		2°Salt ~50m	False? ²
Agricultural land	✓	Land	✓	2°Salt ~50m	True ³
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁴
		VROTS	✓	WT = <2m	True ⁴
		Ramsar / signif wetlands	✓	GFS >=3	True ⁴
Cultural & heritage	✓	Aboriginal	?	Salt ~50m	True ⁵
		Historic	?	Salt ~50m	
		Natural	✓	Public Land	

Comment or observations

Cultural & Heritage = c_rne1 (layer not disclosed)
VROT = both Flora and Fauna
Both Ramsar & Significant Wetland

General – This lower Barwon River/Connewarre/Breamlea wetland system and surrounds is a recognised major environmental asset, with increasing rural/urban development. Majority of salinity is primary, with adjoining areas of farming land that requires sensitive management to protect the local environmental asset. District is generally low lying with poor drainage and periodical flooding events.

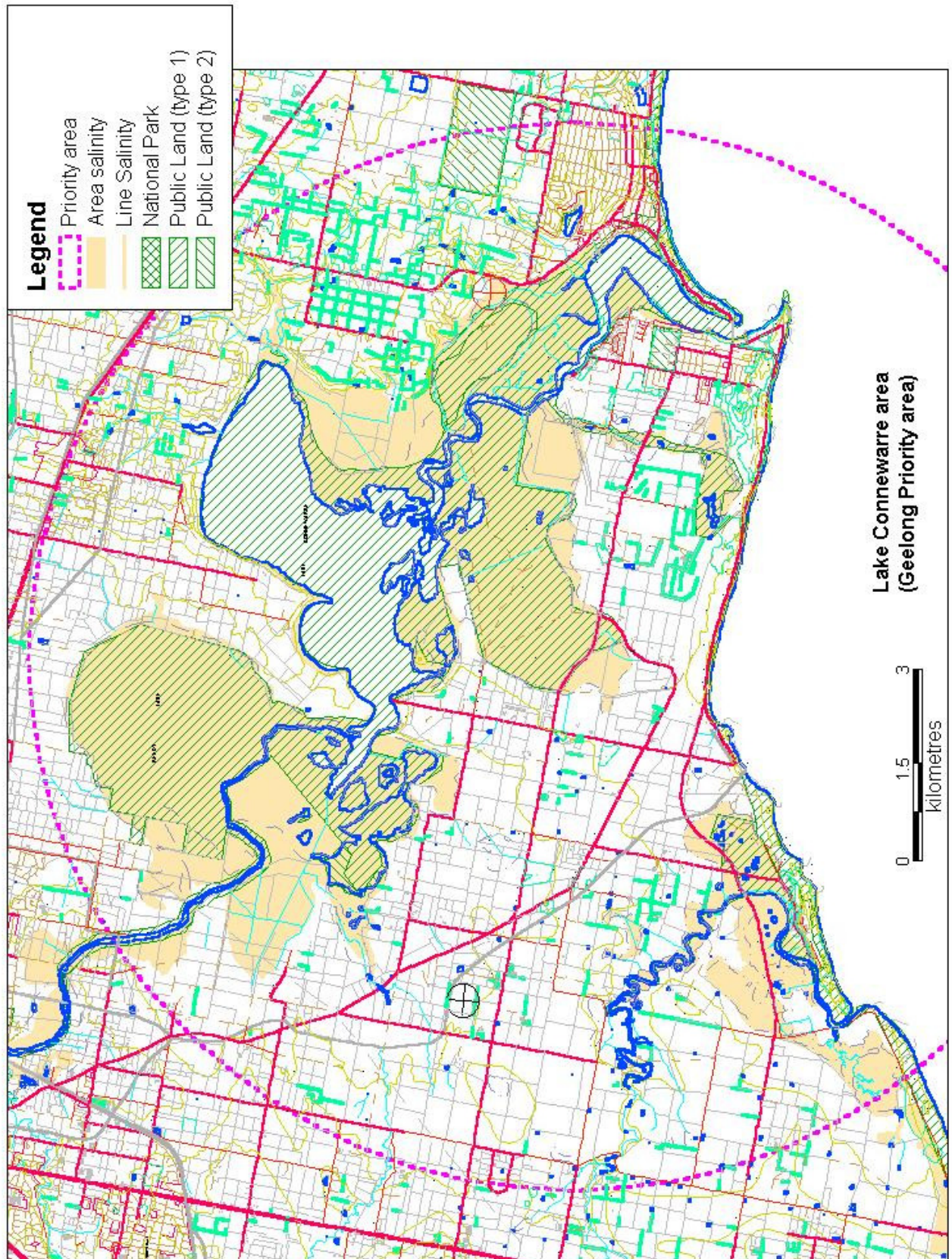
1 Black Rock-Breamlea Road is shown as intersected. However, main Geelong-Barwon Heads Rd is not shown as intersected but clearly runs through salinity and wetland areas.

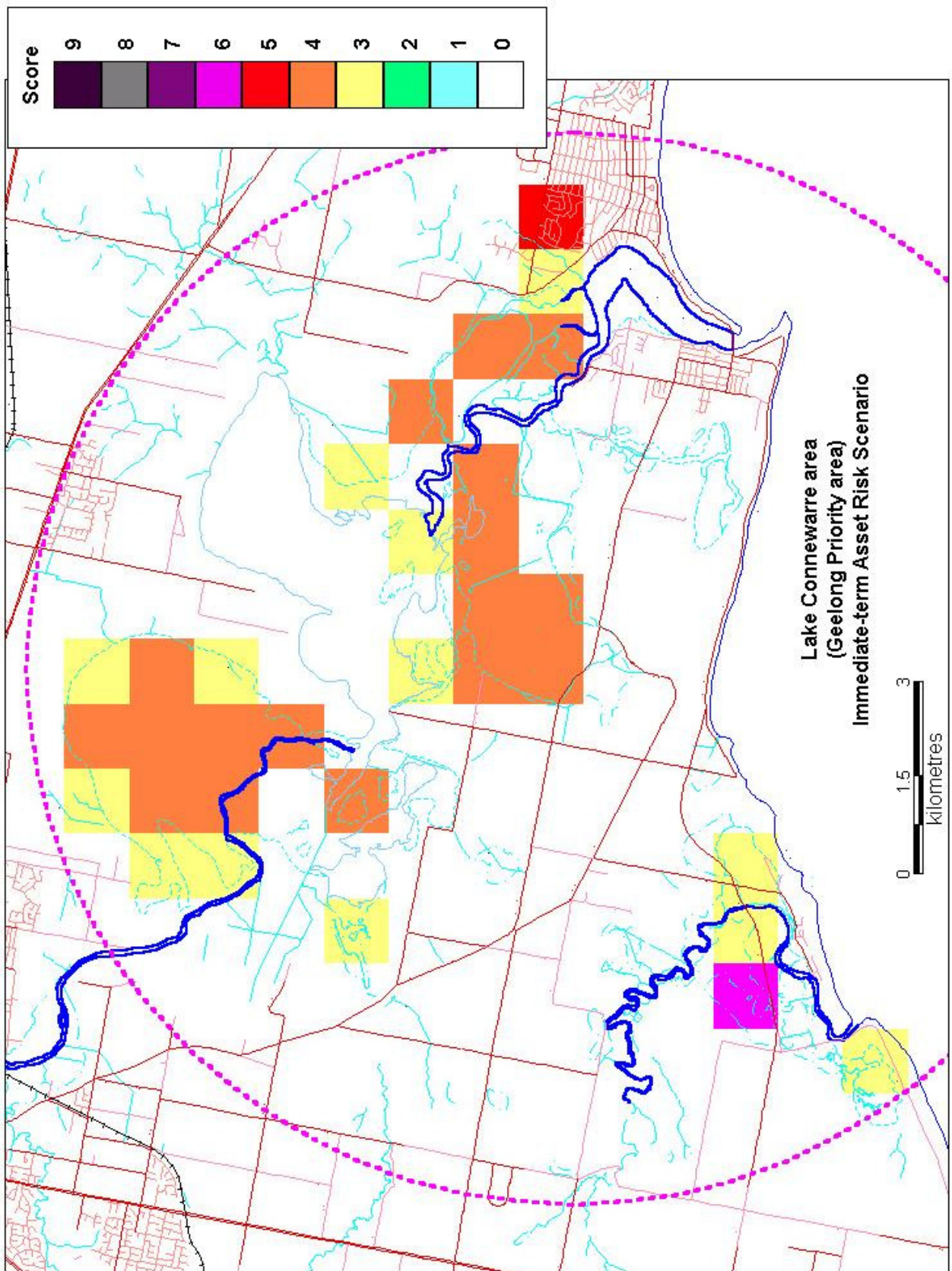
2 No intersections with utilities identified, however they are expected due to rural-urban development, hobby farms and subsequent utilities near saline/wetland areas. Black Rock Barwon Water (Geelong) sewage treatment plant and facilities located in this area.

3 Land near Breamlea intersected. This area is low lying and very likely to be primary salinity. Other low value agricultural land adjoining Lake Connewarre is not shown as intersected.

4 The lower Barwon River/Connewarre, Breamlea wetland systems are intersected and are listed as very high environmental value (Ramsar, Public land and many VROTS)

5 Intersections for both lakes and surrounds as expected.





Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 3
Location title: Modewarre
Name of assessor: Graeme Anderson

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity Hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail	✓	2°Salt ~50m	False? ²
		Towns		WT = <2m	
Utilities	✓	Electricity		2°Salt ~50m	
		Gas	✓	2°Salt ~50m	Unsure ³
		Water		2°Salt ~50m	
		Telstra		2°Salt ~50m	
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁴
Water resources	✓	Reservoirs	✓	GFS >=3	Partly True ⁵
Environment	✓	Public land	✓	WT = <2m	True ⁶
		VROTS	✓	WT = <2m	True ⁶
		Ramsar / signif wetlands		GFS >=3	
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = both Flora and Fauna

General comments: - numerous secondary salinity sites throughout catchment, intersecting roads and agricultural land. Largest mapped saline discharge site is backwash/wetland of Lake Modewarre. Wurdibuloc Reservoir (Geelong Water Supply) sits at the crest of the catchment, with salinity discharging nearby – uncertain of threat to reservoir – possibly low.

