Funded by the Sub Surface Drainage Program (Goulburn Murray Water), the Shepparton Irrigation Region Implementation Committee in conjunction with the Goulburn Broken Catchment Management Authority through the Shepparton Irrigation Region Catchment Strategy.

Environmental Management Program

Sustainable Irrigated Landscapes

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Photos. Main –Drumanure Uniting Church Site. Trio – Baxters Pit Picola, Wyuna River Reserve, Cantwells Grassland.

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ACKNOWLEDGEMENTS

The development, implementation and completion of the report for this project would not have been possible if not for the following people. Their guidance, assistance and technical support was invaluable during all aspects of the project from the planning stage through site identification and assessment, data processing and final report compilation.

Those contributing to the success of this document include-

<u>The Environmental Management Program - Department of Primary Industires. Tatura.</u>

Alex Sislov	Fiona Copley	Rebecca Heard
Allison McCallum	Andrew Morrison	Suzanne Johnstone
Daniel Hunter	Kathryn Stanislawski	Joel Pike
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<u>Project Steering Committee</u>

Bruce Wehner	Jenny Wilson	Evan Christen
Peter Dickinson	Adrian Piani / Charles Bird	Tim Barlow

Others include Terry Hunter from Goulburn Murray Water, Kim Pettie from Sinclair Knight Merz and Doug Robinson from Trust For Nature.

The cooperation from Landowners and Trust For Nature Covenantors was also most gratefully appreciated.

Those deserving special recognition for continuous assistance during project implementation include Alex Sislov, Andrew Morrison, Allison McCallum and Susan Barker all from DPI Tatura and Daniel Hunter from Sinclair Knight Merz (formerly DPI Tatura).

1 SUMMARY

Today, less than 3% of the dominant vegetation type (Plains Woodland) remains on public and private land in the Shepparton Irrigation Region (SIR) (GBCMA 2000). These mostly small, scattered and isolated sites represent the dwindling remnants of their vegetation type or Ecological Vegetation Classes (EVC) across Northern Victoria and are under continuous degrading processes. Surface impacts such as weed invasion, uncontrolled grazing and pest animals coupled with sub surface threats from rising watertables and land salinisation contribute to ever increasing degrading processes and pressures on these sites.

The Sub Surface Drainage Program (Goulburn-Murray Water) in cooperation with Hydro-Environmental Pty Ltd, identified this project as one of the high priority Research and Investigation (R&I) projects (Project number GI03036) titled "Assessment of High Value Environmental Features within SIR" (Hydro-Environmental 2003). The emphasis was for the protection of selected environmental features from the effects of high ground-water levels.

This project entailed the identification of 106 terrestrial, wetland, riparian and grassland sites (134 assessments in total) for on site habitat quality assessment by ranking each site according to a stringent set of ten 'Habitat Quality Assessment Criteria' (DSE. 2005). Each site is described in a data sheet in Appendix A of this report. Watertable and Electrical Conductivity (EC) data was obtained Sinclair Knight Merz (SKM) allowing accurate calculations of watertable depth and EC at each site in the SIR Watertable Benchmark year of 1996. Several thousand readings were analysed resulting in a site specific 'Salinity Threat Score'. The resulting data of the 'Habitat Quality Score' and the Salinity Threat Score' were put through an Environmental Risk Matrix to ascertain a 'Priority Ranking' to identify sites with high habitat / environmental value that are under imminent / potential threat from rising watertables and high salinisation.

A small number of the 106 sites identified were unable to be 'Priority Ranked" due to the distance bores were situated from the respective site. Similarly some riparian sites included in this study do not have bores close enough for reasonable consideration of accurate bore data. Sites given a very high Priority Ranking are recommended for consideration for ground-water protection whilst other high priority sites are equally discussed in the recommendation for pertinent reasons.

Eleven sites ranked Very High Priority, 22 ranked High Priority, 37 ranked Medium Priority and
20 ranked Low Priority for ground-water protection whilst the remaining 16 sites could not be assessed due to the lack of bore data or bores being located to far from sites to have an acceptable draw-down influence. All sites are included in various tables and maps, however, only those ranked "High and Very High Priority" are discussed in the recommendations.

2 INTRODUCTION

In Victoria, salinity currently affects approximately 260,000 hectares of land and is increasing rapidly with an estimation of over 3,000,000 hectares will be affected within 50 years (DSE Info Sheet No 1 2003). The Goulburn Broken Region is one of four high salinity risk regions in Victoria. Consequently, the Goulburn Broken Regional Catchment Strategy identified salinity as the biggest threat to the Catchment's natural assets.

Contributing to the Goulburn Broken Catchment Strategy is works undertaken by the Sub Surface Drainage Program (SSDP). The primary objective of the SSDP is to protect and reclaim the Shepparton Irrigation Region's land and water resources from salinisation.

The primary goal of the Goulburn Broken Native Vegetation Management Plan is to 'maintain the extent of all native vegetation types at 1999 levels in keeping with the goal of 'net gain' listed in Victoria's Biodiversity Strategy 1997 and Victoria's Native Vegetation Management Framework (DSE 2003).

This unique project provides valuable information to help address the key catchment threat and links the primary goals of the Native Vegetation Plan and the SSDP. The project identifies over 100 natural feature sites in the Shepparton Irrigation Region and assesses their priority for watertable management. It breaks new ground in recommending watertable management for biodiversity assets rather than productivity, as has generally been the case in this report.

Remaining native vegetation particularly in the lower catchment now exists as scattered, small blocks of remnant woodlands with linear reserves/networks along creeks, railways and roadsides; forests and woodlands along the major rivers; wetlands; grassland remnants in paddocks and along linear reserves and scattered old trees in exotic pastures/crops. The sites mapped and described in this study are consistent with this description from the Native Vegetation Plan and the DSE habitat assessment process. There is now more information about their habitat value and the degree of threat posed from ground-water and consequently more informed decisions about their management can be made.

3 BACKGROUND

Hydro-Environmental Pty Ltd (2003) prepared a Strategic Plan for the SSDP within the Shepparton Irrigation Region (SIR) and presented a 5-year work program addressing the significant research and investigation (R&I) activities within the SIR.

The R&I projects have been prioritised and preliminary scopes of work, project time-lines and cost estimates prepared. This project covers one of the high priority R&I projects (Project number GI03036) titled "Assessment of High Value Environmental Features within SIR" (Hydro-Environmental 2003) with an emphasis on the protection of selected environmental features from the effects of high ground-water levels. An overview of the project is contained in the section "Project Scope".

Environmental features may be defined as ecological systems that play a vital role in the community providing ecological, social and economic benefits. Many natural ecosystems found within the SIR on both public and private land are considered as 'high value' environmental features. The value of these ecosystems is gauged by several ecological and socio-economic criteria such as endangered species and how irreplaceable they are. A number of tools such as 'Biodiversity Action Planning' (BAP) and 'Landscape preferencing' have been developed to help with the depiction of high value environmental features. However these tools are in their early stages of development and therefore identification of environmental features at a farm scale is very limited.

For the purpose of this project, environmental features can be categorised depending on whether or not they have a natural reliance or an interaction with the watertable. Environmental features naturally interacting with the watertable include riparian and wetland ecosystems. Environmental features that generally do not naturally interact with the watertable are native grasslands, woodlands or remnant stands of vegetation (Kelly 1994b).

A major threat to environmental features in the SIR has been an increasing watertable. Removal of native vegetation coupled with poor irrigation practices, has been the major contributor to the monumental upward movement (MDBC 2004). In some areas the watertable is less than one metre below the surface. Noted consequences of this in the SIR have been irrigation salinity and subsequent waterlogging (Kelly 1994a). Not all environmental features in the SIR are currently under immediate threat. In areas where there is limited irrigation the watertable is generally lower and environmental features are at less risk. Conversely, the most threatened features in the region are correlated with areas of higher intensity irrigation. Furthermore, with the predictions of increased salinity and watertables for the future (G-MW 2002), there is growing concern, especially for environmental features that do not naturally interact with the watertable.

The impacts that salinisation and waterlogging can have on the environment is potentially devastating, ranging from the alteration of vegetation and habitat structure to the complete destruction of wetland and woodland environs (Kelly 1994b). These impacts exerted upon the environment can be described as a direct or an indirect effect of salinisation or waterlogging.

Direct effects such as the death of vegetation or macro-invertebrates are the most obvious. However, it is important to consider the indirect or flow on effects as well, such as habitat alteration and loss or, the increased susceptibility of disease and predation (Kelly 1994a). The indirect effects may have the potential to inflict greater stress on the natural environment if degradation continues unchecked. Nevertheless through the DSE Site Assessment process this project could only consider the direct effects of high watertables on selected sites.

In the past the primary focus of ground-water management has been for salinity mitigation on agricultural land. In particular, ground-water pumping has been used to lower the watertable. The success of this practice has been noticeable where there has been localised drawdown of the water table in the vicinity of the pump, thus easing the pressure of high watertables. Continuation of the program may also seem an imperative step for preserving high value environmental features in the SIR, although feasibility may depend on the sustainability of disposal options and the hydrologic balance in the system. Over the last one hundred years environmental features have continuously evolved, coping with the constant pressures of anthropogenic stress. This will also need to be considered in the development of mitigation plans and measures.

The Biodiversity Action Planning (BAP) Process has two landscape zones within this study, Central Creeks BAP undertaken at the same time as this study and the Yarrawonga BAP undertaken near the end of this study period. Both projects benefited from being run in almost parallel supplying information and site location visa-versa to the extent that several sites are identified in both projects. A selection of these sites include - Dip Bridge Katamatite, Drumanure Uniting Church Drumanure, Invergordon Reserve, Katamatite Bushland Reserve, Kinnairds Wetland, Kempsters Bridge Reserve and Walsh’s Bridge Reserve, Naring Grasslands, Robinson’s Trust For Nature, Stevenson’s Trust For Nature, Black Swamp and Purdies Swamp, Creighton’s Trust For Nature Riparian, Wunghnu Bushland Reserve, Numurkah Rifle Range, Grey’s Bushland Reserve, Koonoomoo Recreation Reserve, Old Coach Road Remnant and Old Coach Road Reserve and Farrells Road Reserve.

4 PROJECT SCOPE

Ultimately this project has focussed on the protection of environmental features from the effects of elevated watertables and salinity. This project is the first in a series that ultimately culminates with the implementation of protective procedures for high value environmental features within the SIR. This project undertook the initial steps of identifying and prioritising public environmental features for protection. The identification of high value features on private land has also been considered, however, the available information concerning these features is very limited. Although previous studies have been conducted to identify environmental features in the SIR, there has been no specific study to identify high value environmental features subject to the effects of high watertables with the intention for protection through ground water pumping.

Hydro-Environmental (2003) defined three key objectives for project G103036, which have subsequently been were then refined. Based on discussions with Hydro-Environmental Pty Ltd, the Environmental Management Program (EMP) of DPI, GMW and URS (2004) defined three new key objectives for the project.

Objective 1. Determine the location of all valuable environmental features in the SIR with the main focus on public features, that are either currently or potentially at risk of degradation as a result of high watertables.

Objective 2. Determine how ground water is, or could be, affecting the health and well being of all features identified under Objective 1.

Objective 3. Place an objective valuation on the environmental features that are or could be affected by high water tables in the SIR and define their significance and priority for protection.

This document identifies all high value environmental features located on public land and at least some significant high value features located on private lands. Each feature has been individually assigned significance based on their role in the local and regional and national community. Finally, the features identified have been prioritised for ground water protection (ie installation of public salinity control pump).

High value environmental features vulnerable to ground water impact have been given a higher priority for protection.

5 A THREE STAGE PROJECT ROADMAP (METHODOLOGY)

After close consultation with the DPI through the Environmental Management Program (EMP) (Tatura) and Goulburn Murray Water, the main objectives and tasks for the project plan were finalised in February 2005. The format of the plan and project is displayed as a 'road-map'. The roadmap is designed to enable easy understanding of the plan and project structure. Objectives were defined in Stage 1. Stage 2 illustrates the processes within the project, culminating with the final documentation, Stage 3. Each stage and objective is discussed further accompanied by the methodology and processes adopted to achieve final prioritisation of all sites assessed. The roadmap is shown in Figure 1.

This roadmap generally recognises three main stages of the project. (URS 2004)

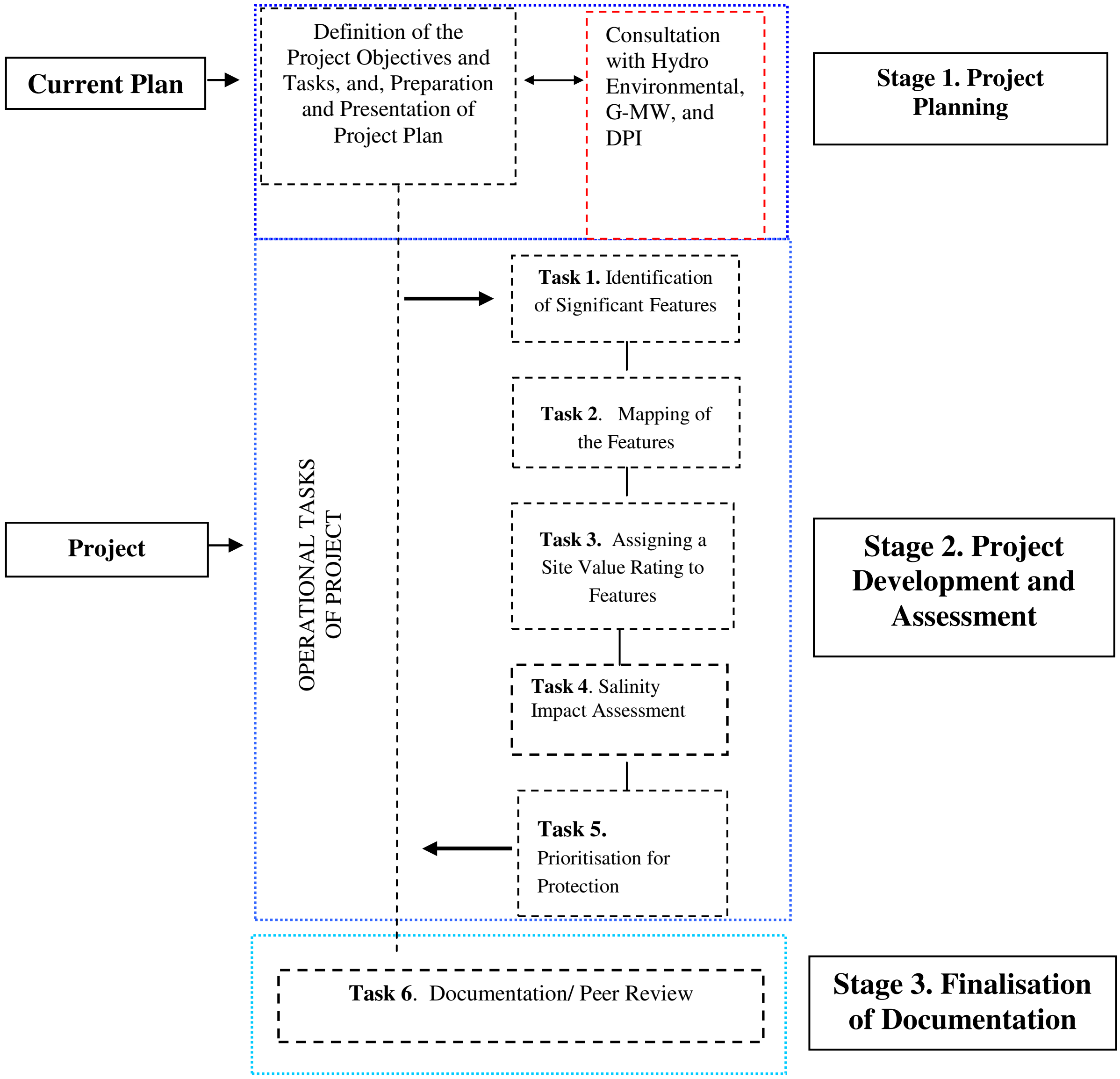

Figure 1. Assessment of High Value Environmental Features Project Roadmap.