¹ Multiple (>13) road/salinity intersections recorded and verified.

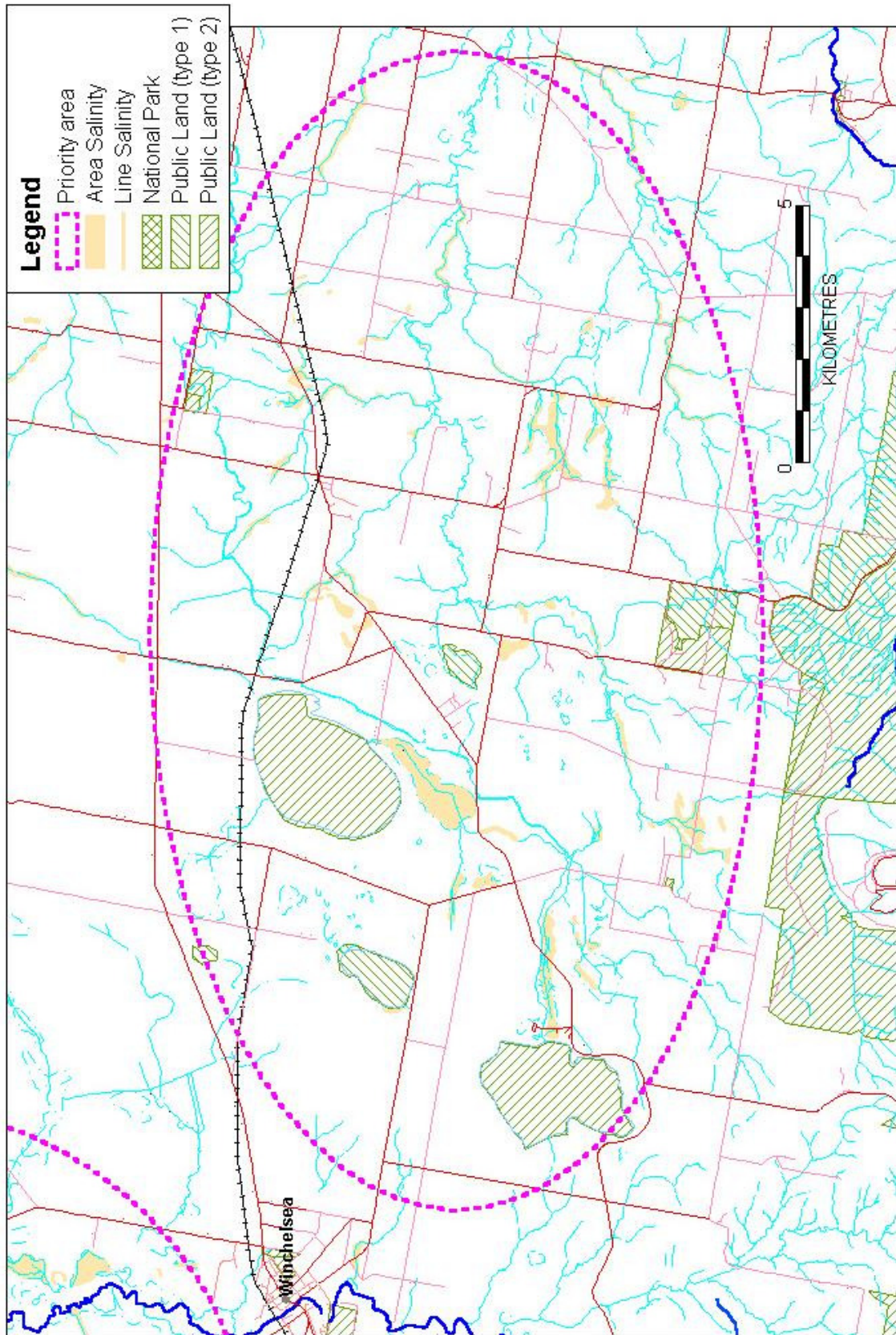
² Rail line shown but no apparent intersections with salinity.

³ No intersection shown, shows rail line. Does gas run along rail line? Unsure

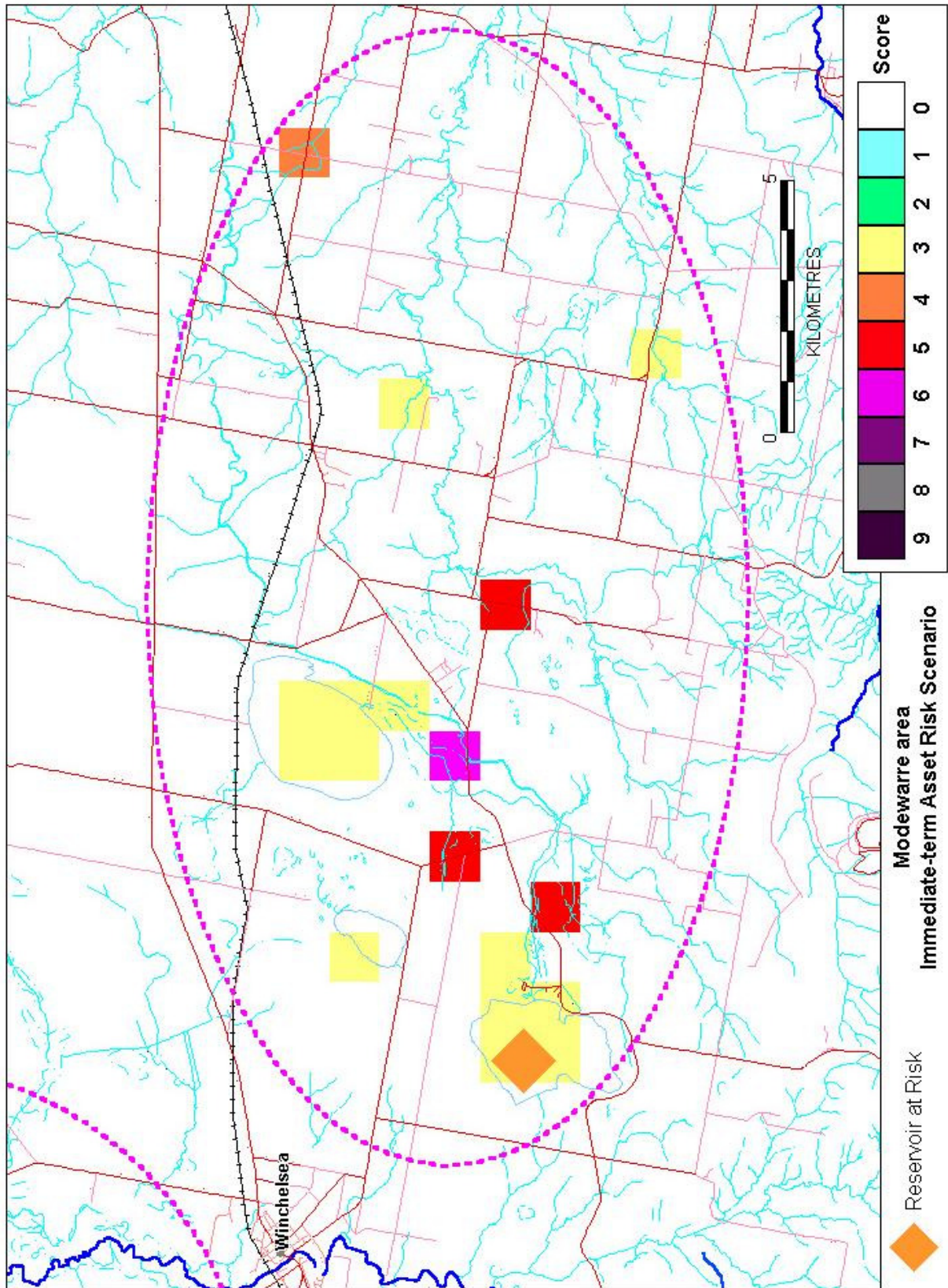
⁴ Multiple agricultural land/salinity intersections. Largest single discharge area is a wetland/backwater of Lake Modewarre. All other sites are secondary salinity – but were likely to have been wet/waterlogged areas originally, but under vegetation.

⁵ Wurdibuloc Reservoir sits on top of the catchment. It is fed via artificially from West Barwon Reservoir for Geelong urban water supply. Saline discharge occurs immediately below reservoir.

⁶ Shows Gherang Swamp, Lake Modewarre and Wurdibuloc Reservoir as intersected with salinity. These areas are public land, possibly with VROTS. Browns Swamp not shown but should be as (public land and salinity area). Yarra Pigmy Perch located in upper Thompson Ck, not intersected, possibly not in data?.



Modewarre area
Salinity basemap



Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 4
Location title: Gordon – Lal Lal
Name of assessor: Peter Dahlhaus – assessed 22/12/02

Asset Risk Scenario	Change to risk
Immediate to near term	No change
Far term	Change in severity and extent (big increase)

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	Complex ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities	✓	Electricity	✓	2°Salt ~50m	Uncertain ²
		Gas	✓	2°Salt ~50m	True ³
		Water		2°Salt ~50m	
		Telstra		2°Salt ~50m	
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁴
Water resources	✓	Reservoirs	✓	GFS >=3	Check ⁵
Environment	✓	Public land	✓	WT = <2m	Check ⁵
		VROTS	✓	WT = <2m	Uncertain ⁶
		Ramsar / signif wetlands		GFS >=3	
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = both Flora and Fauna

Electricity = mains (southern intersection); Gas = pipe (eastern intersections)

General Comment: This area could possibly be dropped from the “priority” assets at risk areas. This area has been included because the reservoirs lie within a ‘hazardous’ GFS. Check with CHW to see if that’s justified. Two other pixels score >3. The one near Elaine which is not really a problem, since the powerline is not really at risk, the road intersection is false and the agricultural land salinity is Class 1 on grazing country. The one west of Ballan (score 6) has unmade rural road, gas main, cleared public land and/or unknown VROT at risk.

¹ Only True for the intersection of O’Connors Lane and Flack’s Racecourse Rd – both minor rural roads. Intersection at Sharrocks Rd is False as road is elevated on hillside above salt. Intersections at Murphy’s Road not found (False).

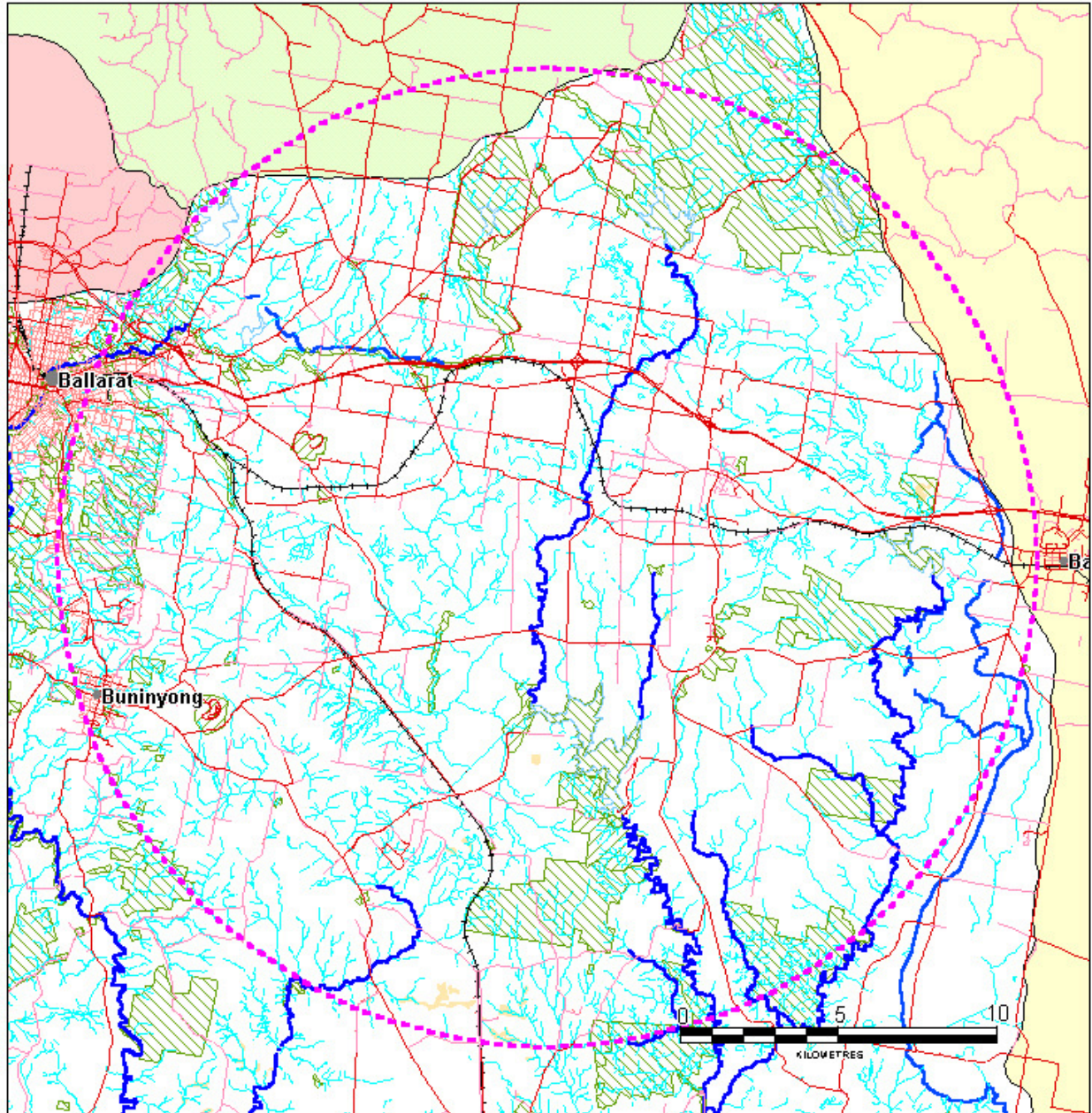
² Power Pylons near Murphy’s Road (Elaine) in or near low-grade salinised land. Probably not an issue.

³ Gas main pipeline intersects salinity adjacent to Flack’s Racecourse Road underpass of Western Freeway, west of Ballan.

⁴ Low grade (Class 1) intersections near Elaine. Small Class 2 patches west of Ballan.

⁵ Reservoirs are in ‘hazardous’ GFS. May not be a problem. Needs checking with CHW. Public Land intersections are the Reservoirs.

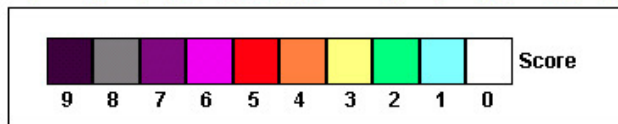
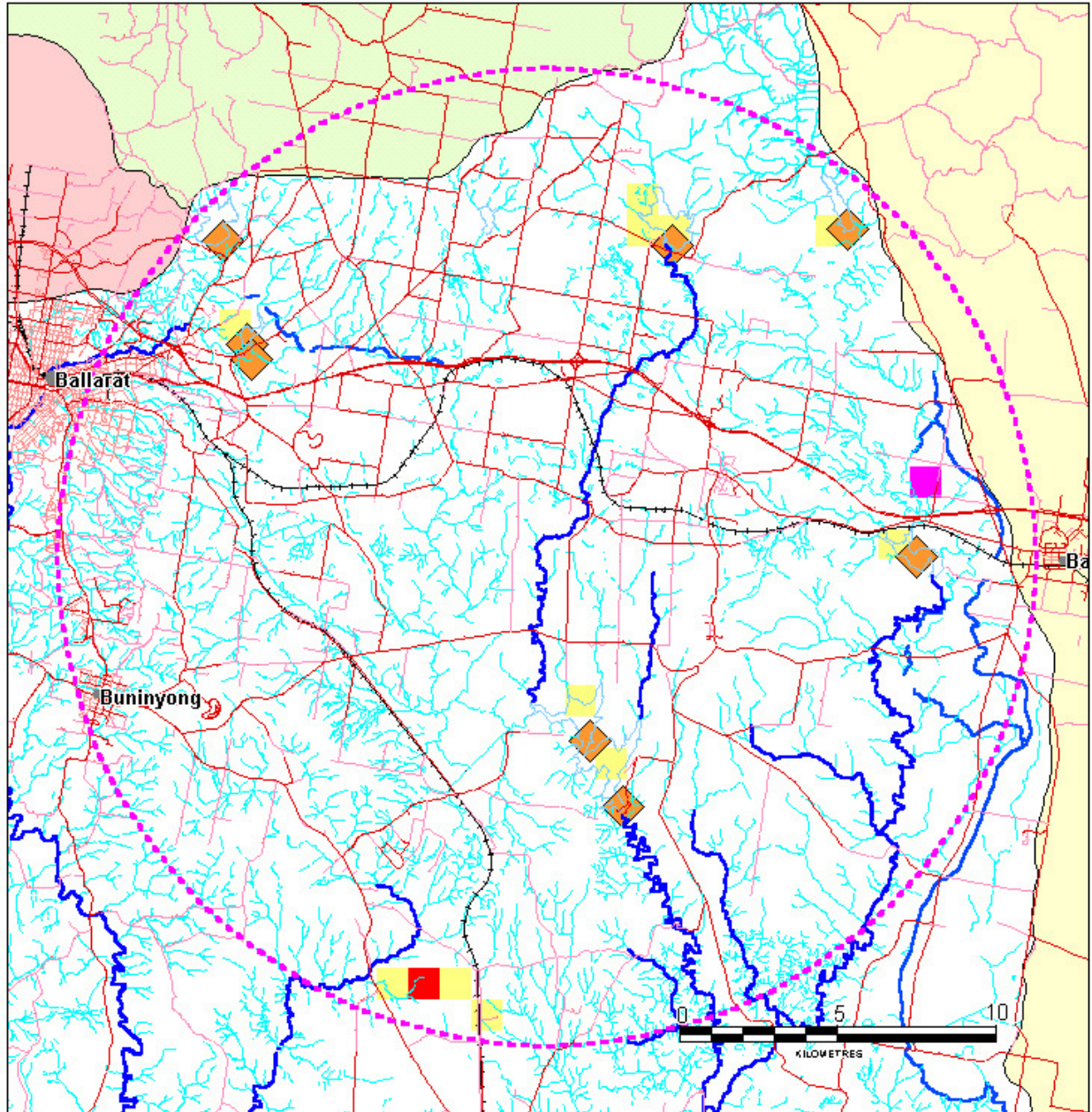
⁶ Uncertain which species at risk. Some intersections coincide with ‘significant roadside vegetation’ areas.



Legend

-  Priority Area
-  Area Salinity
-  Line Salinity
-  National Park
-  Public Land (type 1)
-  Public Land (type 2)

**Gordon - Lal Lal area
Salinity basemap**



**Gordon - Lal Lal area
Immediate-term Asset Risk Scenario**

 Reservoir Asset at risk

Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 5
Location title: Murdeduke
Name of assessor: *Mike Stephens & Cam Nicholson– Assessed by Cam 13/12/02*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities	✓	Electricity	✓	2°Salt ~50m	True ²
		Gas		2°Salt ~50m	
		Water		2°Salt ~50m	
		Telstra	✓	2°Salt ~50m	True ³
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁴
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁵
		VROTS	✓	WT = <2m	Unsure ⁶
		Ramsar / signif wetlands	✓	GFS >=3	True ⁷
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = Fauna
 Both Ramsar & Significant Wetland
 Electricity = mains
 Telstra = cable (southernmost intersection)

¹ No obvious road breakdown but located in discharge areas.

² High tension pylons in discharge area, also (lower voltage) timber poles in discharge areas.