5.1 Stage 1: Preparation of the Plan

Stage 1 was the preparation of a plan document. The main intention of the project plan involved consulting with DPI-EMP, Hydro Environmental and G-MW in order to define the key objectives and outcomes for the project, define the tasks, estimates of timeframe, costs and resources, and determining the links and overlaps with other projects. The purpose of the plan was to guide the project (Stages 2 and 3). As noted previously, the Project Plan was adopted and revised by DPI – EMP in February 2005. The final DPI Project Plan is a separate document to this report.

5.2 Stage 2: Project Development

Stage 2 was the project development stage. The Project development saw five tasks each with a number of sub-tasks that were carried out in order to achieve the desired outcomes for the project. The assessment component / process of these tasks are diagrammatically summarised in Figure 2, outlining site value, risk and prioritization assessment processes adopted.

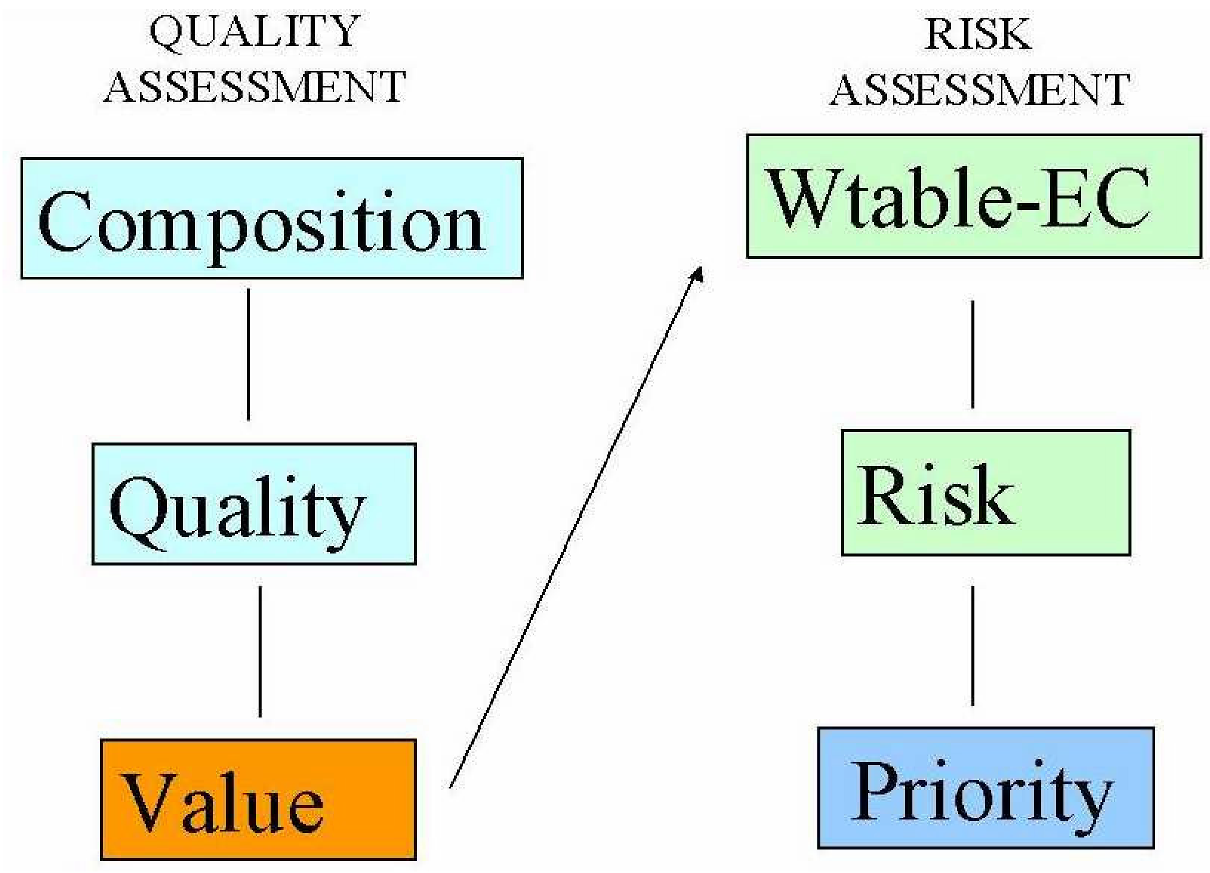

Figure 2. Site Quality Assessment – Site Risk Assessment Flow Chart.

5.3 Stage 3: Final Documentation

Stage 3 involved the final preparation and presentation of a draft document for peer review and comments. This document provides a list of recommended SIR environmental features/sites that require immediate ground water protection. Additionally it lists sites that do not require ground water protection in the immediate future as well as sites deemed not to warrant ground-water protection in the long term due to their assessed ecological / environmental value.

6 INDIVIDUAL PROJECT STAGES AND TASKS

6.1 Project Plan (Stage 1 – Task 1)

A Project Plan was prepared to guide the project and is described in greater detail in Section 5.1

and Figure 1.

6.2 Project Development and Assessment (Stage 2 -Tasks 1 – 5)

This Stage is the most complex of all three stages. Hydro-Environmental Pty Ltd (2003) originally set 3 tasks that complied with the three original objectives, however these 3 **tasks** were superseded. Based on discussions with Hydro-Environmental, DPI - EMP, and G-MW, (with an understanding of the current issues facing high value environmental features and ground water in the SIR), a new set of tasks to achieve the objectives was established. These tasks were designed to enable direct links with other similar projects considering similar issues. The five tasks listed below form the basis of this project :-

Task 1	Identification of Significant Features;
Task 2	Mapping of Significant Features using GIS;
Task 3	Site Habitat Quality / Value Assessment;
Task 4	Salinity Impact and Threat Assessment;
Task 5	Site Prioritisation for Protection (Risk Assessment)

6.2.1 Identification of Significant Features (Stage 2 – Task 1.1)

<u>Task Objective</u>

Identify the classifications of riparian, woodland, wetland and grassland environmental features in the SIR that have a natural, unnatural, or the potential for interaction with the watertable.

Task 1.1 researched the broad feature classifications that occur in the SIR. A good source of information for this, was the 'Bioregional Action Plan' (BAP) for the Goulburn-Broken Catchment. The 'Wetlands, Biodiversity and Salt' project being conducted by the DSE was also a good source of information concerning wetlands. Selected SIR Wetland and Terrestrial Management Plans written by DPI also provided detailed site information.

<u>Task Methodology</u>

Figure 3 is a map which depicts the range / distribution of environmental sites across the SIR (EMP Tatura.). A larger A3 size maps is included as Appendix 1.

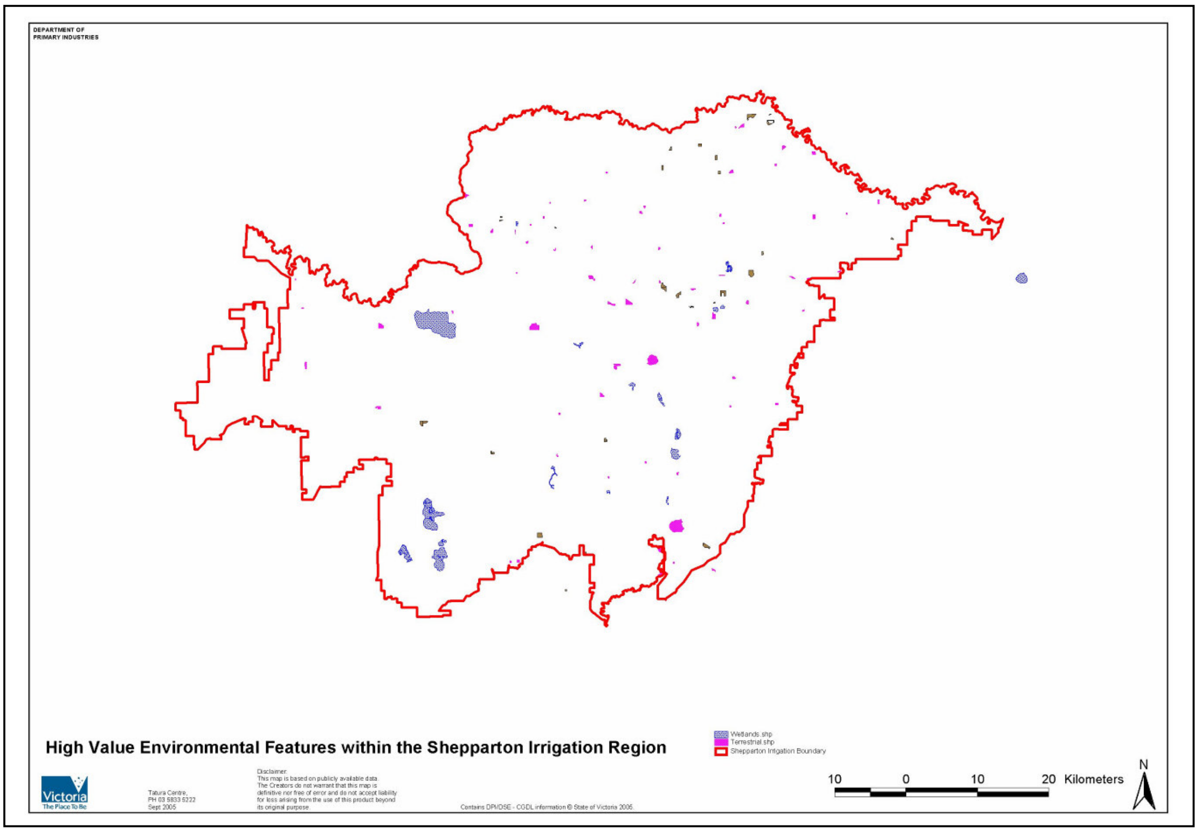

Figure 3. HVEF Site distribution across the SIR showing representative spread of selected sites.

6.2.2 Locate Significant Features (Stage 2 -Task 1.2)

Task Objective

Identify and locate significant environmental features in the SIR situated on public land. Identify also, those environmental features situated on private land (where precise accurate and up to date information is available). Consideration of private features is also important, as 90% of land in the SIR is privately owned.)

Task 1.2 researched available resources (GIS Land Management Layers, Parks Victoria Management Plans and as listed below) identifying all relevant environmental features in the SIR. SKM (2002a) and, SKM (2002b) available from G-MW provided assistance identifying some high value features in the SIR located on public land. The process of researching environmental features was aligned also with current Bioregional Action Planning (BAP) research being conducted by the DSE and DPI (Echuca) as this helped with the identification of features particularly on private land. Doug Robinson from Trust For Nature (TFN) Benalla also provided potentially high value sites on private land from Trust For Natures "Covenanted Sites Register". The assessment of TFN sites was strictly undertaken with the permission of the respective land-owner. Additional resources that were utilised are as follows;

- government sources (DSE, GBCMA);
- Surface water management environmental assessment documents ;
- Sub-surface water management environmental assessments ;
- Private sources (environmental agencies etc ;
- Terrestrial and Wetland Management Plans ;
- specialised tools: 'Landscape Preferencing' - Jenny Wilson, DSE, Benalla , and 'Vegetation Condition Mapping' - Pam Clooney, DSE/DPI, Bendigo;
- similar regional projects ('Wetlands, Biodiversity and Salt" - Dr Sabine Schrelber DSE); and
- Internet (search runs) and journal databases.

a) A preliminary desk top assessment was carried out to determine if an environmental feature is being, or has the potential of being, affected by ground water, with the focus being on the relative threat to biodiversity and the probability of resistance to change. The risk assessment included variables such as;

- Depth of ground water;
- Salinity (EC) of ground water;
- Soil type;
- Salt tolerances;
- Duration of high water tables;
- Climatic conditions

All sites identified for assessment are included in this report despite some sites being of very low ecological / habitat value. The inclusion of these sites was deemed necessary to add robustness to the report and removal any degree of bias towards only selecting 'known high value' sites.

- To assist with identification of features, surface elevation data was used to locate lower ground areas where water can accumulate and inundate. These areas will have a higher ground-water recharge and possibly higher watertables.
- Features identified were categorised into one of four separate ecological classes (wetlands, woodlands, riparian and grasslands).

Task Methodology

6.2.2.1 Sites

In total there are 106 terrestrial (woodland, riparian and grassland) and wetland sites assessed for habitat quality and watertable / EC across the SIR, however clusters of sites are evident particularly in the dryland areas north or Shepparton (Figure 3 / Appendix 1). The scattered and clustered distribution was expected considering the variety in agricultural intensity of irrigated and dryland farmland in the SIR. The majority of these sites are less than 10 hectares in size, however, some sites particularly some of the wetland complexes are relatively large (Corop Lakes Complex), and range between 10 hectares and 200 + hectares in size. As expected small sites required one habitat quality assessment whilst larger sites supporting more than one EVC required more than one habitat quality assessment (Kanyapella Basin). Over 130 habitat quality assessments were completed for the 106 sites assessed for this project.

6.2.2.2 Site Selection

The initial process of selecting sites for inclusion in the project took consideration of sites listed in the Land Conservation Council Report inclusive of the SIR. Other sites were derived from terrestrial and wetland management plan lists considered for plan priority by the EMP-DPI, Tatura. This plan priority list included several large terrestrial sites such as the Wyuna Bushland - River Reserve. Trust for Nature, Benalla administers several Covenant Sites within the SIR, hence these sites were also considered valuable for inclusion in the project. These Trust For Nature sites are all private sites owned predominantly by the farming sector or by Trust For Nature in the case of the Naring Grassland.

Some 31 Trust For Nature covenanted sites are located within the SIR, however only 14 sites were habitat assessed despite considerable efforts by Doug Robinson, Regional Trust for Nature Coordinator, Benalla.

Every effort was made to contact the remaining Covenantors whilst still respecting privacy requirements. Only 20 sites (14 covenanted and 6 private sites) of the 106 sites assessed are private (Table 1). Access to private remnant sites for the purpose of this report was found somewhat difficult. It is well recognised that several good quality remnants exist on private land within the SIR however due to access restrictions it was decided that the aforementioned Trust for Nature sites would adequately satisfy the private site component of this report.

Table 1. Distribution of Sites and Assessments across vegetation types.

	Terrestrial	Grassland	Wetland	Riparian	Total
Total Sites	61 (8)	7 (2)	14 (1)	24 (3)	106 (14)
Assessments	77	10	20	25	132

(Bracketed figures are Trust for Nature sites inclusive in the 'total sites')

As expected the majority of sites included are terrestrial woodlands mostly dominated by a Grey Box (*Eucalyptus microcarpa*) overstorey. Indigenous grasslands in a modified agricultural landscape are rare (pers comm Doug Robinson, 2005) hence the limited number of sites assessed.

Wetlands assessed tended to be in complexes especially the Corop Lakes wetland complex including the Wallenjoe, Mansfield, One Tree, Two Tree and Gaynors swamps/wetlands. This complex is the biggest in the SIR and constitutes the majority of the wetland site assessments.