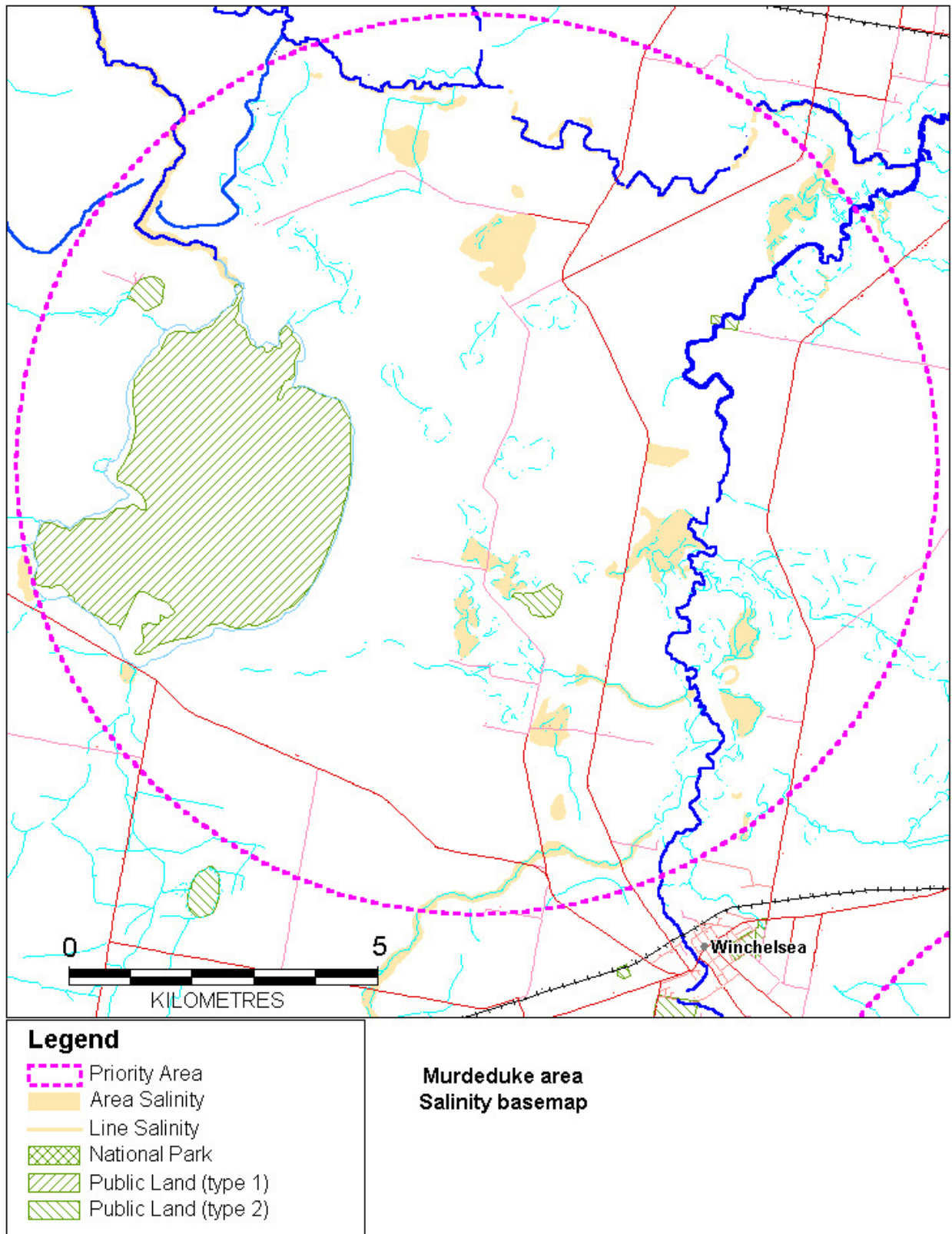
³ Telstra lines located through discharge areas.

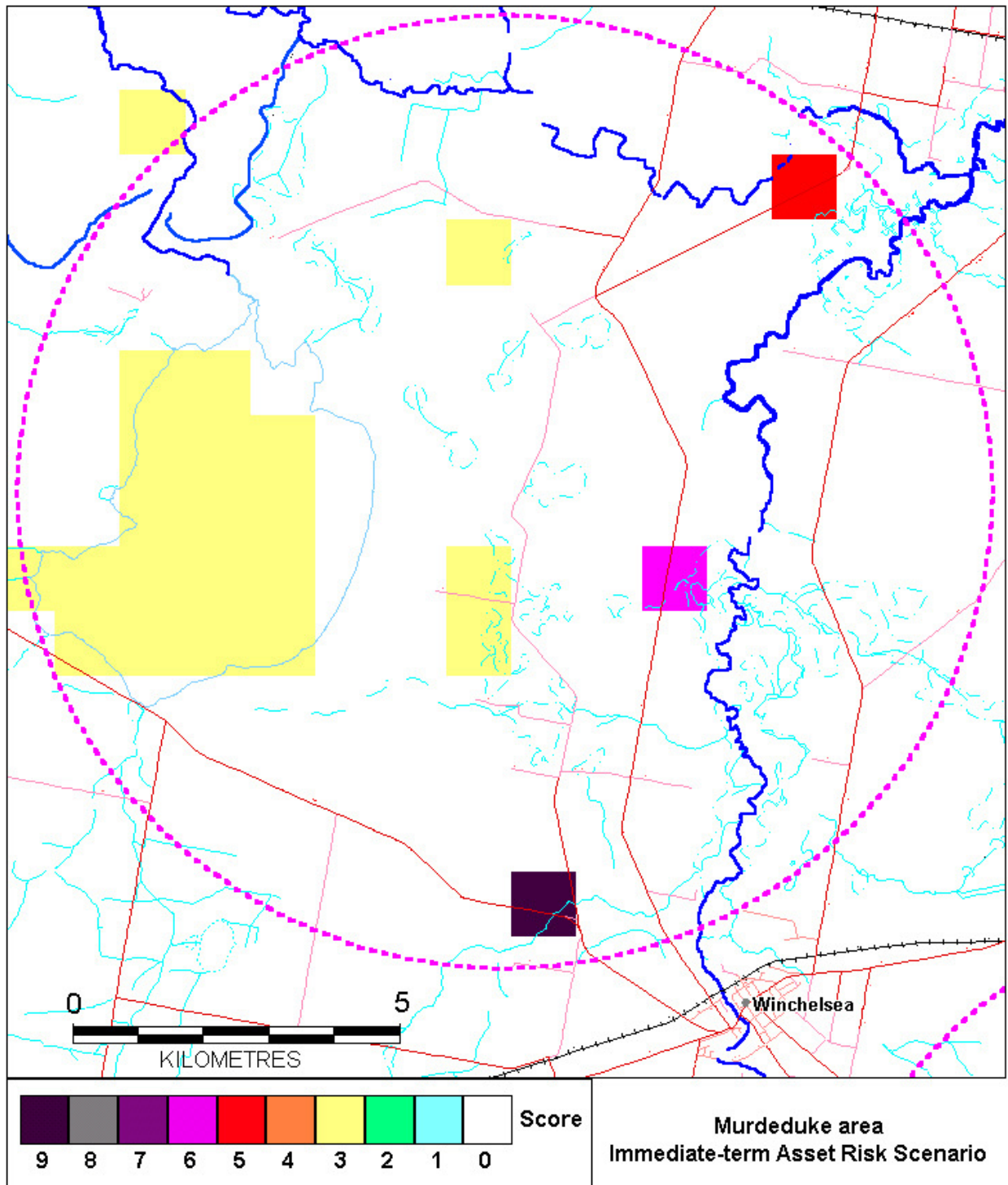
⁴ Salinity discharge map pretty accurate.

⁵ Lake Murdeduke .

⁶ Not sure what fauna is at risk.

⁷ Lake Murdeduke.





Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 6
Location title: Warncoort
Name of assessor: *Mike Stephens & Cam Nicholson – Assessed by Cam 5/12/02*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity and extent (decrease)
Far term	Change in severity and extent (increase)

Asset at Risk (immediate-term)		Asset class		Salinity Hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail	✓	2°Salt ~50m	True ²
		Towns		WT = <2m	
Utilities	✓	Electricity	✓	2°Salt ~50m	True ³
		Gas	✓	2°Salt ~50m	Unsure ⁴
		Water		2°Salt ~50m	
		Telstra	✓	2°Salt ~50m	True ⁵
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁶
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁷
		VROTS	✓	WT = <2m	Unsure ⁸
		Ramsar / signif wetlands		GFS >=3	
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = Fauna
 Electricity = mains (north line NE – SW trending)
 Gas = pipe (southern line NE – SW trending)
 Telstra = cable (middle line NE – SW trending)

¹ Bitumen road breakdown – Shire Roads only

² Rail line runs through discharge area, but track well elevated.

³ High tension pylons not in discharge area, but (lower voltage) timber poles are in visible discharge areas.

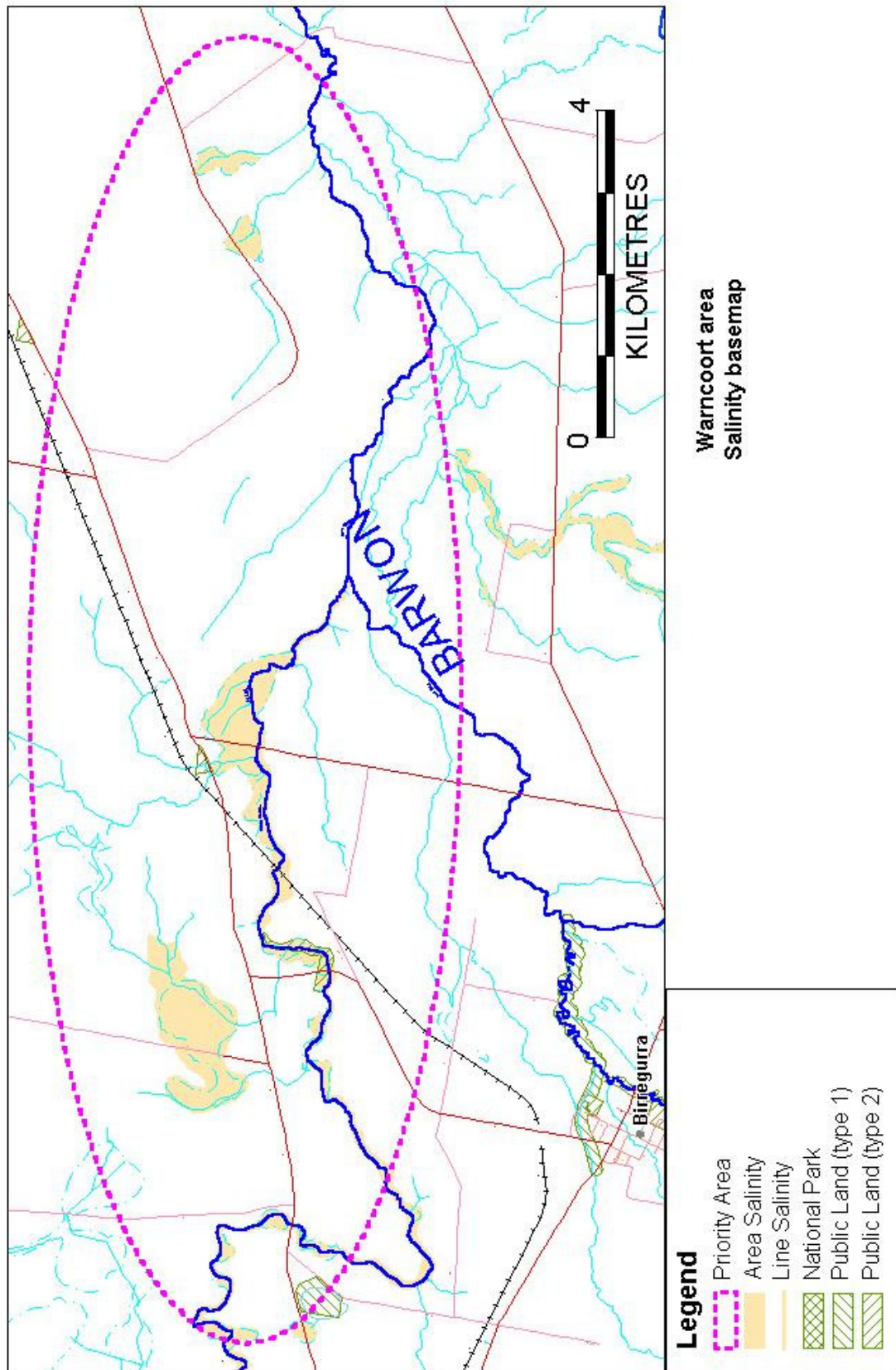
⁴ Gas pipeline didn't run through discharge areas that were visible from the road.

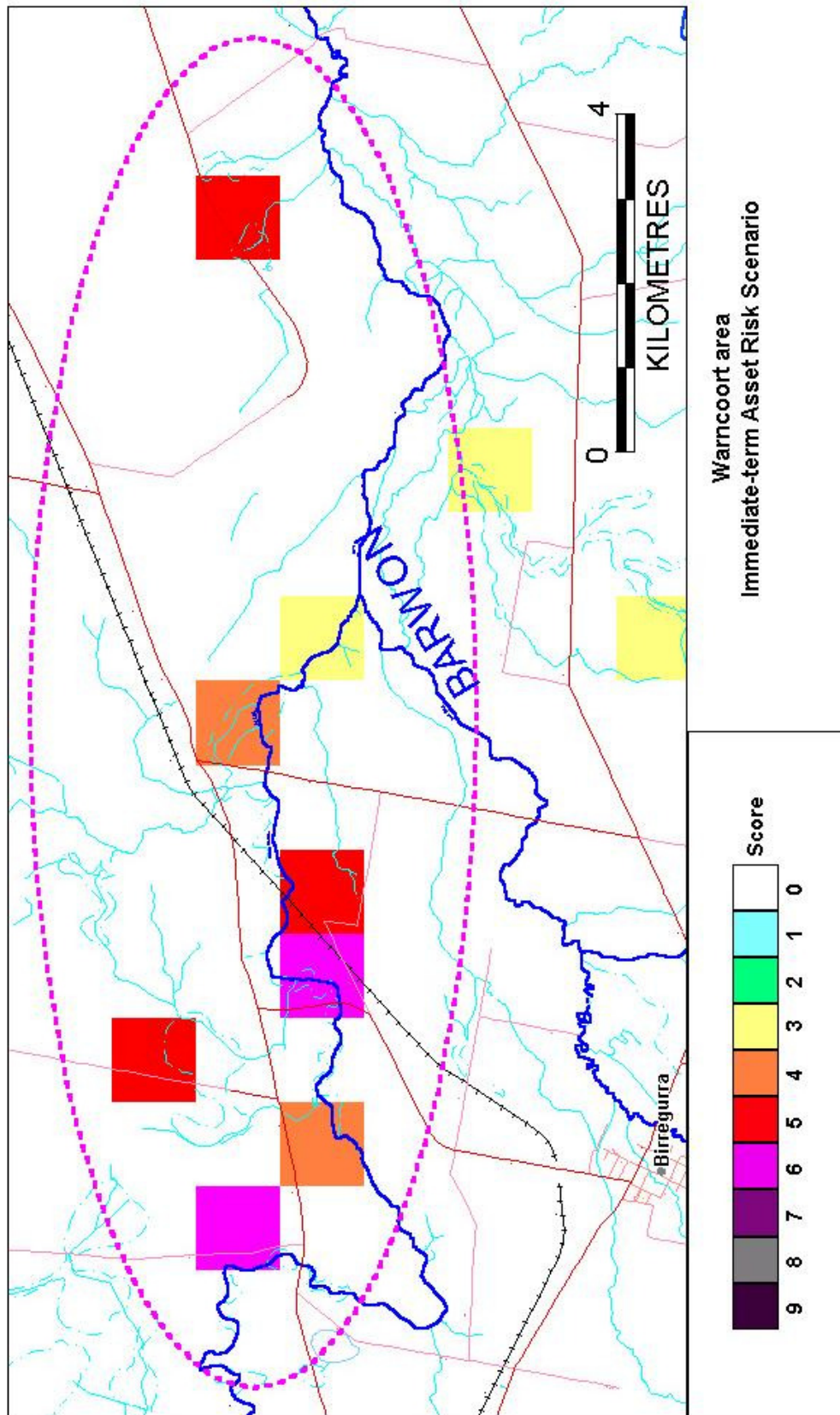
⁵ Telstra lines located through many discharge areas.

⁶ Salinity discharge map pretty accurate.

⁷ Area of public land very small – unsure of 'value' as most is along the drainage channel.

⁸ Not sure what fauna is at risk.





Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 7
Location title: Weering – Colac area
Name of assessor: Peter Dahlhaus – assessed 21/12/02

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail	✓	2°Salt ~50m	False ²
		Towns		WT = <2m	
Utilities	✓	Electricity		2°Salt ~50m	
		Gas		2°Salt ~50m	
		Water		2°Salt ~50m	
		Telstra	✓	2°Salt ~50m	True ³
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁴
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁵
		VROTS	✓	WT = <2m	Uncertain ⁶
		Ramsar / signif wetlands	✓	GFS >=3	True ⁷
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = both Flora and Fauna
 Both Ramsar & Significant Wetland
 Telstra = cables

¹ Roads at risk east of Beeac and south of Colac. Minor issues near Lake Cundare. The area south of Colac is particularly of concern as salinity is encroaching on urban areas. Parts of Irrewillipe Road, Cant St, Hart St and Armstrong Sts transect areas of Class 1 salinity. Class 1 salinised land is currently for sale as low-density residential area.

² Railway intersection not found.

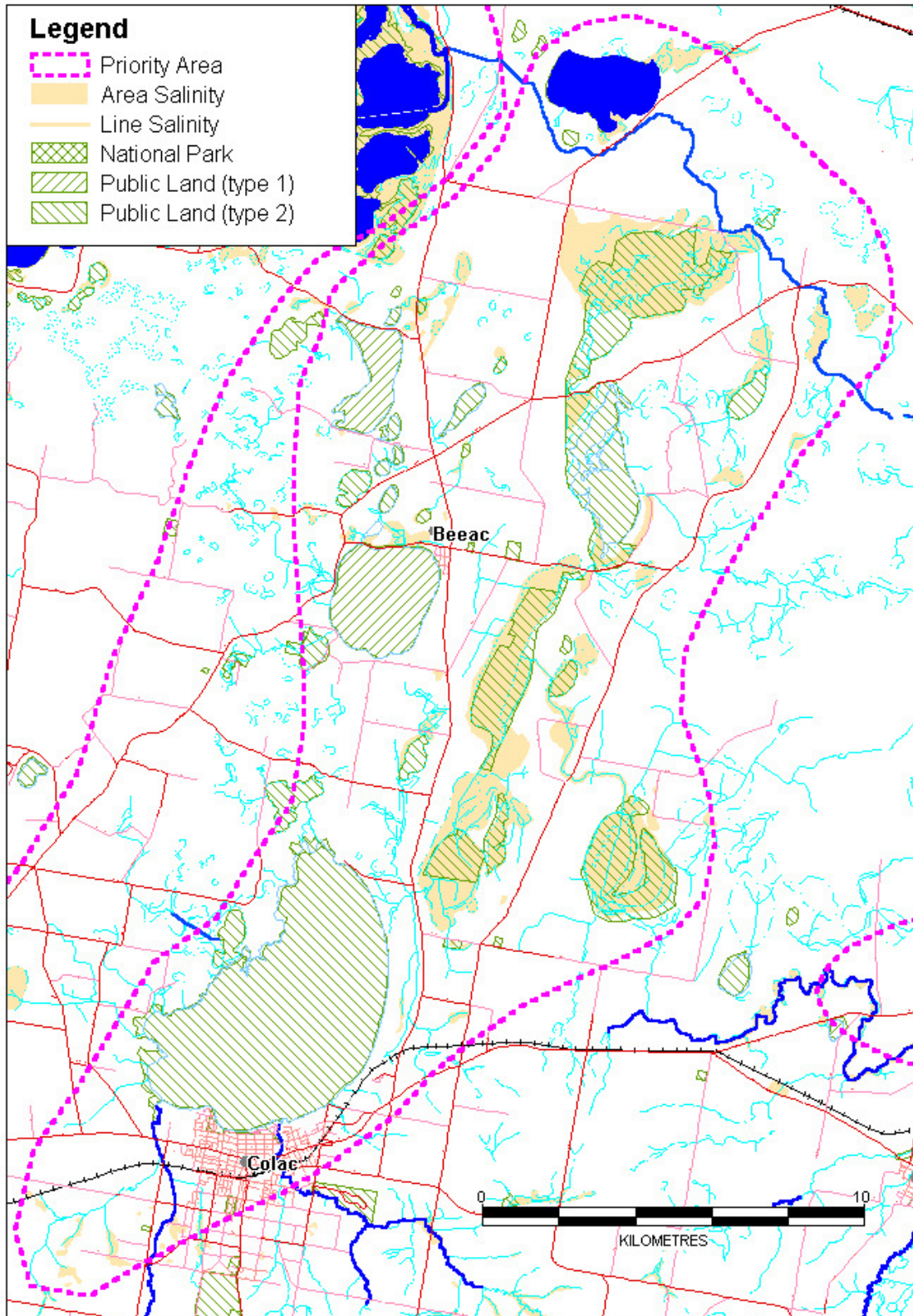
³ Telstra cable runs through Class 1 saline area near Lake Cundare. Other intersections not shown on map found near Lough Calvert (Class 2).