Riparian sites assessed sit within a generally continuous vegetated strip naturally associated with a watercourse. The Broken Creek, Nine-Mile Creek and the Goulburn River were sites deemed to be of significant riparian significance hence the number of sites assessed within their riparian strips. It must however be remembered the sites assessed are an average representation of the riparian vegetation and not continuous assessment of kilometres of river frontage.

It was considered and agreed that the number and distribution of assessments across these 4 vegetation categories was both an adequate assessment of natural features within the SIR and exceeded the initial expectation of the project. All 106 sites, some with multiple assessments are listed in Table 2.

Table 2. Study Sites Identified in the SIR by Name and Site number.

SITE #	SITE NAME	SITE #	SITE NAME
118	Arcadia Bushland Reserve	105	McDonald Remnant TFN
42	Ardmona Recreation Reserve	49	McManus Road Reserve
54	Black Swamp	38	Merrigum Recreation Reserve
16	Barmah Racecourse Reserve	25	Minchins Road Bushland Res
20	Baxters Pit	79	Muckatah Recreation Reserve
53	Purdies Swamp	28	Munroes Swamp
39	Brays Wetland	3	Nanneella Bushland Reserve
119	Bunbartha Pony Club Reserve	94	Naring Grassland TFN
12	Cantwells Bushland Reserve	29	Nathalia South Bushland Res
80	Chapel - Parnell Road Remnant	62	Nathalia South Bushland Res
78	Cobram Racecourse Reserve	30	Nathalia South East BLR
58	Congupna Bushland Reserve	1	Night Cart Hill
35	Coomboona River Reserve	69	Numurkah Rifle Range
109	Crawford Remnant TFN	33	O'Brien Road Reserve
99	Creighton Reserve TFN	74	Old Coach Road Remnant
41	Cussen Park	75	Old Coach Road Reserve
47	Daunts Bend River Reserve	7	One Tree Swamp
83	Dip Bridge Road Reserve	24	Picola Recreation Reserve
22	Dohnts Murray Pine	111	Powles Remnant TFN
116	Dowdles Swamp	50	Punt Road River Reserve
71	Drovers Rest Reserve	106	Ramadan Remnant TFN
55	Drumanure Uniting Church Res	43	Reedy Swamp
2	Echuca Racecourse	51	Reilly's Pit
120	Farrell Road Bushland Reserve	117	River Road Reserve
46	Ferguson Road Wetland	98	Robinson Remnant TFN
8	Gaynors Swamp	34	Ross Road Wetland
44	Gemmills Swamp	45	Rumbalara Common
81	Greys Bushland Reserve	9	Rushworth - Tatura Common
95	Harris Reserve TFN	15	Sand Ridge Track Reserve
59	Inglis Bushland Reserve	13	Serpentine Road Reserve
56	Invergordon Reserve	96	Stevenson Reserve TFN
18	James Bridge Roadside	73	Strathmerton Recreation Reserve
14	Kanyapella Basin	40	Tatura - Undera Road Remnant
84	Katamatite Reserve	57	Thompsons Road Reserve
72	Katunga Recreation Reserve	26	Tucketts Road Reserve
65	Kempsters Bridge Reserve	6	Two Tree Swamp
70	Kinnairds Wetland	36	Undera Recreation Reserve
77	Koonoomoo Recreation Res	66	Waaia Recreation Reserve
37	Lancaster Recreation Reserve	5	Wallenjoe Swamp
82	Larissa Road Reserve	67	Walsh's Bridge Lignum
19	Lignum Swamp	11	Wharparilla Recreation Res
21	Lindsays Road Reserve	112	Winterton Remnant TFN
32	Loch Garry	17	Wrights Bridge Reserve
23	Luckes Weir	52	Wunghnu Bushland Reserve
68	Lyons Road Reserve	27	Wyuna River Reserve
4	Mansfield Swamp	63	Yalca Church Reserve
48	Maritz Bend River Reserve	60	Yalca Reserve
10	Mason Road Bushland Reserve	64	Yalca South Bushland Reserve
31	McClellands Road Reserve	76	Yarroweyah Recreation Reserve

6.2.3 Mapping of the Features (Stage 2 – Task 2.1)

Task Objective

Using GIS, map the location of each environmental feature incorporating available spatial parameters such as size, density, vegetation types, etc (the knowledge of these may be critical in future projects). During the mapping process note where possible the ground-water impact for each feature.

The 'ArcView' GIS was used to produce accurate and detailed overlay themes that were applied to the SIR base map to make correlations with features identified. The incorporation of various spatial aspects and other geographic information for the features were included where relevant.

Task Methodology

The mapping of high value environmental features took the form of a GIS Layer map of the SIR depicting all 106 sites. Sites are numbered and correlate to the Site assessment and information sheets within this report. An A3 map is contained as Appendix 1.

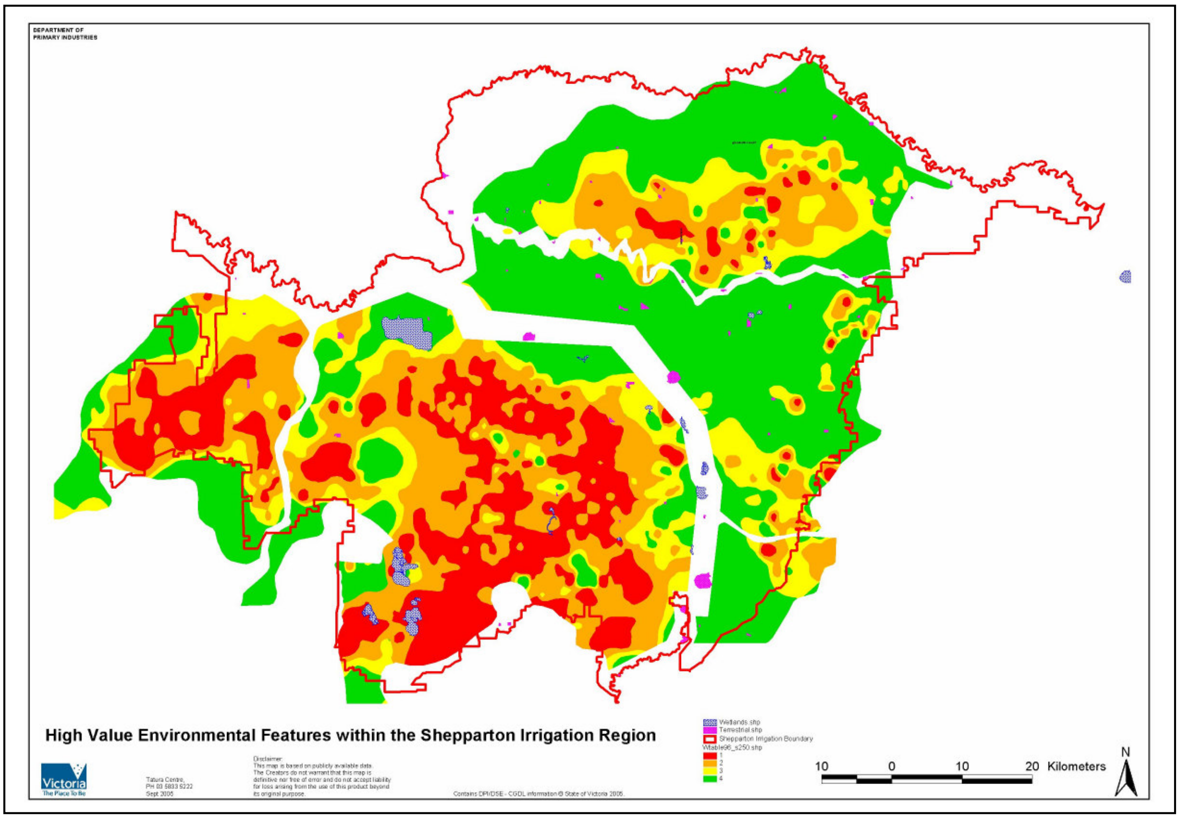

Figure 4. GIS Environmental Feature Site Layer with the SIR 1996 Benchmark Watertable map underlaid.

6.2.4 Site Habitat Quality / Value Assessment (Stage 2 - Task 3.1)

Task Objective

Using an agreed set of criteria, undertake a 'value assessment' of the environmental features identified The value assessment will place a site value of very high, high, medium, or low, for each feature which in turn, assisted in the final prioritisation of selected sites.).

Careful consideration of the final criteria developed was taken. There are existing criteria that exist and these were considered during development. The BAP program and DSE's Environmental management in agriculture – Assessment of Habitat Quality (Straker 2005) **assisted** in this process and it was ensured that the criteria used to determine the 'high value' included:

- Environmental values (uniqueness, irreplacability, endangered biota, connectivity, size, shape, species diversity, naturalness, value to specific faunal groups such as arboreals and avifauna, landscape context etc) ;
- Social values (aesthetics, recreation, etc) ;
- Economic values (*market* - direct use, indirect use, non-use, *non-market* - welfare loss/gains, etc.).

It is important to note that it is the 'high value' class we are concerned with. Nevertheless it is still important to recognise the medium and low value environmental features, and that they are included in this study for future reference.

Task Methodology

6.2.4.1 Site Habitat Quality/ Value Assessment Sheets

The Site Quality Assessment methodology was adopted from the Department of Sustainability and Environment (DSE) 'Environmental Management in Agriculture Worksheets - Native Biodiversity Resource Kit 2004' by Andrew Straker at the DSE Ballarat Office.

Worksheets used to compile a habitat quality assessment for each site included-

- Site Score Sheet No 12 Plains Grassy Forest or Woodlands (Appendix 3);
- Site Score Sheet No 21 Wetlands (Appendix 4); and
- Site Score Sheet No 4 Grasslands (Appendix 5).

The individual assessment components from these worksheets were compared to the more complex habitat area based Hectare assessment procedure (Habitat Hectare Assessment) with several assessment components / criteria being similar in each method (Parkes *et al* 2003). The use of both methods in assessing the same site revealed strikingly similar results. It was concluded and agreed that the Habitat Quality Site Score Assessment Sheets No's 4, 12 and 21 which is a simpler process was adequate for the scope of this study.

Furthermore, the sometimes ‘complex’ Habitat Hectare assessment can be inappropriate for small reserves and remnants typical of sites within this study. The respective worksheets contained in Attachments 3/4/5 was provided to the Steering Committee for comment and approval, which was granted after minor clarification.

6.2.4.2 Habitat Quality Assessment Training

Despite the common sense approach adopted during field assessment of the sites using these Habitat Quality Worksheets, some clarification on the individual component assessment is required to ensure uniformity. It is important to note that all members of the DPI – EMP, Tatura contributed to the assessment of the 106 sites therefore it was appropriate that suitable training was undertaken to ensure assessment were as uniform as possible (Table 3). Training sessions were conducted at sites selected for inclusion with individual assessments undertaken on the same (one) hectare block. Individual score variances were no greater than 1.5 points out of a possible 20 point maximum for Woodlands, Riparian and Wetlands and a possible maximum of 16 for Grasslands. Further assessment uniformity and robustness was tested by the random double assessment of the same reserves.

Table 3. Double-up Habitat Quality Assessments to support Assessment uniformity and robustness.

Reserve Name	**First Quality Score**	**Second Quality Score**	**Score Difference**
H 16 Reserve Kotupna	11	12.5	+1.5
Yielma Bushland Reserve	13	11.5	- 1.5
Wyuna River Reserve	17.5 / 16.5	16 / 17.5	-0.5
Yalca Bushland Reserve	8	8.5	+0.5
Greys Bushland Reserve	11	10	- 1
McClellands Road Reserve	12	13	+ 1

The nominal variances in scores attained for the same reserve by different Assessors emphasises the uniformity in site assessment.

6.2.4.3 Habitat Quality Assessment Components

The following components of the ‘Assessment of Habitat Quality’ developed for DSE by Straker (2005) satisfies the task objective ‘ **A set of criteria were developed to be used in a 'value assessment' for those environmental features identified** ‘.

In order to further justify the integrity of this Habitat Quality Assessment process (over and above that detailed in the individual sheets contained in Appendix 3/4/5 it is necessary to clarify certain points considered in each component of assessment. The following methodology points for each component are taken directly from Straker (2005) with additional supporting information.

Large Trees

Large trees are an integral component of a healthy ecological environment providing hollow habitat for arboreal animals, nesting provisions for birds, niche and food requires for insects, birds, and arboreals. (Glanznig 1995; Burgman and Lindenmayer 1998; Parkes *et al* 2003). Large trees also provide a considerable volume of leaf litter and valuable useable woody material over younger recruitment (Graetz *et al* 1995). Large trees are not a consideration in the Grassland Habitat Quality Assessment

Recognised methodology used in assessing large trees-

- Use a tape to initially assess trees at or near the benchmark DBH.
- Understorey tree species are not assessed as part of the large tree component.
- Include any dead trees that obtain the large tree diameter at the DBH benchmark.
- Measure individual trunks separately if trees are multi-trunked at DBH.

Canopy Cover

The quality and abundance of the canopy cover is indicative of the health of the over storey and the frequency of trees within a site (Glanznig 1995). The assessment process sets a 10% ‘benchmark’ for Plains Grassy Woodlands and a 30% ‘benchmark’ for Plains Grassy forest. Canopy cover is not a consideration in the Grassland Habitat Quality Assessment.

Recognised methodology used in assessing canopy cover-

The canopy cover is the percentage of the site that would be under a shadow cast by the foliage if the sun were directly above.

- Dead trees should be assessed as having 0% of their canopy cover.
- Lower limbs do not form part of the canopy cover.
- Include any large trees assessed previously that reach minimum canopy height.
- Cover estimate should take account of the gaps within the canopy of each tree and the gaps between trees.
- The use of a canopy cover guide for Eucalypts was paramount.

Understorey

The understorey component carried 25% of the total possible score (5 of the total score of 20).

This weighting is indicative of the importance and value of a natural indigenous and intact understorey with at least 2 strata of ground covers (herbaceous layer) and a shrub layer which can be divided into 2 levels (up to 1 metres and up to 5 metres).

Recognised methodology used in assessing understorey-

- Only native species should be considered as part of the understorey.
- In general, the understorey should be assessed according to what is currently observed, not what may be assumed to be present in the future.
- Cover refers to projective foliage cover across the entire site: ie that covered by a shadow should the sun be directly above.
- The height of the understorey should include the height of the flower, including any long lasting ‘dead’ material from previous seasons.
- One species may occupy more than one life form depending on the height of individuals within the site.

Weediness

The presence of weeds at a site depending on their abundance and species diversity is an indication of site disturbance (Burgman and Lindenmayer 1995). Sites that suffer little or no disturbance tend to resist weeds well as the indigenous cover remains intact largely inhibiting weed establishment (Graetz *et al* 1995; Burgman and Lindenmayer 1998). Generally, a site with nominal disturbance will not be as invaded by weeds or be susceptible to weed invasion as those sites with considerable disturbance (Lamp and Collet 1996). Sites supporting nominal weed invasion or free of weeds are more likely to have a better understorey or will re-colonize with indigenous understorey species given an available seed bank and the appropriate condition (Cunningham *et.al*.1992). Weed presence / absence was the second most weighted component in the Habitat Quality Assessment process.

Recognised methodology used in assessing large trees-

- Weeds include introduced and non-indigenous native ‘weed’ species.
- Weed cover is the estimated average percentage foliage cover of all weed species across the site: ie that covered by a shadow should the sun be directly above.

The combined weighting (40%) of Understorey and Weediness (degree of weed free) proved an important indicator of the quality of the site as a healthy diverse and intact understorey was also generally virtually weed free.

Alternately if a site was very weedy, little indigenous understorey was observed nor was the site expected to flourish and dominate the herbaceous layer with indigenous understorey due to persistent weed competition (pers comm. A. Sislov 2005).