⁴ More agricultural land is at risk than is shown on intersections.

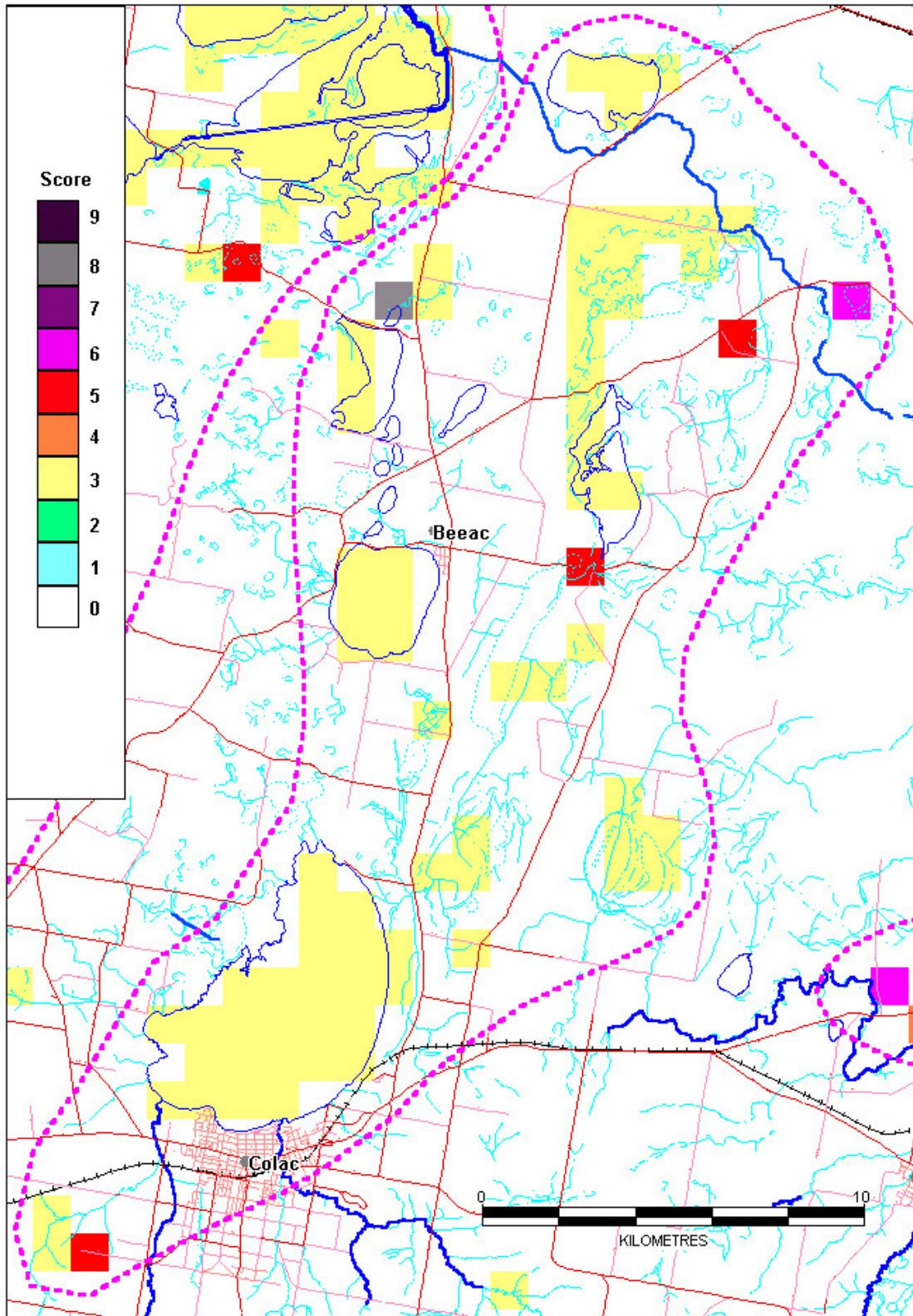
⁵ Public Land in the Lough Calvert area and many lakes are affected by salinity. Most is probably primary, with secondary expansion. A significant proportion of the public land in Lough Calvert area is used for grazing.

⁶ Flora and fauna species at risk are not known.

⁷ Ramsar and significant wetlands are saline, although most are probably primary. Lake Cundare and Lake Beeac were crusty with salt crystals at the time of inspection.



Colac_Weering area
Salinity basemap



**Weering - Colac area
Immediate-term Asset Risk Scenario**

Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 8
Location title: Corangamite
Name of assessor: *Peter Dahlhaus – assessed 21/12/02*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities	✓	Electricity	✓	2°Salt ~50m	Uncertain ²
		Gas		2°Salt ~50m	
		Water	✓	2°Salt ~50m	True ³
		Telstra	✓	2°Salt ~50m	True ⁴
Agricultural land	✓	Land	✓	2°Salt ~50m	True
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁵
		VROTS	✓	WT = <2m	Uncertain ⁶
		Ramsar / signif wetlands	✓	GFS >=3	True ⁵
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = both Flora and Fauna
 Both Ramsar & Significant Wetland
 Electricity = mains (NW edge)
 Water = mains (W edge)
 Telstra = cable (E edge)

¹ Road at risk at corner of Cundare Rd and Cotties Rd. Cracked pavement on Foxhow Rd at intersection with Gnarkeet Chain of Ponds.

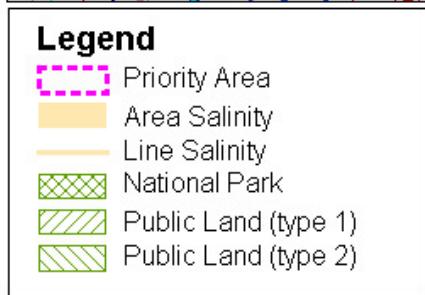
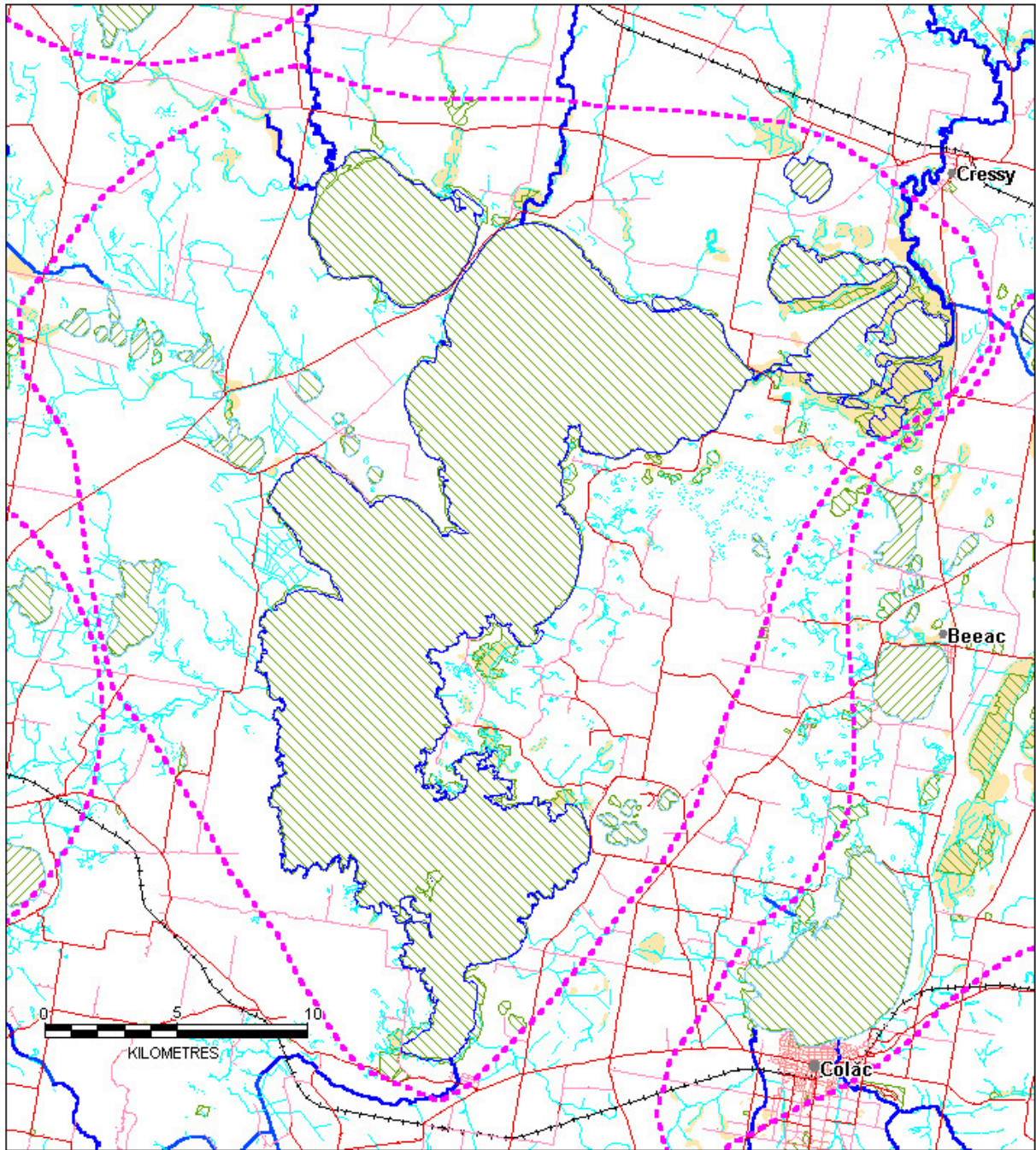
² Electricity Pylons in or near Class 1 salinity discharge area along Salt Creek adjacent to Lower Darlington Rd.