Recruitment

Recruitment can be an indication of low disturbance, an appropriate wetting regime, a healthy parent structure providing a seed bank and nominal impacts allowing juveniles to 'recruit' the site (Burgman and Lindenmayer 1998). Good recruitment is also gauged by all indigenous woody species recruiting, as ongoing recruitment will re-populate the site as mature individuals die.

- Only indigenous woody species taller than prostrate shrubs are assessed.

Organic Litter

Abundant organic litter is an indication of healthy strata and ongoing nutrient cycling as grass, leaves, twig and branch material is being produced as living material on plants then cycling to dead material that falls to the ground or can be for some time retained on the plant. Good organic litter layers contribute to good soil biota / soil microfauna contributing to healthier ecosystems.

Recognised methodology used in assessing organic litter-

- Organic material is defined as organic material detached from the parent plant, including both coarse and fine plant debris and material such as fallen leaves, twigs and small branches less than 10 cm in diameter present on the ground.

- Organic litter percentage cover estimates should take account of the litter that may exist under overhanging vegetation (eg. Small shrubs growing close to the ground).

- To assist with the assessment of how much of the organic litter may be due to native species, consider the proportion of native and introduced species on the site and their overall likely contribution to the organic litter cover.

Logs / Fallen Timber

The presence of logs within a site is at least partly indicative of the ecological health of the respective site. Logs provide habitat for insects and small reptiles whilst birds and terrestrial mammals use logs for cover and feeding grounds (Glanznig 1995; Strahan 1996; Burgman and Lindenmayer 1998). The presence, production and retention of logs are important for the existence and longevity of numerous ground dwelling reptile species. (Cogger 1996).

The presence of logs also serves as an indicator of nominal human interference. If a site displays a regular distribution of varying age fallen timber it is likely there has been nominal firewood collection and usually contributes to a healthy stable soil fauna, insects and small reptile population. Fallen timber also indicates the age and health of large old trees on site (Glanznig 1995)

Recognised methodology used in assessing logs / fallen timber-

- Use a diameter tape to initially assess logs at or near 10 cm and the appropriate large log diameter threshold until this can be confidently assessed by 'eye'.
- Pay particular attention to logs 10 – 20 cm in diameter as these can often be overlooked or difficult to observe in some vegetation types.
- Use a default length of 0.5 m for any cut stumps that are less than breast height.

Landscape Context

Vegetation quality assessments in this report are made from the previous seven components relating directly to the site. However, the quality and long-term survival of a site is also dependent on other factors influencing the site (Parkes *et al* 2003). Size, Neighbourhood and Core Area are considered Landscape Context components within the assessment process. Small, isolated sites within an intensive agricultural area score low to very low in these components purely because of the modified landscape in which the site sits. Large sites usually with some degree of connectivity along a watercourse or sites contributing to a wetland complex normally score moderate to high in these Landscape context components. Riparian sites, in particular, may accrue high context scores often because of their degree of connectivity.

Neighbourhood

Neighbouring vegetation contributes to site connectivity reducing the effects of site isolation sometimes referred to as 'vegetation islands' (Burgmann and Lindenmeyer 1996). The landscape context component is important for the long-term ecological viability of a site. The movement or transfer of flora and fauna to and from sites assists in site integrity and diversity providing the transfer is indigenous and not introduced pest plants and animals (Parkes *et al* 2003).

Recognised methodology used in assessing neighbourhood-

- Natural wetlands and lakes (not artificial / constructed dams etc), estuaries and rivers should be considered ‘ native vegetation’ for the purposes of neighbourhood assessment.

- Defined by the percentage of area covered by native vegetation within one kilometre of the site being assessed.

Size and Core Area

The size and the shape of a site have a profound effect on the floral and faunal composition of a site (Burgman and Lindenmayer 1998). Edge effect (the effect the adjoining environment has on a site) on a long narrow site may inhibit site occupation by arboreal mammals, reptiles and birds due to climatic condition, predation or vegetation disturbances (Glanznig 1995; Graetz *et al*. 1995; Burgman and Lindenmayer 1998). A square site has (all things being equal) less edge effect than a long narrow site as there is less core area effected by edge influences. Conversely a large site is ‘not always’ a good quality site whilst secluded undisturbed small sites may be of better quality.

- Size is defined by the size of the area being assessed and any ‘adjoining’ vegetation.

- Core area is defined the distance of the site being assessed from a block of native vegetation greater than 50 hectares.

6.2.5 Site Habitat Quality Scores (Stage 2 -Task 3.2)

Task Objective

Apply the 'site value assessment' on the environmental features identified using the criteria.

Quality / value assessment of all environmental features mapped in Task 2.1 and identified in Task 3.1 were completed. This involved assessing the feature on-site (environmental/social values) and when practical off-site using relevant resources (social/economic values). It was assumed through preliminary research and in reference to SKM (2002a and b), that there may be between 10 and 25 high to very high value sites identified within the SIR.

Task Methodology

On completion of extensive Habitat Quality / Value Assessments a score was derived indicating the habitat quality of each site. The maximum score for Woodlands and Wetlands is 20 and the maximum for Grasslands is 16. The majority of scores ranged from 8 to 15 with a few better quality sites reaching 17 and 17.5. Table 4 below lists all sites assessed and their respective Habitat Quality Score.

Table 4. Sites identified with respective Habitat Quality / Value Assessment Scores.

Site No	Site Name	Habitat Score	Site No	Site Name	Habitat Score
118	Arcadia Bushland Reserve	14	10	Mason Road Bushland Reserve	15
42	Ardmona Recreation Reserve	0	31	McClellands Road Reserve	12
54	Black Swamp	10	115	McCracken Remnant TFN	12./10
16	Barmah Racecourse Reserve	5	105	McDonald Remnant TFN	12
20	Baxters Pit	6.5	49	McManus Road Reserve	9
53	Purdies Swamp	9.5	38	Merrigum Recreation Reserve	8.5
39	Brays Wetland	5.5	25	Minchins Road Bushland Res	10
119	Bunbartha Pony Club Reserve	12	79	Muckatah Recreation Reserve	2.5
12	Cantwells Bushland Reserve	14.5	28	Munroes Swamp	12.5
12	Cantwells Grassland	9	28	munroes woodland	14
80	Chapel - Parnell Road Remnant	4.5	3	Nanneella Bushland Reserve	7.5
78	Cobram Racecourse Reserve	4.5	94	Naring Grassland TFN	9
58	Congupna Bushland Reserve	13.5	94	naring Grassland TFN wood	12.5
35	Coomboona River Reserve	11	29	Nathalia South Bushland Res	10
109	Crawford Remnant TFN	9.5	62	Nathalia north Bushland Res	11.5
99	Creighton Reserve TFN	16	30	Nathalia South East BLR	10
41	Cussen Park reserve	3	1	Night Cart Hill	6
41	Cussen Park wetland	10.5	69	Numurkah Rifle Range	14
47	Daunts Bend River Reserve	17.5	33	O'Brien Road Reserve	8
83	Dip Bridge Road Reserve	12.5	74	Old Coach Road Remnant	7
22	Dohnts Murray Pine	8	75	Old Coach Road Reserve	8
116	Dowdles Swamp	10	7	One Tree Swamp	7
71	Drovers Rest Reserve	5	7	one Tree Swamp grassland	8
55	Drumanure Uniting Church Res	16	24	Picola Recreation Reserve	0
2	Echuca Racecourse	3	111	Powles Remnant TFN	10
120	Farrell Road Bushland Reserve	14.5	50	Punt Road River Reserve	16
46	Ferguson Road Wetland	14	106	Ramadan Remnant TFN	12
8	Gaynors Swamp	14.5	43	Reedy Swamp	14
8	Gaynors Swamp Grass	8	43	reedy Swamp woodlands	14.5
44	Gemmills Swamp	13.5	51	Reilly's Pit	9.5
44	Gemmill Swamp Woodland	11.5	117	River Road Reserve	10
81	Greys Bushland Reserve	11	98	Robinson Remnant TFN	6
26	H 16 Tucketts Road Reserve	11	34	Ross Road Wetland	6
95	Harris Reserve TFN	16	45	Rumbalara Common	17
59	Inglis Bushland Reserve	14.5	9	Rushworth - Tatura Common	13
56	Invergordon Reserve	1.5	15	Sand Ridge Track Reserve	14.5
18	James Bridge Roadside	11.5	13	Serpentine Road Reserve	1
14	Kanyapella Scott track	17	96	Stevenson Reserve TFN	12.5/15.5
14	Kanyapella Warrigal creek	12	73	Strathmerton Recreation Reserve	2.5
14	Kanyapella Mitchell track	17	40	Tatura - Undera Road Remnant	2
14	Kanyapella Levee track	16.5	57	Thompsons Road Reserve	4
14	Kanyapella Tehan road	17	6	Two Tree Swamp	13
84	Katamatite Reserve	13	6	Two Tree Swamp grassland	12
72	Katunga Recreation Reserve	1	36	Undera Recreation Reserve	1
65	Kempsters Bridge Reserve	15	66	Waaia Recreation Reserve	3
70	Kinnairds Wetland	12	5	Wallenjoe Swamp	16/13.5
77	Koonoomoo Recreation Res	2	67	Walsh's Bridge Lignum	12
37	Lancaster Recreation Reserve	6.5	11	Wharparilla Recreation Res	0
82	Larissa Road Reserve	9	112	Winterton Remnant TFN	11
19	Lignum Swamp james bridge	5.5	17	Wrights Bridge Reserve	7.5
21	Lindsays Road Reserve	16	52	Wunghnu Bushland Reserve	16.5
32	Loch Garry	12	27	Wyuna River Reserve	16.5
23	Luckes Weir	15	63	Yalca Church Reserve	7
68	Lyons Road Reserve	10.5	60	Yalca Reserve	8.5
4	Mansfield Swamp	11/13.5	64	Yalca South Bushland Reserve	8/8.5
4	Mansfield Swamp Grassland	9	76	Yarroweyah Recreation Reserve	0
48	Maritz Bend River Reserve	17.5	61	Yielma Bushland Reserve	13/11.5

6.2.6 Salinity Impact Assessment (Stage 2 – Task 4.1)

Task Objective

Determine the physical impacts being exerted or which may be exerted by the ground-water on the environmental features identified.

a) For each high value environmental feature identified, this project determined the main effect ground water is having or could impose in the future. For example, increased salinity in the root zone and prolonged waterlogging (flora) etc.

b) Where available historical monitoring data/aerial photography was also used.

c) Assessment was undertaken on the likely impact of rising watertables to existing fauna populations/habitat (in broad terms).

NOTE: All high value features for this sub-task (at current high risk or not) were considered as there may be the possibility of threat from ground water in the future.

Task Methodology

Salinity

Ghassemi *et al* (1995) defined salinisation as 'the process whereby the concentration of total dissolved solids in water and soil is increased due to natural or human induced processes'. Salinisation can occur as a result of a range of factors including changing climatic patterns, large scale irrigation practices, clearing of vegetation, the replacement of trees by shallow rooted plants such as pasture and crops and the discharge of saline agricultural or industrial waters (Burgman and Lindenmayer 1998). According to Ghassemi *et al* (1995) the extent of human induced salinisation in Victoria alone as at 1995 totalled 685,000 hectares with 385,000 hectares being effected by shallow water tables in irrigated land. The Shepparton Irrigation Region suffers all of these human induced salinisation processes leading to further degradation of both agricultural land and vegetated remnant sites.

Bores and their proximity to Reserves and Remnant Blocks

The bore network across the SIR is extensive and number in the thousands however not all bores were required for analysis as the majority lay several kilometres away from study sites and were considered outside the area of influence or draw-down area. It would be very convenient, exceptionally accurate and very coincidental if all of the 732 bores selected and investigated in this study were located within the bounds of the various reserves and remnant blocks, however, this was not the case. Some bores conveniently lie within the reserve boundary however most do not, therefore a 3-kilometre radius 'area of bore capture' was proposed. It was agreed that this 'relatively immediate' bore range from the reserve would give an accurate as possible indication of water tables and EC despite the bores lying outside the reserve. An example of bore locations to a reserve is described in Figure 5 below.

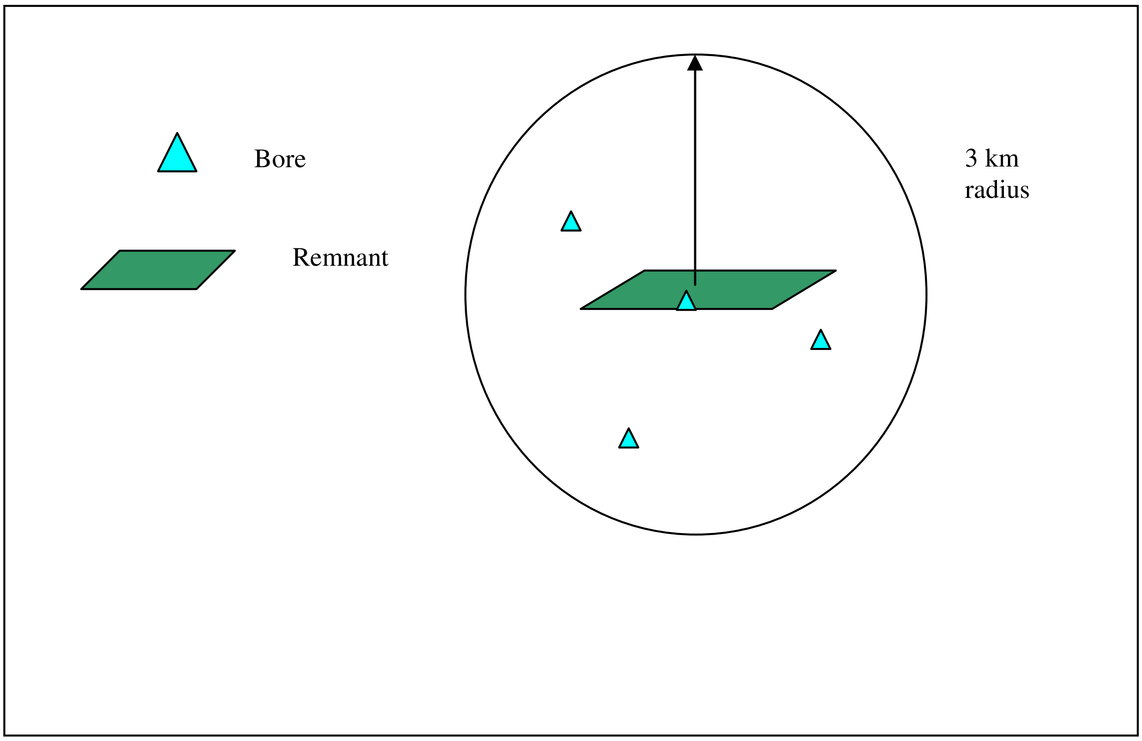

Figure 5. Diagrammatic example of bore proximity to reserve or remnant.

6.2.6.2 Water-tables

Water tables naturally rise and fall according to climatic conditions and extended rain fall periods or wet years (Ghassemi *et al* 1995; Burgman and Lindenmayer 1998). However, human interferences particularly vegetation clearance and extensive summer irrigation change water table levels often realising a rise to the extent that some areas experience a 1 metres rise per year immediately post vegetation removal (Ghassemi *et al* 1995). Rising water-tables laden with high salt concentrations have been a concern in the Shepparton Irrigation Region for several decades. Salinity became a major concern in the Bamawm area in the 1930's (DPI 2004). Many strategies and programs have been developed and undertaken to help address this issue but few have specifically addressed the depth of water-tables in relation to the protection of high value environmental features and sites (URS 2004).