³ Water mains intersects salinised area (Class 2) Lismore Rd, just north of Elwood Rd intersection.

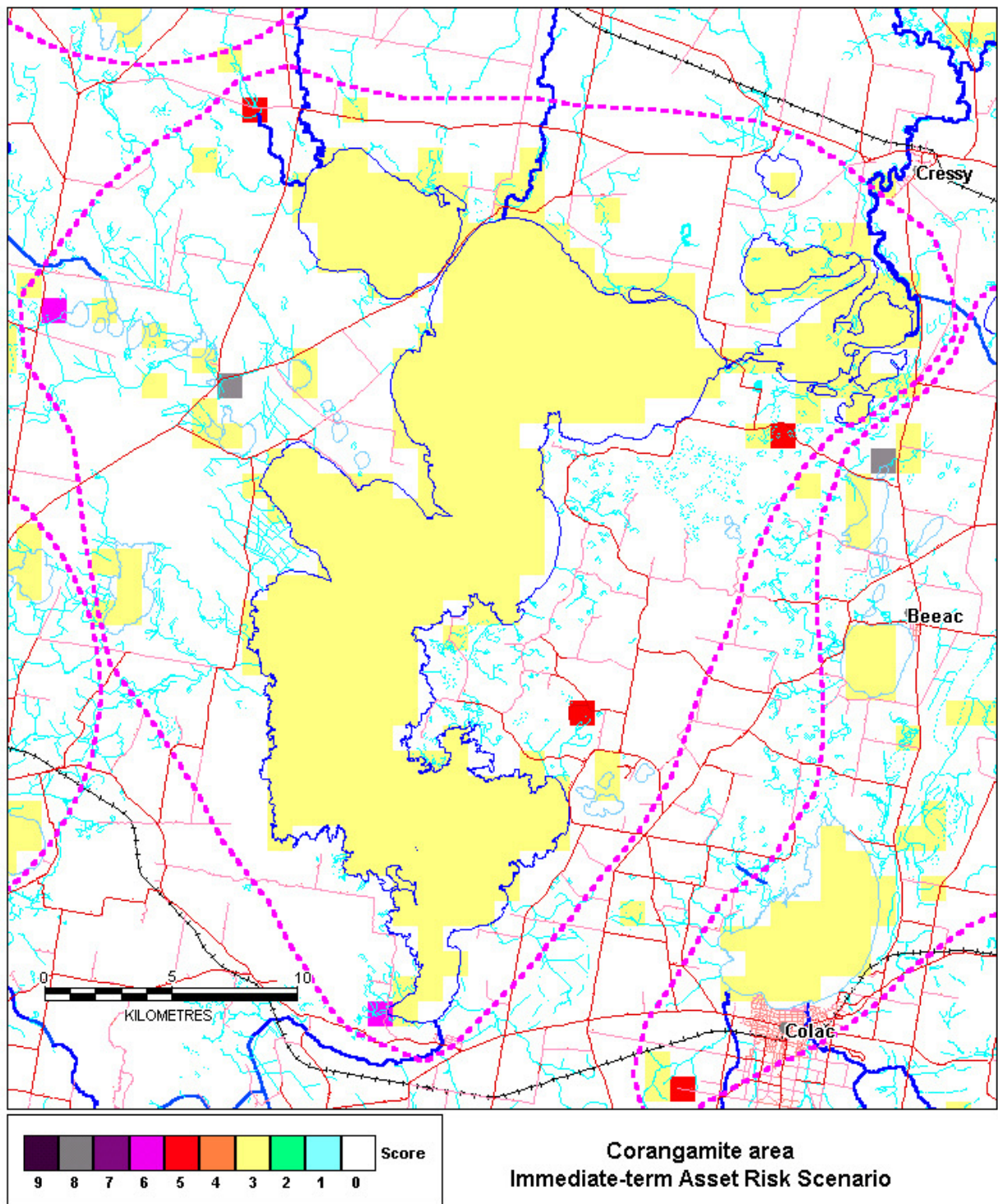
⁴ Cable crosses the Woody diversion channel at diversion weir.

⁵ Public Land, Ramsar Wetlands, Significant Wetlands all through this region. Lake Corangamite, etc. These are the subject of two other NAP studies – Wetlands inventory and the Drainage Review.

⁶ Almost certainly true because of Lake fauna, but don't know which species.



**Corangamite area
Salinity basemap**



Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 9
Location title: Derrinallum
Name of assessor: Cam Nicholson – assessed by Cam 5/12/02

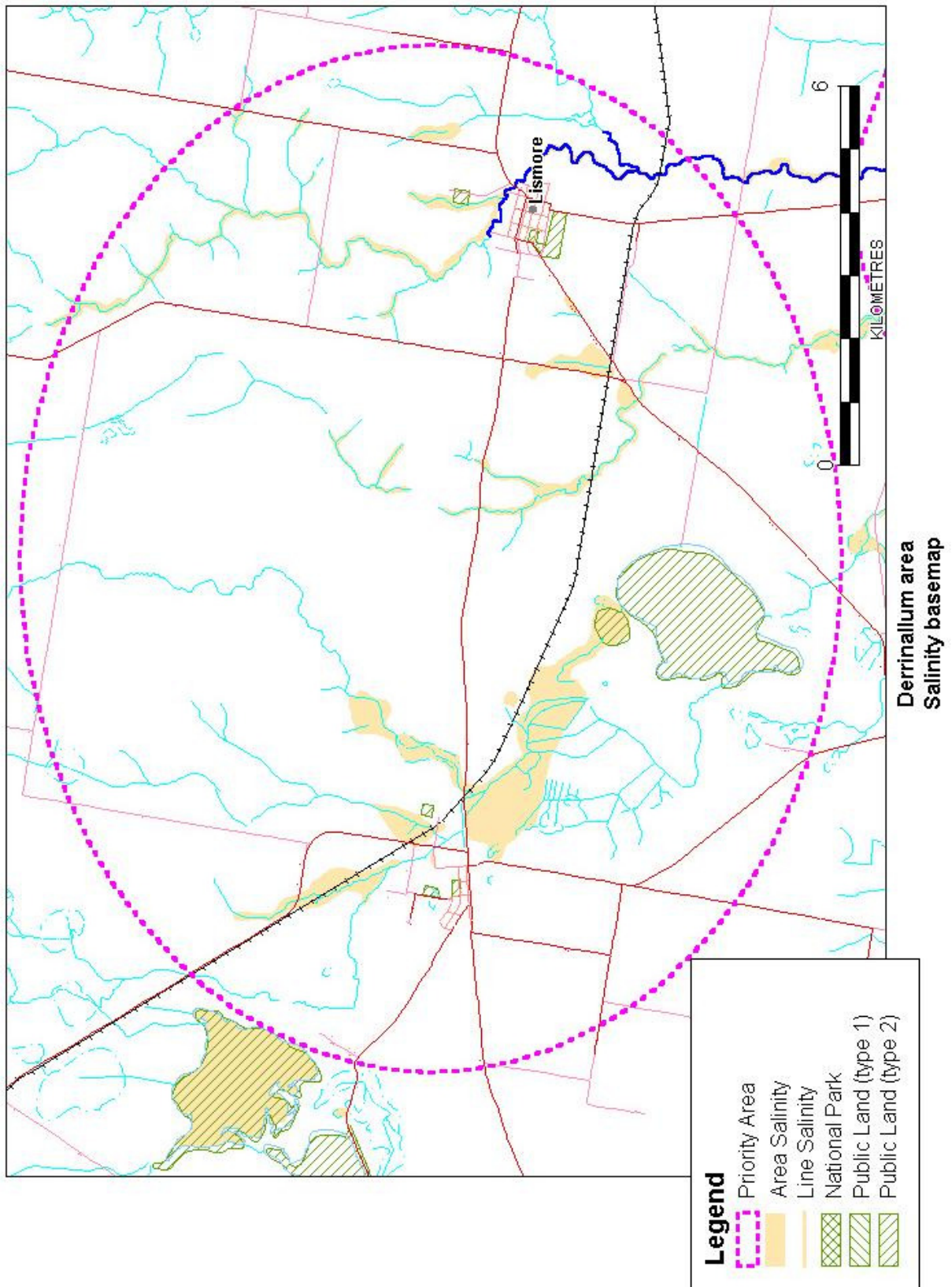
Asset Risk Scenario	Change to risk
Immediate to near term	No change
Far term	Change in severity and extent