The analysis and assessment of water-table depths associated with the 106 study sites constitutes the primary objective of this study. Water table analysis is one of the factors contributing to the 'Salinity Threat Score' instrumental in the final site prioritisation for protection. Site specific watertable readings (within a 3-kilometre radius of the site) were deemed imperative to ensure accuracy and robustness of the final priority recommendation cited in this report. This bore network investigation exceeds the initial project intention to use and rely on the SIR Watertable Maps updated and produced annually by SKM, Tatura. Water-table readings for each bore are listed in Table 5 as Appendix 6. (Site Water tables and EC levels).

6.2.6.3 Watertable Maps

Water table maps have been developed for the SIR since the early 1980's (SKM 2005). These maps show the SIR watertable at four levels indicated by four different colours providing a 'regional' perspective of the watertable. Though these maps are an important resource it was deemed that the maps were too general and did not provide accurate information about water tables deeper than 4 metres. Alternately specific water table depths at specific sites were taken from databases derived from bores installed for watertable and Electrical Conductivity monitoring, maintained by SKM, Tatura.

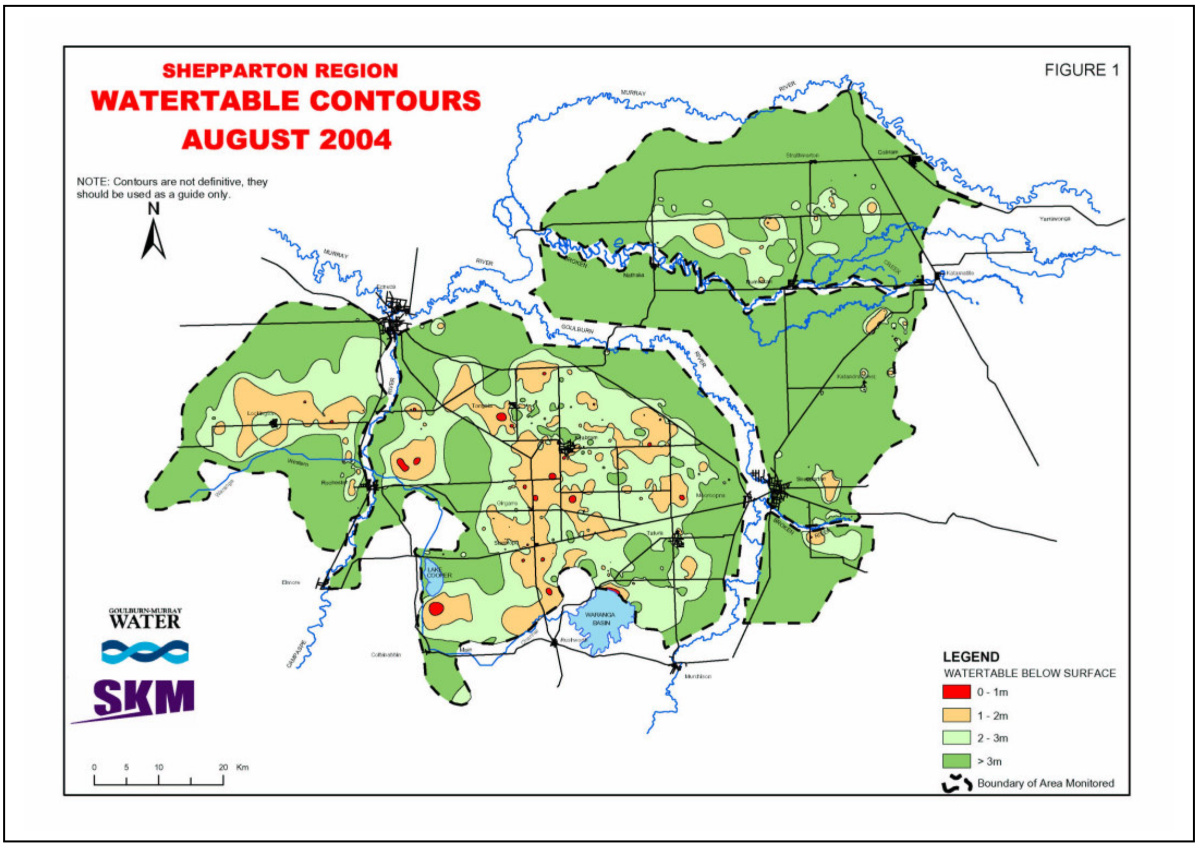

Figure 6. An example of the SIR Watertable Maps 2004. (SKM 2005)

6.2.6.4 1996 Benchmarks

The '1996 Watertable Map of the Shepparton Irrigation Region' used in this study / report is the 'benchmark' water-table level recognised as the average water-table level across the SIR (SIRIC 2005). This 'benchmark' map is reviewed and endorsed annually by the Shepparton Irrigation Region Implementation Committee to ensure the most appropriate representative single watertable map is used instead of the cumbersome manipulation of several maps over several years.

Should a more recent map be deemed a better representation of the watertable, its 'benchmark' status would require SIRIC approval. Goulburn Murray Water adopt this benchmark endorsement for the prioritisation of their works program (pers comm. T Hunter 2005).

With consideration of this SIRIC endorsement, the influence the past 8 – 10 years of dry or drought has had on water-table and in-turn regional bore readings leading to bias in the readings, it was decided to use this SIRIC 'benchmark 1996 watertable' as the basis for bore and EC readings. This decision was supported by the Sub Surface Drainage Program (pers comm. T Hunter 2005). The 1996-year still involved the analysis of approximately 4500 readings.

These readings were condensed to a 'high' watertable level, a 'low' watertable level and an 'average' for the year. It was considered that a median was not necessary. Even though the high water table level is the level regarded as having the greatest threat to the feature under assessment, a low water table level was considered valuable as an indicator of stability in water table at least in the benchmark year. Considerable variations between the low and high watertable levels within 1996 were not experienced suggesting most water tables were relatively stable during this time.

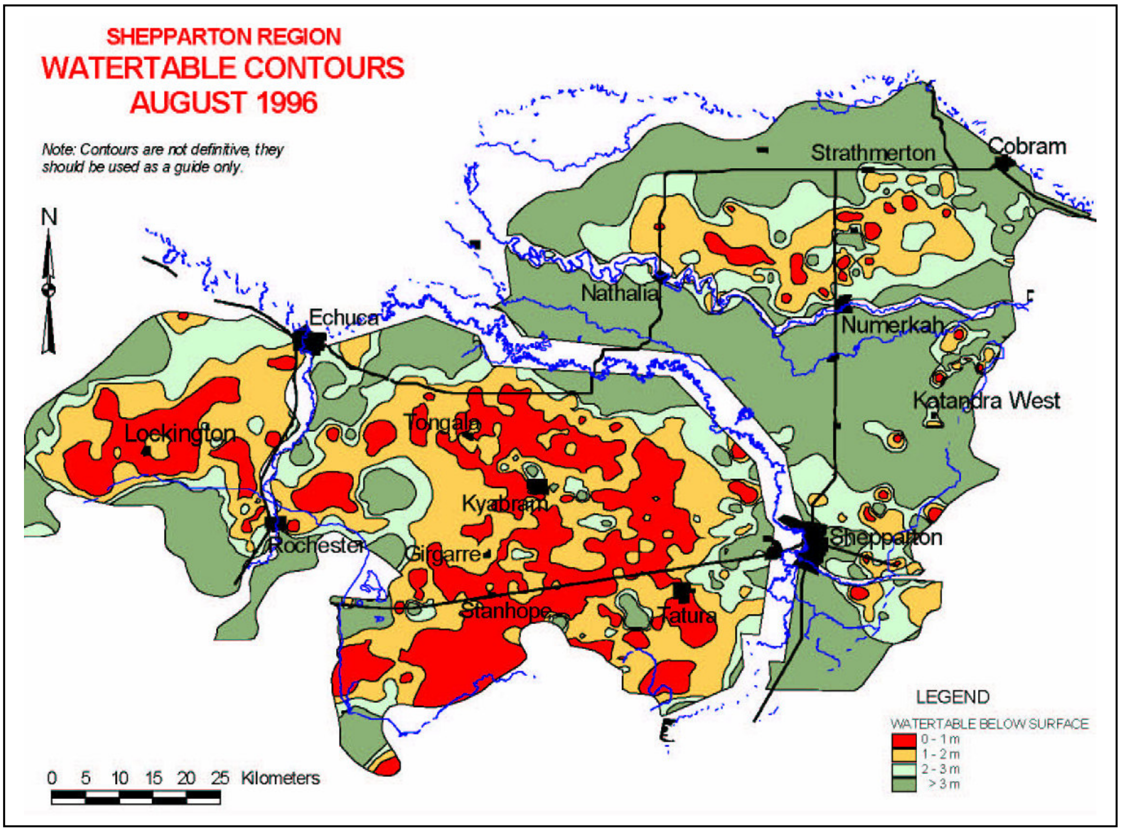

Figure 7. Shepparton Irrigation Region - 1996 'Benchmark' Watertable Map (SKM 1996)

6.2.6.5 Electrical Conductivity - EC

The aforementioned bore databases also listed EC readings for each bore. The readings correlate with water table levels and are listed in Table 6 as Appendix 7. These readings and levels contribute to the 'Salinity Threat Score' as depicted in the Salinity Threat Matrix (Table 8).

6.3 Ecological Risk Assessment

Ecological Risk Assessment (ERA) is the process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stresses (US EPA 1998). The process is used to systematically evaluate and organise data, information, assumptions and uncertainties in order to help understand and predict the relationships between stresses and ecological effect in a way that is useful for environmental decision making. ERA can be used to predict the likelihood of future adverse effects (prospective) or evaluate the likelihood that effects are caused by past exposure to stresses (retrospective) (US EPA 1998)

ERA considers the range of potential consequences and how likely those consequences are to occur. Consequence and likelihood are combined to produce an estimated level of risk associated with the particular hazardous event in question (*Guidelines for Ecological Risk Assessment* –US EPA 1998).

In this study application the-

-**likelihood** is associated with the threat from salinisation. That is how likely is the threat of damage from the watertable and EC on the respective asset (Woodland – Wetland etc).

THREAT is the **LIKELIHOOD** of an action.

-consequence is associated with the condition or quality the asset is left in as a result of, or as a consequence of the impeding threat.

CONSEQUENCE is the result of the action on the QUALITY of the asset.

Example. A water table rises from 3.24 metres below natural surface to 2.67 metres below natural surface with an EC of 6780 us/cm during an exceptionally wet winter at a site with high environmental values. The same watertable threat exists at a site with a low environmental value, THEN, the consequence of the action (threat from the rising water table) is greater (more damaging) at the site with the high environmental value over the site with the low environmental value.

Likelihood is applied to the Salinity (Woodlands, Wetlands, Grasslands and Riparian) Matrices through the calculation of Water-table depth and EC. The resulting score is the 'Salinity Threat' imposed on each site. **Consequence** is applied to the Risk Matrix through the calculation of Salinity Threat and the Habitat Quality Score to derive a Site Risk Score. The resulting score is the 'Risk' each site is subject to. The risk then converts to a 'Priority' directly related to the quality of the site and the threat from salination.

6.4 Species Salt Tolerance Levels

The ranges of EC in axis Y in the following matrix is an average of salt tolerances of vegetation found in the strata of the respective environment. For example a woodland environment will have an overstorey strata of Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), River Red Gum (*E. camaldulensis*) or Black Box (*E. largiflorens*) or a mix thereof depending on the Ecological Vegetation Class applicable. The understorey may consist of species such as Silver Wattle (*Acacia dealbata*), Gold Dust Wattle (*A. acinacea*) Golden Wattle (*A. pycnantha*) Drooping Cassinia (*Cassinia arcuata*) and Tangled Lignum (*Muehlenbeckia florulenta).* Indigenous ground covers are usually a mix of at least *Danthoina, Juncus, Poa, Aptriplex, Carex* and *Themeda.* All of these species and others present across the study sites have different root depths and salt tolerances. With indigenous vegetation structure containing several species at usually three strata it was virtually impossible to structure a matrix table to cater for each species, therefore 'as best as possible' average ranges were struck that would reflect species and species structure tolerance bands. The same approach was taken for wetland, riparian and grassland environments.

Land and Water Australia has a database prepared by Paul Bailey, Paul Bon and Kay Morris in 2002 (Monash University and Victorian university of Technology) titled 'The Australian Biodiversity Salt Sensitivity Database' containing information on the sensitivity and tolerance of over 1200 species of Australian taxa to salt. This database was analyised and data for site specific dominant species was selected and is contained in Table 7. This is not an exhaustive list rather a collation of mostly indigenous species present on the database. Naturally not all indigenous species at all 106 sites were present on the data base therefore a best possible list is included herein.

Table 7. Salt Tolerances for selected site specific species found in the strata of the study sites.(Land and Water Australia – Bailey, Boon & Morris 2002 and DCNR 1995)

Common Name	Scientific Name	Salt Tolerance
Yellow Box	*Eucalyptus melliodora*	Germination at 6000
Grey Box	*Eucalyptus microcarpa*	Germination at 6000 LD50 11690
River Red Gum	*Eucalyptus camaldulensis*	LD 50 23380 Germination at 6000
Black Box	*Eucalyptus largiflorens*	Germination at 6000 LD50 22211 (230 – 2500)
Lightwood	*Acacia implexa*	Low
White Cypress Pine	*Callitris glaucophylla*	Moderate
Hedge Wattle	*Acacia paradoxa*	Moderate
Drooping Sheoak	*Allocasuarina verticillata*	4384 growth reduced Germination at 1169
Drumsticks	*Pycnosorus globosus*	3500 – 5800
Water Buttons	*Cotula coronopifolia*	1400 – 3500
Ruby Saltbush	*Enchylaena tomentosa*	1400 – 3500
Creeping Saltbush	*Atriplex semibaccata*	600 - 1400
Tangled Lignum	*Muehlenbeckia florulenta*	450 - 4400
Black Sheoak	*Allocasuarina littoralis*	Germination at 2922
Drooping Cassinia	*Cassinia arcuata*	Up to 3800
Common Tussock Grass	*Poa labillardieri*	870 – 3460
River Sheoak	*Casuarina cunninghamiana*	4384 – 8767
Yellow Gum	*Eucalyptus leucoxylon*	Germination at 6000
Sugar Gum	*Eucalyptus cladocaylx*	LD50 at 12274
White Box	*Eucalyptus albens*	LD50 at 10813
Common Spike Rush	*Eleocharis acuta*	7000 some mortality
Duckweed	*Lemna minor*	10000 biomass reduced
Common Reed	*Phragmites australis*	280 – 2200 dieback at 12000
Toad Rush	*Juncus bufonius*	600 – 3500
Windmill Grass	*Chloris truncata*	600 – 3500

Notations:

870 – 4360	Range of Tolerances
Germination at 6000	Tolerated germination at this salinity level.
LD50 at 12274	50% death at this salinity level

Methodology

Matrix Tables

The matrix tables in this section have been derived from a series of papers and references but have been modified to suit the parameters of this study (Burgman *et al* 1993, Calow P 1998, Cura J.J 1998).

Several project specific requirements were taken into consideration during the construction of these matrix tables.

These included-

- Depth of water-table increments applicable to the SIR (X axis)
- Types of Vegetation and Vegetation Communities (BVT and EVC) within the SIR (Y axis)
- Variations in Vegetation Types from Site to Site (Y axis)
- Salt sensitivity and tolerance of species present at study sites (Y axis)

Site Specific Salinity Threat Scores

The matrix tables in this section allow the calculation of a site specific 'Salinity Threat' for each of the Woodland, Wetland, Riparian and Grassland sites. Each site where available has a watertable level reading/s and an EC reading/s (Tables 5 and 6 Appendix 6 and 7) and it is these readings that have been worked through the respective matrix table to derive a 'Site Specific Salinity Threat' score. These 'Salinity Threat' scores contribute to the further and final calculation outlined in Section Stage 2 Task 4.3, explaining the 'Site Risk Matrix'.

Table 8. Salinity Threat (Likelihood) Matrix (Woodlands)

Site Salinity (EC) (Y)		Site Watertable depth (metres) >3m = 1	2-3m = 2	1-2m = 3	0-1m = 4
= 4 6000 +	Higher Salinity	4	8	12	16
= 3 4000 – 6000		3	6	9	12
= 2 2000 – 4000		2	4	6	8
= 1 0 – 2000	Less Saline	1	2	3	4

Formula:

Salinity Threat = (Y axis) Salinity (EC) value x (X axis) Watertable depth value

Table 9. Salinity Threat (Likelihood) Matrix (Riparian)

Site Salinity (EC) (Y)		Site Watertable depth (metres): >3m = 1	2-3m = 2	1-2m = 3	0-1m = 4
= 4 6000 +	Higher Salinity	4	8	12	16
= 3 4000 – 6000	↑	3	6	9	12
= 2 2000 – 4000	↑	2	4	6	8
= 1 0 – 2000	Less Saline	1	2	3	4

Formula:

Salinity Threat = (Y axis) Salinity (EC) value x (X axis) Watertable depth value

Table 10. Salinity Threat (Likelihood) Matrix (Grasslands)

Site Salinity (EC) (Y)		Site Watertable depth (metres) >3m = 1	2-3m = 2	1-2m = 3	0-1m = 4
= 4 5000 +	Higher Salinity	4	8	12	16
= 3 3000 – 5000		3	6	9	12
= 2 2000 – 3000		2	4	6	8
= 1 0 – 2000	Less Saline	1	2	3	4

Formula:

Threat = (Y axis) Salinity (EC) value x (X axis) Watertable depth value

Table 11. Salinity Threat (Likelihood) Matrix (Wetlands)

Site Salinity (EC) (Y)		Site Watertable depth (metres) >3m = 1	2-3m = 2	1-2m = 3	0-1m = 4
= 4 8000 +	Higher Salinity	4	8	12	16
= 3 4000 – 8000		3	6	9	12
= 2 2000 – 4000		2	4	6	8
= 1 0 – 2000	Less Saline	1	2	3	4

Formula:

Threat = (Y axis) Salinity (EC) value x (X axis) Watertable depth value

6.6 Categorisation of Salinity Threat Scores (Stage 2 Task 4.2)

The Site Salinity Threat scores (Table 13) derived from these Woodland, Wetland, Riparian and Grassland matrices can now be used in the Site Risk Matrix (Table 14) to derive a Site Risk. Definitions of these Salinity Threat scores / levels are explained in Table 12.

This table explains the definitions for the various threat ranking by uniform colour.

Table 12. Definition Table for Salinity Threat (Likelihood) categories.

Very High Threat	12 to 16	**Very High Threat -** Sites falling into this category experience a high watertable (0 – 2 metres from surface) and an EC level that is deemed to be threatening the root zone and / or a level intolerable to the species present.
High Threat	8 to 11	**High Threat -** Sites falling into this category experience a lesser but potentially invasive watertable (0 – 3 metres from surface) combined with an EC range that is also potentially threatening the root zone and / or a level intolerable to the species present. There is potential for damaging consequences if either / both threat components were to rise.
Moderate Threat	4 to 7	**Moderate Threat -** Sites falling into this category experience a lower however changes in the watertable could present some level of threat (> 3 metres from surface) combined with an EC range that is also potentially threatening the root zone and / or a level intolerable to the species present. There is lesser potential for damaging consequences however if either / both threat components were to rise site in this category could experience a higher salinity threat.
Lower Threat	1 to 3	**Lower Threat -** Sites falling into this category are at nominal threat from the effects of salinity considering the low to very low watertable against either a low EC or an EC that is high but the watertable is very low and possibly confined.

Table 13. Salinity Threat scores for each site according to bore data obtained (SKM 2005)

Site no	Site Name	Salinity	Site no	Site Name	Salinity
118	Arcadia Bushland Reserve	No EC	10	Mason Road Bushland Reserve	No EC
42	Ardmona Recreation Reserve	3	31	McClellands Road Reserve	4
54	Black Swamp	No EC	115	McCracken Remnant TFN	4
16	Barmah Racecourse Reserve	1	105	McDonald Remnant TFN	8
20	Baxters Pit	4	49	McManus Road Reserve	4
53	Purdies Swamp	No EC	38	Merrigum Recreation Reserve	9
39	Brays Wetland	12	25	Minchins Road Bushland Res	4
119	Bunbartha Pony Club Reserve	4	79	Muckatah Recreation Reserve	6
12	Cantwells Bushland Reserve	8	28	Munroes Swamp	No WT
12	Cantwells Grassland	8	28	Munroes woodland	No WT
80	Chapel - Parnell Road Remnant	3	3	Nanneella Bushland Reserve	3
78	Cobram Racecourse Reserve	2	94	Naring Grassland TFN	8
58	Congupna Bushland Reserve	4	94	Naring Grassland TFN woodland	8
35	Coomboona River Reserve	4	29	Nathalia South Bushland Reserve	12
109	Crawford Remnant TFN	8	62	Nathalia north Bushland Reserve	12
99	Creighton Reserve TFN	No EC	30	Nathalia South East BLR	12
41	Cussen Park reserve	12	1	Night Cart Hill	8
41	Cussen Park wetland	12	69	Numurkah Rifle Range	6
47	Daunts Bend River Reserve	16	33	O'Brien Road Reserve	4
83	Dip Bridge Road Reserve	3	74	Old Coach Road Remnant	1
22	Dohnts Murray Pine	4	75	Old Coach Road Reserve	1
116	Dowdles Swamp	No Data	7	One Tree Swamp	12
71	Drovers Rest Reserve	12	7	One Tree Swamp grassland	12
55	Drumanure Uniting Church Res	4	24	Picola Recreation Reserve	No WT
2	Echuca Racecourse	4	111	Powles Remnant TFN	1
120	Farrell Road Bushland Reserve	1	50	Punt Road River Reserve	4
46	Ferguson Road Wetland	9	106	Ramadan Remnant TFN	6
8	Gaynors Swamp	16	43	Reedy Swamp	3
8	Gaynors Swamp Grass	16	43	Reedy Swamp woodlands	3
44	Gemmills Swamp	12	51	Reilly's Pit	4
44	Gemmill Swamp Woodland	12	117	River Road Reserve	6
81	Greys Bushland Reserve	3	98	Robinson Remnant TFN	3
26	H 16 Tucketts Road Reserve	4	34	Ross Road Wetland	4
95	Harris Reserve TFN	4	45	Rumbalara Common	9
59	Inglis Bushland Reserve	4	9	Rushworth - Tatura Common	8
56	Invergordon Reserve	1	15	Sand Ridge Track Reserve	1
18	James Bridge Roadside	4	13	Serpentine Road Reserve	No WT
14	Kanyapella Scott track	4	96	Stevenson Reserve TFN	4
14	Kanyapella Warrigal creek	4	73	Strathmerton Recreation Reserve	No EC
14	Kanyapella Mitchell track	4	40	Tatura - Undera Road Remnant	8
14	Kanyapela Levee track	4	57	Thompsons Road Reserve	12
14	Kanyapela Tehan road	4	6	Two Tree Swamp	No WT
84	Katamatite Reserve	12	6	Two Tree Swamp grassland	No WT
72	Katunga Recreation Reserve	12	36	Undera Recreation Reserve	8
65	Kempsters Bridge Reserve	12	66	Waaia Recreation Reserve	16
70	Kinnairds Wetland	6	5	Wallenjoe Swamp	No WT
77	Koonoomoo Recreation Res	1	67	Walsh's Bridge Lignum	4
37	Lancaster Recreation Reserve	8	11	Wharparilla Recreation Res	No WT
82	Larissa Road Reserve	4	112	Winterton Remnant TFN	1
19	Lignum Swamp james bridge	4	17	Wrights Bridge Reserve	4
21	Lindsays Road Reserve	4	52	Wunghnu Bushland Reserve	No Data
32	Loch Garry	6	27	Wyuna River Reserve	6
23	Luckes Weir	8	63	Yalca Church Reserve	6
68	Lyons Road Reserve	2	60	Yalca Reserve	12
4	Mansfield Swamp	No WT	64	Yalca South Bushland Reserve	16
4	Mansfield Swamp Grassland	No WT	76	Yarroweyah Recreation Reserve	2
48	Maritz Bend River Reserve	No EC	61	Yielma Bushland Reserve	16

6.7 Segregation of High Value Environmental Sites (Stage 2 - Task 4.3)

Task Objective

Segregation of all high value environmental features affected or which may be affected by ground water in the future and note their location.

(a) Identification of all 'high value' environmental features affected by high ground-water levels and salinity has been separated from other sites, as these are the features we are concerned with.

(b) The address, geographical distribution and geographic coordinates for each are listed on the respective site assessment / data sheet.

b) Other information relating to these high value sites were collated for the purpose of mapping in latter tasks and detailed on the assessment / data sheets include;

- spatial aspects of the feature: size,
- Ecological Vegetation Classes/types;
- Soil Types

Task Methodology

The previous calculation of a Salinity Threat Score lends itself to the final calculation 'Site Risk Score' to then establish a Site Priority according to salinity threat and site quality. The Site Risk Score is the combined calculation of the Salinity Threat Score and the Habitat Quality/ Value Score to derive a numerical ranking from-

- **Very High Risk**- The site is under the greatest risk from salinity and has considerable habitat value
- **High Risk-** The site is subject a threatening risk of salinity and has a reasonable habitat value.
- **Moderate Risk**- The site is currently safe from the threat of salinity and has average habitat value
  - **BUT**

  Can have a combination of high threat and a lower habitat quality or a lower threat and a higher habitat quality.
- **Low Risk**- The site is not under threat from salinity but can have nominal through to high habitat value as the salinity threat is not present.

The Site Risk Scoring Matrix (Table 14) below allows the calculation of the 'Site Risk Score" that then converts to a Site Priority for Ground water Protection Score.

Table 14. Site Risk Scoring Matrix (Risk Establishment)

SITE Number / Name		Site Quality Values (Consequence) (X)			
		1 - 5 **Low** **1**	**6 - 9** Medium **2**	**10 - 13** High **3**	**13 -20** Very High **4**
Salinity Threat (Likelihood) (Y)		Lower Site Quality Value	→	→	Higher Site Quality Value
Score of 12 to 16 4	Higher Salinity Risk ↑	High Sal Risk @ Low Quality Site =Moderate Priority 4	8	12	High Sal Threat @ VHigh Quality Site = V High Priority 16
Score of 8 to 11 **3**		3	6	9	12
Score of 4 to 7 **2**		2	4	6	8
Score of 1 to 3 **1**	Lower Salinity Risk	Low Sal Risk @ Low Quality Site = Lowest Priority 1	2	3	Low Sal Risk @ V High Quality Site = Moderate Low Priority 4

Formula:

HVEF Priority Risk = Threat (Likelihood) (**Y axis**) x Site Value (Consequences) (**X axis**)

6.8 Prioritisation for Protection (Stage 2 -Task 5.1 & Task 5.2)

Task Objective

Priority Criteria for protection from ground water.

Develop a set of criteria determining the priority for protection.

a) A set of criteria based on specific factors that describe the need for protection (these factors may include the rate of deterioration, endangered species, ecological significance, rate of succession, severity of impact etc) were considered and in part are reflected in the Habitat Quality Assessment.

NOTE: The priority for protection essentially is a function of the combined significance and relative threats imposed by rising ground water and also the identification and prediction of the likely extent and degree of degradation that will occur under the "no intervention scenario" (if there was no ground water relief).

b) The criteria has been can be designed into a matrix scoring system (similar to previous).

c) Recognise at least three classes for the prioritisation for the protection process. For example;

'Immediate Protection' 'Gradual Protection' 'Protection Pending'

Implement the criteria and prioritise the high value environmental features for protection.

A. A final re-assessment on high and very high value sites was undertaken to ensure robustness of process and to eliminate bias towards any particular site or sites. Further research material was used where necessary to confirm or adjust.

B. Sites were categorised based on how each feature complied with the criteria and the score achieved.

Task Methodology

From the Site Risk Score a Site Priority for Ground water Protection Score is possible. It is reasonable to expect that if a site is subject to very high threat from salinity and has a very high habitat value it should as a consequence have a very high priority for ground-water protection. Table 15 below shows the relationship between Site Risk and Site Prioritization for Ground water Protection.

Table 15. Site Risk Levels and scores comparative to the Final Priority for Ground water Protection ranking's including appropriate definitions.

Very High Risk	12 - 16	**Very High Priority** – Immediate Action required. Environmental Feature retains a very high ecological, social and economic value and is largely at considerable risk from the effects of salinity.
High Risk	8 - 11	**High Priority -** Regular monitoring required. Environmental Feature retains either a high ecological, social and economic value and is at real risk from the effects of salinity should conditions change, especially watertable height.
Medium Risk	4 – 7	**Medium Priority** – Close monitoring needed. Environmental Feature retains either a medium- high ecological, social and economic value and is potentially at risk from the effects of salinity.
Lower Risk	1 - 3	**Lower Priority** – Risks are broadly acceptable. Environmental Feature retains a low to very high ecological, social and economic value and is unlikely to be at risk from the effects of salinity at this time as the salinity risk is not present. (A very low watertable)

Table 16. Site Priority Rankings and Scores derived from the Site Risk Matrix Table.