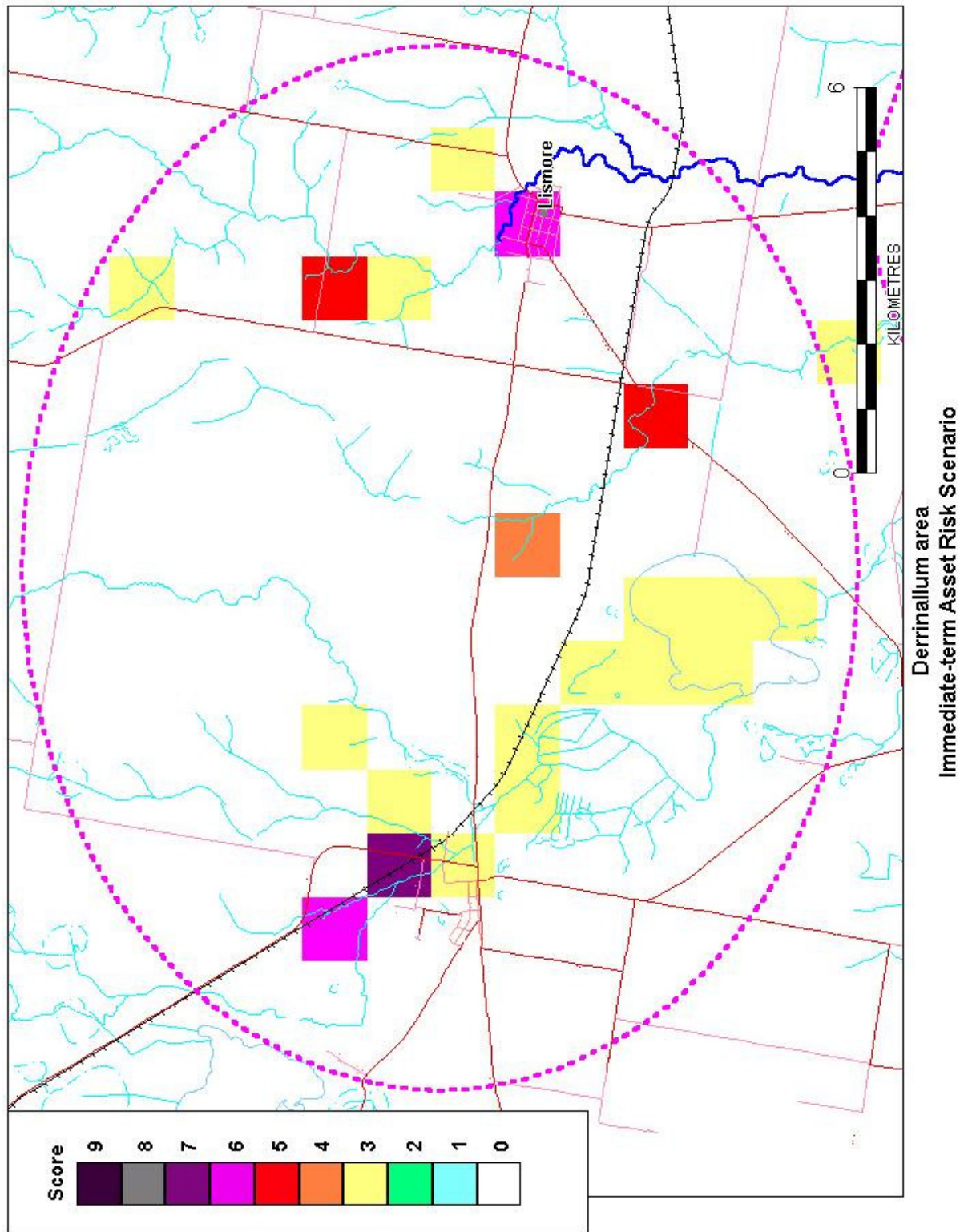
Asset at Risk (immediate-term)		Asset class		Salinity Hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail	✓	2°Salt ~50m	True ²
		Towns		WT = <2m	
Utilities	✓	Electricity		2°Salt ~50m	
		Gas		2°Salt ~50m	
		Water	✓	2°Salt ~50m	Unsure ³
		Telstra	✓	2°Salt ~50m	True ⁴
Agricultural land	✓	Land	✓	2°Salt ~50m	True ⁵
Water resources		Reservoirs		GFS >=3	
Environment	✓	Public land	✓	WT = <2m	True ⁶
		VROTS	✓	WT = <2m	Unsure ⁷
		Ramsar / signif wetlands		GFS >=3	
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = Flora and Fauna
 Water = water mains
 Telstra = (1) hub, cables (main), (1) exchange

¹ Bitumen road patching through discharge areas.
² Rail line runs through discharge area, but track well elevated.
³ Couldn't identify where water pipelines ran.
⁴ Telstra lines located through many discharge areas – couldn't locate exchange or hub.
⁵ Salinity discharge map pretty accurate.
⁶ Lake Tooliorook.
⁷ Not clear what flora & fauna is under threat – need to check.





Second generation salinity action plan
Integrated Catchment Salinity Risk Prioritisation (ICSRP)
Validation of priority areas

Location No. 10
Location title: Camperdown
Name of assessor: *Peter Dahlhaus – assessed 21/12/02*

Asset Risk Scenario	Change to risk
Immediate to near term	Change in severity
Far term	Change in severity and extent

Asset at Risk (immediate-term)		Asset class		Salinity hazard	Validation (true/false)
Infrastructure	✓	Roads	✓	2°Salt ~50m	True ¹
		Rail		2°Salt ~50m	
		Towns		WT = <2m	
Utilities		Electricity		2°Salt ~50m	
		Gas		2°Salt ~50m	
		Water		2°Salt ~50m	
		Telstra		2°Salt ~50m	
Agricultural land	✓	Land	✓	2°Salt ~50m	True ²
Water resources	✓	Reservoirs	✓	GFS >=3	Uncertain ³
Environment	✓	Public land	✓	WT = <2m	True ⁴
		VROTS	✓	WT = <2m	Uncertain ⁴
		Ramsar / signif wetlands	✓	GFS >=3	True ⁴
Cultural & heritage		Aboriginal		Salt ~50m	
		Historic		Salt ~50m	
		Natural		Public Land	

Comment or observations

VROT = Fauna
 Both Ramsar & Significant Wetland

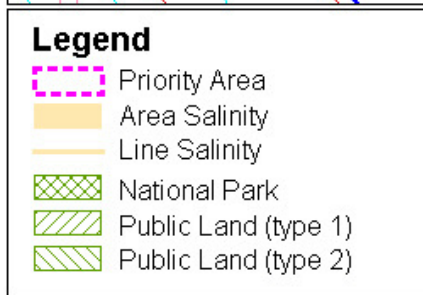
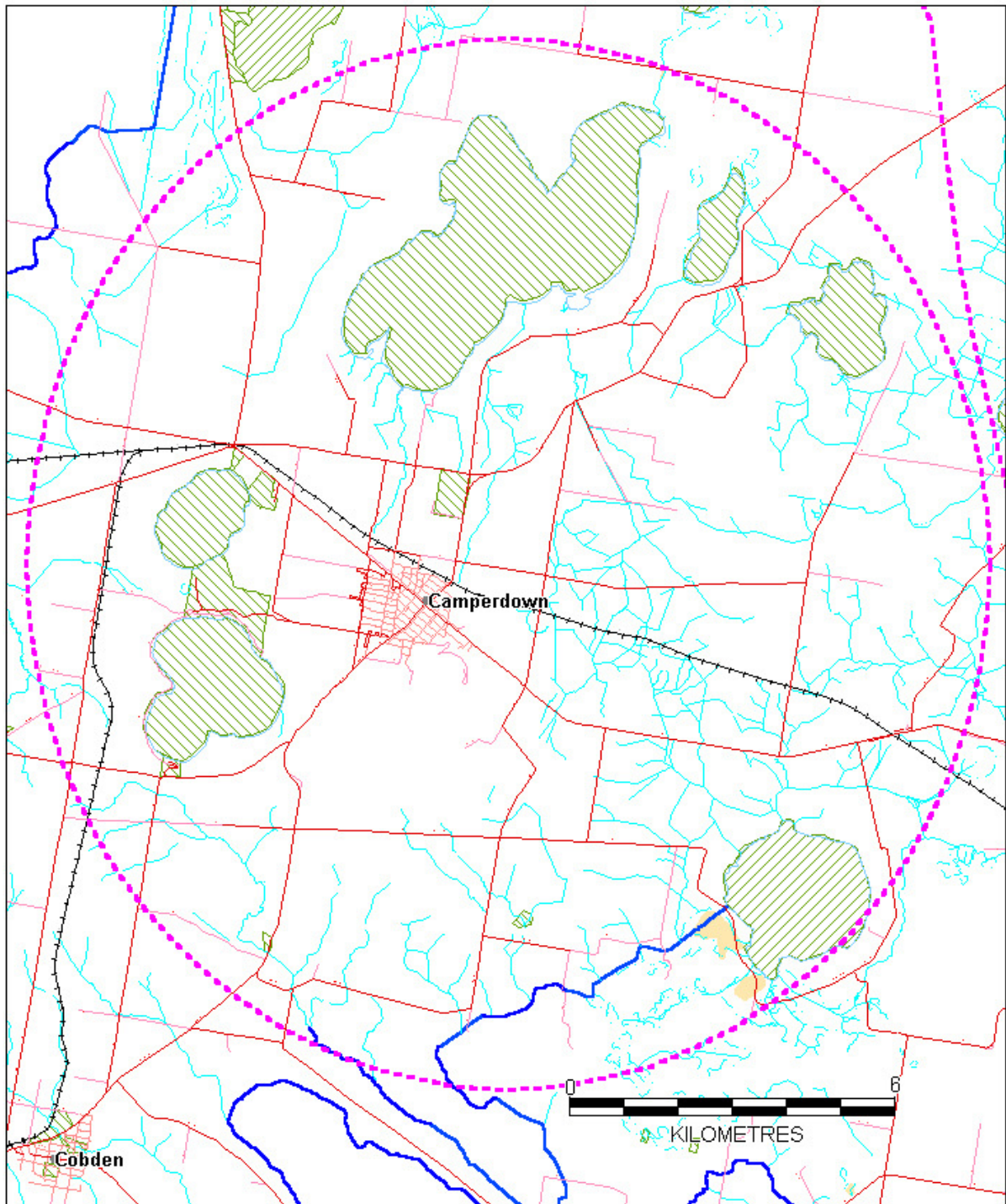
General Comment: This area probably does not warrant singling out in the region. This area was included because of the Reservoir which is in a 'hazardous' GFS, but being on the top of a hill, is almost certainly not at risk. However, it would be prudent to phone South West Water to check if the reservoir has a history of salinity. The area of agricultural land at risk is a small area in a drainage depression and the infrastructure asset risk is minimal. The Lakes have been included because they are in a 'hazardous' GFS, and some may need to be managed for salinity. It might be easier if the management of the environmental assets was included with the neighboring Corangamite area.

¹ Minor issue with road around the southern edge of Lake Purrumbete where road intersects are of low-grade salinity.

² Low lying area south of Lake Purrumbete. Small area of land in the floor of a drainage depression.

³ Donalds Hill Reservoir is in a 'hazardous' GFS, but is on the crest of a hill. It's highly unlikely to be affected by salinity at the site (I'd say that it isn't). Check with South West Water Authority to see if salinity of the Reservoir has been increasing.

⁴ All environmental intersections are Lakes Gnotuk, Bullenmerri, Colongulac, Purrumbete, Koreetnung and Kariah. A couple of fauna VROTS south of Lake Purrumbete, but don't know which species.



Camperdown area
Salinity basemap