site no	Site Name	Priority Ranking	Priority Level	Site no	Site Name	Priority Ranking	Priority Level
118	Arcadia Bushland Reserve	No EC		10	Mason Road Bushland Reserve No EC		
42	Ardmona Recreation Reserve	1	low	31	McClellands Road Reserve	6	Medium
54	Black Swamp	No EC		115	McCracken Remnant TFN	6	Medium
16	Barmah Racecourse Reserve	1	Low	105	McDonald Remnant TFN	9	High
20	Baxters Pit	4	medium	49	McManus Road Reserve	4	Medium
53	Purdies Swamp	No EC		38	Merrigum Recreation Reserve	6	Medium
39	Brays Wetland	8	high	25	Minchins Road Bushland Res	6	Medium
119	Bunbartha Pony Club Reserve	6	medium	79	Muckatah Recreation Reserve	2	Low
12	Cantwells Bushland Reserve	12	very high	28	Munroes Swamp	No WT	
12	Cantwells Grassland	6	medium	28	Munroes woodland	No WT	
80	Chapel - Parnell Road Remnant	1	low	3	Nanneella Bushland Reserve	2	Low
78	Cobram Racecourse Reserve	1	low	94	Naring Grassland TFN	6	Medium
58	Congupna Bushland Reserve	8	high	94	Naring Grassland TFN wood	6	Medium
35	Coomboona River Reserve	6	medium	29	Nathalia South Bushland Res	12	High
109	Crawford Remnant TFN	9	high	62	Nathalia north Bushland Res	12	very high
99	Creighton Reserve TFN	No EC		30	Nathalia South East BLR	12	High
41	Cussen Park reserve	4	medium	1	Night Cart Hill	6	Medium
41	Cussen Park wetland	12	very high	69	Numurkah Rifle Range	8	High
47	Daunts Bend River Reserve	16	very high	33	O'Brien Road Reserve	4	Medium
83	Dip Bridge Road Reserve	3	low	74	Old Coach Road Remnant	2	Low
22	Dohnts Murray Pine	4	Medium	75	Old Coach Road Reserve	2	Low
116	Dowdles Swamp	No Data		7	One Tree Swamp	8	Medium
71	Drovers Rest Reserve	4	medium	7	One Tree Swamp grassland	8	Medium
55	Drumanure Uniting Church Res	8	High	24	Picola Recreation Reserve	No WT	
2	Echuca Racecourse	2	Low	111	Powles Remnant TFN	3	Low

site no	Site Name	Priority Ranking	Priority Level	Site no	Site Name	Priority Ranking	Priority Level
120	Farrell Road Bushland Reserve	4	Medium	50	Punt Road River Reserve	8	High
46	Ferguson Road Wetland	12	very high	106	Ramadan Remnant TFN	6	Medium
8	Gaynors Swamp	16	very high	43	Reedy Swamp	4	medium
8	Gaynors Swamp Grass	8	High	43	reedy Swamp woodlands	4	medium
44	Gemmills Swamp	16	very high	51	Reilly's Pit	4	Medium
44	Gemmill Swamp Woodland	12	very high	117	River Road Reserve	6	Medium
81	Greys Bushland Reserve	3	Low	98	Robinson Remnant TFN	2	Low
26	H 16 Tucketts Road Reserve	6	Medium	34	Ross Road Wetland	4	Medium
95	Harris Reserve TFN	8	High	45	Rumbalara Common	12	very high
59	Inglis Bushland Reserve	8	High	9	Rushworth - Tatura Common	12	High
56	Invergordon Reserve	1	Low	15	Sand Ridge Track Reserve	4	Medium
18	James Bridge Roadside	6	Medium	13	Serpentine Road Reserve	No WT	
14	Kanyapella Scott track	8	High	96	Stevenson Reserve TFN	8	Medium
14	Kanyapella Warrigal creek	6	Medium	73	Strathmerton Recreation Reserve No EC		
14	Kanyapella Mitchell track	8	High	40	Tatura - Undera Road Remnant	3	Low
14	Kanyapela Levee track	8	High	57	Thompsons Road Reserve	4	Medium
14	Kanyapela Tehan road	8	High	6	Two Tree Swamp	No WT	
84	Katamatite Reserve	16	Very high	6	Two Tree Swamp grassland	No WT	
72	Katunga Recreation Reserve	4	Medium	36	Undera Recreation Reserve	3	Low
65	Kempsters Bridge Reserve	16	very high	66	Waaia Recreation Reserve	4	Medium
70	Kinnairds Wetland	6	Medium	5	Wallenjoe Swamp	No WT	
77	Koonoomoo Recreation Res	1	Low	67	Walsh's Bridge Lignum	6	Medium
37	Lancaster Recreation Reserve	8	High	11	Wharparilla Recreation Res	No WT	
82	Larissa Road Reserve	4	Medium	112	Winterton Remnant TFN	3	low
19	Lignum Swamp james bridge	4	Medium	17	Wrights Bridge Reserve	4	Medium
21	Lindsays Road Reserve	8	High	52	Wunghnu Bushland Reserve	No Data	

site no	Site Name	Priority Ranking	Priority Level	Site no	Site Name	Priority Ranking	Priority Level
32	Loch Garry	6	Medium	27	Wyuna River Reserve	8	high
23	Luckes Weir	12	High	63	Yalca Church Reserve	4	medium
68	Lyons Road Reserve	3	Low	60	Yalca Reserve	8	high
4	Mansfield Swamp	No WT		64	Yalca South Bushland Reserve	8	high
4	Mansfield Swamp Grassland	No WT		76	Yarroweyah Recreation Reserve	1	low
48	Maritz Bend River Reserve	No EC		61	Yielma Bushland Reserve	12	very high

7 SOCIAL VALUES

The social value of any environment is difficult to accurately document let alone the social value of small isolated largely modified bushland reserves dotted among a farm dominated landscape. Nevertheless consideration should be afforded to the social values placed on these reserves and to some extent this has been achieved during extensive individual habitat site assessment and inspection. To qualify the methods used to assess the social value (from an environmental perspective) of sites, this section outlines several aspects regarding 'site social value'.

Firstly it is important to note the following extract from the National Framework for the Management and Monitoring of Australia's native Vegetation (ANZECC 1999).

"The benefits of improved approaches to native vegetation management and monitoring are not only environmental. Important social and economic benefits are also derived from sustainable native vegetation management"

According to the ANZECC 1999 Report the Social benefits of indigenous / remnant sites include-

1. Providing places of scenic beauty

Clearly not all sites within this study could be deemed as providing scenic beauty, however, several sites still possess a considerable degree of 'naturalness' despite their isolation within a vastly modified surrounding landscape. Two example of this are the Mason Road Bushland Reserve north of the Waranga Basin and the Drumanure Uniting Church riparian strip on the Nine Mile Creek, Drumanure.

Figure 8. Mason Road Bushland Reserve - Waranga Basin (Photo Mcleod 2005)

Figure 9. Drumanure Uniting Church Site. Nine Mile Creek - Drumanure

(Photo Mcleod 2005)

2. Providing sites for tourism and recreation

The Kinnairds Wetland immediately east of Numurkah was once titled a swamp receiving only local recognition and was heavily grazed by dairy cattle (pers comm. A Canobie 2005). However, with an appropriate wetting regime, extensive planting and infrastructure works, a Management Plan, a Committee of Management and considerable public awareness this swamp has become a frequently visited regionally recognised wetland complex. (DPI 2004b)

Figure 10. Kinnairds Wetland from the air, showing its extent and relationship to the surrounding landscape. (Photo. Kinnairds Wetland Management Plan 2001)

3. Providing places for research, education and scientific purposes

Many sites across the Shepparton Irrigation Area are monitored with research undertaken for a vast range of reasons. Bray's Wetland, a privately owned wetland depression near Merrigum is subject to regular bird, vegetation and water quality monitoring and research primarily to gauge ecological recovery of a once highly modified depression post appropriate wetting regimes. (pers comm. K Stanislawski 2005) Research and monitoring of this nature will provide guidance for the recovery of other wetland environments in northern Victoria for environmental, economic and social benefit.

Figure 11. Brays Wetland on the way to recovery through appropriate wetting Regimes and research / monitoring (Photo - O'Connor 2003).

4. Maintaining the distinctive Australian landscape

As a result of intense agricultural development within the SIR very few large natural undisturbed remnant sites remain (DPI 2004a). Large wetland areas such as the “Ramsar” recognised Barmah Forest (which is not included in this study) clearly stands as an example of a ‘distinctive Australian Landscape’. The Kanyapella Basin, a Red Gum dominated natural depression east of Echuca is distinctive of northern Victorian Red Gum forest depressions associated with the Murray River. These forest / woodland environments provide social values as ‘typical Australian Landscapes’ despite obvious evidence of past timber harvesting and grazing.

Figure 12. Kanyapella Basin Warrigal Creek Red Gum forest; a typical Northern Victoria forest landscape (Photo McLeod 2005).

7.1 Social Value Assessment.

With the exception of a few well known and frequently visited sites such as Cussen Park in Tatura and Kinnairds Wetland east of Numurkah, the social benefits of the majority of the sites contained in this report are very hard to predict or even estimate. The vast majority of other smaller terrestrial sites and to some extent larger wetlands such as Mansfield Swamp west of Stanhope and Reedy Swamp north of Shepparton only experience random and or seasonal visitation. Thus depending on activities such as duck shooting, organised fox drives or sporadic fishing, camping and sight seeing visitation. No **official** social assessment was undertaken to estimate such visitation, nor was the social importance or significance of these reserves / remnants. However, included in the habitat quality assessment component of the study was a ‘prediction’ of the visitation and or management attention each site may have experienced or current experiences. A number of observations were undertaken during the habitat assessment to assist in this prediction.

7.1.1 Site Visitation

Frequent visitation of a site is obvious even with good intention not to disturb the area. Frequent visitation is evident by the daily use of vehicle tracks; a regular supply of fresh rubbish; new vehicle tracks across grass; removal of timber; fresh camp fire sites; extraction of plants and harvesting of flowers; dumping of garden refuse; makeshift shooting ranges and tracks or roads cut up after heavy rain. All of these impacts were observed randomly across various sites during field assessments. Site proximity to townships or heavily populated areas can induce greater visitation. The Wunghnu Bushland Reserve east of Wunghnu is an example of where there is clear evidence of visitation to enjoy a natural indigenous environment.

Figure 13. Wunghnu Bushland Reserve. A frequently visited bushland reserve immediately east of Wunghnu. (Photo McCallum 2005)

7.1.2 Level of Management of Sites

Track maintenance, fence construction, presence and degree of revegetation, clean fire breaks, retention of fallen timber, stock exclusion and reasonable care of infrastructure are all signs of a 'level of management ' a site may be afforded. Some sites exhibited this 'level of management' whilst most sites did not enjoy the attention they would or may have in past decades.

Rutted and rough tracks, fallen fences, absence of fire breaks, nomadic stock on site and regular removal of fallen timber is indicative of a poorly maintained site in terms of the sites 'social value' of its environment.

7.1.3 Site Infrastructure

Cussen Park, immediately north west of Tatura has considerable social value for its infrastructure, wetlands and vegetated landscape. Though the Park is somewhat modified from its original natural environment and enjoys good awareness / placement, this Park attracts people on a social value perspective for its infrastructure as well as its environment. During a two-hour assessment period mid day some 9 people utilized the area for various reasons (pers comm. A Sislov 2005).

Figure 14. Cussen Park. A popular recreational facility on the fringe of Tatura. (Photo Stanislawski 2005).

7.1.4 Field and Game Association

The Field and Game Association of Victoria contribute to the care taking of several Reserves within the SIR in an effort to retain these sites in reasonable ecological condition for hunting an recreational purposes (Pers comm. K Stanislawski 2005). For example, the Shepparton Field and Game Association are actively involved in the management, works and protection of Reedy Swamp immediately north of Shepparton.

This Branch of the Association regards the Reedy Swamp complex as an important environmental and social asset to the Shepparton region and legally utilise the wetland during prescribed duck seasons (pers comm. K Stanislawski 2005). Evidence and extent of this social activity can only be really judged on duck opening weekend when sites such as Reedy Swamp are occupied by several shooters. The remaining duck season may see random shooter presence however visitation is not solely restricted to shooters. Sites such as these also support sporadic camping, fishing and sight seeing.

7.1.5 Ornithological Society

The Ornithological Society of Australia (Vic) frequent select sites across the SIR to monitor the continued presence and research the possible re-appearance of birds to these sites. (pers comm. F Copley 2005). Entries of sightings to the various fauna databases are indicative of the visitation and social value these sites hold at least from an avifauna perspective.

7.1.6 Age and extent of revegetation

The Congupna Bushland Reserve, Wyuna River Reserve and the Inglis Bushland Reserve support small patches of indigenous understorey revegetation whilst the Lancaster Recreation Reserve, Drovers Rest Bushland Reserve and Minchins Road Reserve boast quite extensive revegetation works. The extent and age of revegetation can indicate the environmental and social value the reserve has in the local community. The effort expended to improve the ecological integrity of the site can be indicative of the social value the local community has for the reserve.

Figure 15. Lancaster Recreation Reserve revegetation effort is indicative of the environmental and social value of the reserve held by the Lancaster community (Photo McLeod 2005).

7.1.7 Sporting Activities

Some sites, particularly small public recreation reserves support the remnants of a busy weekend of sport or the activities associated with a public hall or the like. Sites like the Lindsay Road Reserve south of Picola appears to still support some degree of weekend sporting activity and a reasonable degree of site management such as fire breaks, weed control and track maintenance. Other public land recreation reserves associated with various townships or districts such as the Undera Recreation Reserve, Cobram and Echuca Racecourse Reserves and the Muckatah Recreation Reserve / Pony Club enjoys greater levels of visitation and maintenance. However, the extent of use particularly in the past has lead to considerable landscape modification and a subsequent decline in natural features.

These highly modified reserves are clearly an important social resource in the community providing various activities outside the urban hub of Shepparton however the social value of these sites largely rests in the activity the sites provide and generally not the ecological value of the site.

The mowing of indigenous grasses and eucalypt regeneration for car parking, the clearing of indigenous saplings for road widening and the construction of new horse yards immediately around Grey Box remnants are all indicative of the nominal social value placed on environmental features in some of these study sites.

7.2 Social Value Summary of Sites

It is, as previously mentioned, difficult to estimate the social value of these sites from an environmental perspective. Perhaps at best, the most accurate summation is that some sites are of considerable social value depending on their proximity to towns and communities, their current use despite its impact on the environment, faunal and floristic naturalness or their seasonal offerings. Other sites, all things considered seem of little social significance for their environmental values as again proximity, use and site composition may discourage any degree of site awareness and/or visitation.

8 ECONOMIC

The economic value of these 106 sites from an economic perspective is quite difficult to establish. For example: does the presence of a population of possums or gliders and the presence of a vulnerable Pea at one particular site make that site much more economically valuable than a site known to seasonally support various species of migratory ducks. The 'economic value' of these sites is much more complex than what species are present or aesthetic appeal a site may have in order to attract the spending public. Alternatively should the economic value of a site 'environmentally' be based on what product can be extracted or harvested from that site? **If** this is valid, then sites that suffer fire wood collection should then be deemed a higher economic value environmentally than sites that are sparse of collectible produce. Clearly this theory (purely from an environmental value perspective) is not viable.

Should the site be valued for its potential to support insectivorous birds in order to control fluxes in insect pests in adjoining pasture, orchard, vineyard or crop lands? Birds occupying this niche such as Ibis are usually transient following food supply across their feeding range. Gregarious fauna and their abundance is inherently linked to the niche capability of the site rather than the bust and boom nature of mono-cultural farm environments. It has been proven that the occupation of a vegetated site by insectivorous birds and mammals contributes to the reduction of insect pests within neighbouring farm environments.

Selling the site on the open market would provide an exceptionally accurate indication of site value, however the environmental value of the site could be jeopardised by subsequent development, harvesting, introduced planting or total clearing. Sites of this nature can and have been protected by covenants through the Trust For Nature Covenant Program.

Remnants and treed areas assist in controlling water tables by intercepting accessions to the water table. Water tables associated with vegetated areas adjoining farmland can experience lower levels of water table than open completely cleared sites. A well-recognised well-treed lucerne farm north of Tatura once had a water-table between one and two metres below natural surface. Since the establishment of lucerne and extensive treed areas the watertable is reported to be below four metres below natural surface, dry years considered. The difference may in most cases be marginal however such differences may be sufficient to allow sustainable farming practices to continue this in itself has an environmental economic value.

In summary it is credible that remnant and treed sites have economic value in the landscape for a host of reason though to what extent. To accurately quantify the economic value of these sites in an environmental perspective, detailed survey and assessment work would need to be undertaken. Such work is well beyond the scope of this study yet some consideration should be afforded to the 'environmental economic' value of a site considered for ground water protection.

9 LIMITATIONS

Several limitations were identified during site identification and mapping, fieldwork and subsequent report compilation of this study. Not all limitation effected the final recommendation however certain aspects of project progress require clarification.

1996 Watertable Benchmark

The SIR 1996 Benchmark water table was used as a Watertable standard for this study. Consideration was paid to include the last 15 years of data however this would have meant the inclusion of approximately 200,000 individual bore reading across a period containing 8 or 9 very dry years and one exceptionally (1: 100 year event) wet year. It was agreed that the inclusion of these years particularly the extended dry period 1997 to 2004 would skew data towards a generally drier overall outcome and a lower (deeper) water table than 'normal'.

Social and Economic Aspects of this Study

This study contains a reasonable account of the social and economic value of protecting environmental sites within the SIR. The discussion is not extensive however it does give a common sense approach to the social and economic value these sites have from an environmental perspective. No figures have been derived rather perceptions have been posed.

Bore Data availability

Sinclair Knight Merz – Tatura provided a comprehensive bore data set containing several hundred thousand individual readings across some 20 years. This data set was refined to include only the 1996 Benchmark watertable data. Even then some sites did not have bores close enough (within 3 kilometres) to allow an accurate reading of the water table at the respective site. Consequently some sites were unable to be assessed for Salinity Threat and subsequent Site Prioritisation. Bore distances from the respective sites are recorded in Tables 5 and 6.

Depth of Water table (Natural Terrestrial Surface to Bed of Wetland)

Watertable readings are taken as Depth Below Natural Surface (DBNS) however the effect of a watertable on a wetland would differ to that on a terrestrial site, accounting for the depth of the wetland. All wetland environments within this study are wadable, hence not more than 1200 - 1500 mm in depth.

Salt tolerances for all species identified recorded in sites.

Salt tolerances for **all** individual species found or recorded was not undertaken and after considerable researching found to be virtually impossible. Northern Victorian plains species by species salt tolerance research appears not to exist, however a data base from Land And Water Australia lists some terrestrial and wetland species applicable to this study. These are listed in the respective table within the report and it is from these species that the EC bands within the matrix tables were derived.

Access to more privately owned sites

Approximately 30 sites within this study are privately owned including Trust For Nature Sites. Access to more private sites was considered however the initial scope of the study from a site perspective was far less than the eventual 106 sites contained herein. It was considered that these 106 sites formed a comprehensive representation of environmental sites across the SIR, private included.

Access to Trust For Nature Sites

Access to all Trust For Nature Sites identified and mapped was not possible due to not all Covenantors responded to requests for access and subsequent assessment. These sites are included in the study as a site identified but no assessment was undertaken.

Seasonal timing of Surveys to coincide with flowering

The timing of Site Habitat assessments did not coincide with season flowering. Assessments were undertaken during winter months due to project time constraints. Species lists for sites were obtained where available (Management Plans) and considered in the Habitat Quality Assessment.

Wetlands survey inclusive of trees and canopy cover

The Habitat Quality Score Sheet No 21 (Wetlands) included the components Large Trees and Canopy Cover. It was found that the vast majority of wetlands in this study did not have trees and subsequent canopy covers. This immediately eliminated a possible three out of 20 marks when assessing wetlands. The assessment process abided by the inclusion of these components however some consideration should be paid when Wetland assessment scores are examined.

Habitat Survey

With several people undertaking site habitat quality surveys there may have been slight interpretation variances of perhaps 1 to 2 marks between assessors. However, as indicated in the report, training and double assessment of some sites indicate good uniformity in site assessment.

Matrix Tables (Electrical Conductivity Ranges (Bands)

EC ranges in matrix tables are in bands or ranges specific to each vegetation environment type (eg - wetland, riparian, woodland and grassland). Every attempt was made to have these ranges cover species tolerances however it was not feasible for the scope of this study to construct a matrix table for each species present. As a compromise salinity tolerance 'bands' were developed in an attempt to best cover these species depending on both their tolerances to salt and various depths to ground water.

Riparian Sites Identified

The inclusion of riparian sites was deemed necessary so as to cover all vegetation types within the region. It should however be acknowledged that these sites (even if subject to a shallow watertable and an upper range in EC) might not be as effected to such impacts compared to open plain sites subject to similar watertable impacts. This may be because of the proximity to the flushing effect of the river or creek. Several riparian site prioritised high or very high in this study due to shallow water tables and upper ranges in EC also have high Habitat Quality scores indicative of the environmental value of the site. It could be argued that as the site is in good health the watertable is currently having little effect on the site. Additionally the present health of the vegetation could be to some extent dependant on the water table and vegetation is coping with the current EC level. Changes may however have a different effect on the site quality in future years.

10 RECOMMENDATIONS

Table 16 lists the Site Priority Score and Ranking. Not all sites have scores/rankings due to the lack of bore data for those respective sites. The table is self-explanatory however selected sites require further clarification and /or further discussion. All 'Very High Priority Sites' are discussed whilst some 'High

Priority Sites' deserve discussion due to their site habitat value, salinity threat rating or location in the landscape or a combination thereof. Other sites listed are sites that do not have a Priority Ranking but as a result of their ecological value (habitat score) there is concern that these sites could have achieved a High or Very High Priority should bore data been available. It is also recommended that these sites be investigated for bore establishments preferably within the bounds of the reserve in order to consider the site for ground-water protection. Furthermore it is recommended that a trial site be selected from the following Very High Priority Site list for feasibility of a Public Salinity Control Pump. The following recommendations were endorsed at SIRIC 06-8 meeting (1st December 2006).

An endorsement by SIRIC of the High Value Environmental Features Report and its subsequent results will support an endorsement to proceed / enter into negotiation with the Sub Surface Drainage Program (Goulburn Murray Water) to-

-Establishment of a Trial Public Salinity Control Pump (PSCP) by -
1. Lobbying for the establishment of a Trial PSCP at a suitable Very High Priority Site with consideration of appropriate feasibility studies with consideration of capital establishment cost, cost share arrangements and ongoing management and maintenance.

-Extend Monitoring Bore Network by-
2. Lobbying for the establishment of investigation bores at sites listed 'deemed ecologically significant' that are distant to the existing bore network. Lobby to ensure these newly established bores are monitored to determine an appropriate Site Ranking Priority.

As a result of the assessment undertaken herein the following sites in order of priority are recommended for consideration for ground-water protection whilst taking into account the information contained in the respective Site Data Sheets and the Site specific summation below.

1. Cantwells Bushland Reserve - Echuca South (Site 12 -Very High Priority)

Water-table = 0.06

(EC) = 2100

Site Habitat Value = 14.5

Despite a relatively low EC, this site has in the past suffered exceptionally high water-tables. Sections of this woodland and grassland support endangered species / EVC. Cantwells Bushland Reserve also ranks high in priority for Management Plan development with the GBCMA, Parks Victoria and DPI. From an ecological perspective the recent removal of grazing from this site has seen considerable woodland regeneration in the northern section of the reserve, indicative of the potential this reserve may have (pers comm McCallum 2005). Furthermore grasslands within Northern Victoria are exceptionally rare. This reserve contains natural grasslands to the south.

2. Gaynors Swamp - Corop Wetland Complex - Stanhope (Site 8 -Very High Priority)

Water-table = 0.27

(EC) = 32000

Site Habitat Value = 14.5

Gaynors Wetland is part of the Corop lake's Wetland complex known for salination and shallow water tables as indicated. A large wetland in itself indicative of a moderately high habitat score, this site in conjunction with other wetlands in the area provides immense 'seasonal' habitat particularly for waterbirds. Other wetlands within this complex with equally high EC reading but lack water-table readings include Mansfield Swamp, Wallenjoe Swamp and Two Tree Swamps. These sites were unable to be assessed for priority due to the lack of water-table data available, however consideration for assessment / data collection should be pursued.

3. Yielma Bushland Reserve - Yielma (Site 61 - Very High Priority)

Water-table = 0.86

(EC) = 28880

Site Habitat Value = 13

A relatively small and isolated Bushland Reserve with a moderate habitat value however this site is subject to one of the shallowest water tables and a considerably high EC. Herbaceous species *of Atriplex, Chenopodium* and *Enchylaena* are indicative of salting soils. Overstorey Grey Box (*E. microcarpa*) show signs of salination with recent dry years possibly delaying the inevitable.

4. Daunts Bend Goulburn River - Toolamba (Site 47 -Very High Priority)

Water-table = 0.75

(EC) = 6780

Site Habitat Value = 17.5

A very good quality Riparian site close to the Goulburn River near Toolamba subject to a very shallow water-table and an upper EC range for a woodland environment. Considering its riparian nature and the extent and quality of vegetation present, the watertable may not be as threatening to this site as a site exposed to similar condition in a woodland plains environment.

5. Rumbalara Common - Mooroopna (Site 45 - Very High Priority)

Water-table = 1.8

(EC) = 5360

Site Habitat Value = 17

One of the highest habitat value sites in this study though subject to a encroaching watertable and a upper limit EC for a relatively heavily woody riparian site. This site, as with Daunts Bend and Kempsters Bridge sites are riparian sites of quite good habitat value. Again the riparian nature and the extent and quality of vegetation present at this site may render the watertable not to be as threatening as a site exposed to similar condition in a woodland plains environment.

6. Kempsters Bridge - Broken Creek - Nathalia (Site 65 - Very High Priority)

Water-table = 1.15

(EC) = 18200

Site Habitat Value = 15

A riparian site on the Broken Creek near Katamatite with a very high EC and a moderately shallow water table for riparian vegetation. This site presents in quite good ecological condition having very good landscape context. Similar to Daunts Bend consideration must be made as to the riparian nature and the extent and quality of vegetation present at this site hence the watertable may not be as threatening at this site compared to a site exposed to similar condition in a woodland plains environment.

7. Gemmills Swamp - Mooroopna (Site 44 - Very High Priority)

Water-table = 0.58

(EC) = 5190

Site Habitat Value = 13.5

Gemmills Swamp despite its proximity to Mooroopna provides considerable habitat for waterbirds and supports the Goulburn River – Reedy Lake complex. A very shallow watertable and a moderately high EC render this site a consideration for ground-water protection.

8. Ferguson Road Goulburn River - Mooroopna South (Site 46 - Very High Priority)

Water-table = 1.54

(EC) = 7750

Site Habitat Value = 14

A depression associated with the Goulburn River of moderate habitat value (itself) however this wetland contributes to the Goulburn River habitat corridor. A relatively shallow water table and moderately high EC for a wetland environment combined places this site in the lower end of the Very High Priority range. Considered a wetland in a riparian landscape this site could be considered similar to Daunts Bend and Kempsters Bridge.

9. Nathalia North/ South and South East Reserves - Nathalia (Site 29 / 30 / 62 -Very High Priority)

Water-table = 1.31

(EC) = 12600

Site Habitat Value = 10 / 10 / 11.5

Again small sites, immediately north and south of Nathalia between the Murray Valley Highway and the Broken Creek with a moderate Habitat Value however subject to very high EC and a shallow water table for a Grey Box (*E. microcarpa*) and Lignum (*Muelenbeckia*) woodland environment. Perhaps not the most valuable sites ranked in this Very High Priority ranking.

10. Brays Swamp – Merrigum (Site 39 - High Priority)

Water-table = 7660
(EC) = 0.68
Site Habitat Value = 5.5

Despite Brays Swamp having a low habitat value due to the lack of trees and currently a very weedy wetland this site has recovered exceptionally well since the return of an appropriate wetting regime. A low landscape context however a very important site in the Merrigum Stanhope area providing an important link in the wetland chain in the western half of the SIR.

11. Cussen Park Wetland - Tatura (Site 41 - Very High Priority)

Water-table = 1.58 m

(EC) = 8710

Site Habitat Value = 10.5

A small and isolated wetland associated with the Mosquito Depression that enjoys considerable visitation and support from Local Government. Cussen Park suffers frequent shallow water table and upper range EC for wetland environments. Perhaps at the lower end of the priority scale, however, consideration should be paid to the social value of this reserve, despite its modifications.

12. Other Sites of Lower Priority with Unique Features

A number of other sites with lesser priority ranking but with unique features may be due for consideration despite their lower habitat quality or salinity threat or both. These sites should also be considered for 'investigation' for ground water protection. Sites included in this category are-

1. Dohnts Road Murray Pine - Picola	Endangered EVC (Murray Pine Woodland)
2. Wunghnu Bushland Reserve - Wunghnu	Exceptional example of Plains Grassy Woodland
3. Drumanure Uniting Church Bushland	Very good example of Broken Creek Riparian Strip
4. Inglis Bushland Reserve	Very good example of mature Plains Woodland EVC.
5. Naring Grassland	Considered one of the best remaining indigenous grasslands in the SIR / Northern Victoria.

Table 16 lists all sites and their ranking. Those sites ranked 'high' may be due for protection in the near future. Such considerations should take into account factors such as size, proximity, habitat quality, EVC ranking and species composition to name a few. This study provides a ranking and supporting data to derive that ranking. Such ranking should contribute to the decision making process as more investigative work is possible when selecting sites for ground-water protection.

With all due consideration to the purpose of this study it is worth noting that site protection can be achieved through other practices and it is these practices that will equally contribute to the retention of good quality sites. Surface impacts or more importantly the removal or suppression of these surface impacts contribute to the environmental value of the site and value in establishing environmental ground-water pumps.

These surface impacts include

Weed Control - from an environmental perspective the presence of weeds and their subsequent abundance can in time render a site a weed monoculture particularly at the herbaceous layer.

Fencing - the up-keep and or replacement of boundary fences in particular restrict / inhibit random and indiscriminent grazing by domestic stock. Standard farm fences unfortunately do little to control native and introduced herbivores such as kangaroos and rabbits. Fencing should be a consideration in protecting sites with very good indigenous diversity.

Grazing control / management – selective seasonal grazing by domestic stock can provide advantages to bushland sites depending on the stock type, duration of grazing and time of grazing (seasons). Grazing management should be considered in conjunction with other Management Plan strategies. (Lindsay Road Reserve)

Selective revegetation – several sites within this study contained areas of revegetation of varying ages and size. Revegetation programs should be guided and coordinated correctly in both site preparation and indigenous species selection. (Inglis Bushland Reserve – Congupna Bushland Reserve)

Regeneration – the removal of as little as one inhibiting impact can allow areas to vigorously regenerate. The exclusion of areas through appropriate fencing and / or the removal of grazing pressure often induce clumps of regeneration particularly in overstorey species. (Bunbartha Pony Club). Exclusion should be considered to allow regeneration of a site over labour intensive and costly revegetation programs.

Public Awareness- the promotion of sites for their aesthetics, naturalness, species diversity or merely due to its proximity or location is generally an advantage to the site through active protection, funding, infrastructure and so on. This is providing the site is not exploited due to such awareness (Kinnairds Wetland). Appropriate public awareness should also be a consideration when protecting a site.

Signage – appropriate signage is directive and informative encouraging 'generally' correct and appropriate site. Awareness of species presence, restricted areas, historical and cultural values and the management of a site contribute to appropriate usage.

11 CONCLUSION

To conclude, this study and the subsequent report has been driven by three Primary Project Objectives derived through consultation with URS, Goulburn Murray Water, Hydro Environmental Pty Ltd and the Department of Primary Industries. These objective (listed below) have been adequately addressed providing a valuable site and water table / salination assessment of 106 sites across the SIR.

As a consequence of this study this report has-

1. *Determined the location of valuable environmental features in the SIR with the main focus on public features, that are either currently or potentially at risk of degradation as a result of high water tables.*

2. *Determined how ground-water is, or could be, affecting the health and well being of all features identified under Objective 1.*

3. *Placed an objective valuation on the environmental features that are or could be affected by high water tables in the SIR and have defined their significance and priority for protection*

The recommendations contained herein have been derived from an unbiased SIR wide site identification process supported by a well recognised and widely adopted 'site habitat quality assessment' process. Bore databases obtained provided thousand of readings giving further robustness to the assessment process allowing for 'as accurate as possible' site priorities to be struck thus ranking each site for consideration for ground-water protection. The real conclusion is contained in the recommendations herein and the vastness of information in the tables and data sheets in this report.

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