MANNUM
WATERS

MANNUM WATERS MARINA & RESIDENTIAL DEVELOPMENT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1 - EIS

Prepared for
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ENVIRONMENT IMPACT STATEMENT

Volume 1 - EIS

MANNUM WATERS

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The Mannum Waters EIS comprises three volumes:

Volume 1 – EIS

Volume 2 – Appendices

Executive Summary

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- Mannum Aboriginal Community Association Incorporated
- Mannum Golf Club
- SA Water
- ETSA Utilities

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1 Introduction

1.1 BACKGROUND

This Environmental Impact Statement (EIS) describes and assesses the Mannum Waters mixed marina, residential and commercial development as proposed by Tallwood Pty Ltd (Proponent). The EIS has been prepared to support a Development Application to Planning SA (Department for Primary Industries & Resources South Australia, PIRSA).

In March 2005, the Minister for Urban Development and Planning determined that the proposed development should be assessed under the Major Developments provisions of the *Development Act 1993* (Sections 46–48 of the Act). The level at which the proposal is to be assessed is that of an Environmental Impact Statement, the highest level of assessment under the Act.

Prior to preparation of the EIS, a number of reports were prepared by appropriate consultants to assist in the development of the proposal. They included a Preliminary Environmental Assessment prepared for Mid Murray Council, several Aboriginal heritage studies, a wetland management study and a preliminary geotechnical report which were submitted to Planning SA as part of the development application (refer Figure 1.1).

The Major Developments Panel (the Panel), through Planning SA, prepared and released an Issues Paper that briefly described the proposed development and called for comment from any person wishing to have input into the assessment process. Comments on the Issues Paper were collated by Planning SA and were used by the Panel as the basis for the Guidelines. The Guidelines (contained in Appendix A) set out a number of matters that need to be addressed by the proponent in the EIS.

Figure 1.1 - Background reports and papers

1.2 DEVELOPMENT ASSESSMENT PROCESS

Under the *Development Act 1993*, the Minister for Urban Development and Planning can declare a proposed project a Major Development if he or she believes such a declaration is necessary for proper assessment of the development, and where the project is considered to be of major economic, social or environmental importance.

The Mannum Waters proposal has been declared and will be assessed as a proposed Major Development, mainly because of its potential impact on the River Murray's sensitive environment both during construction and after, and the river's value as a water resource, tourist attraction and recreational asset. The stages of the process are shown in Table 1.1.

Table 1.1 – Stages of the Major Developments assessment process

Stage	Activity	Outcome	Status
1	Referral to Major Developments Panel	Panel considers key social, environmental and economic issues and prepares an Issues Paper. This is released for public comment for a period of four weeks, and advertised.	The Issues Paper was released on 14 September 2005.
2A	Determination of the level of assessment	The Panel decides which of three levels of assessment will be used. The three levels are an Environmental Impact Statement (EIS), a Public Environmental Report (PER) and a Development Report (DR). The EIS is the highest level.	The Panel determined that the proposal would be assessed at the EIS level.
2B	Issue of Guidelines	The Panel takes into account comments received in response to the Issues Paper, and publishes Guidelines which inform the proponent of the issues that need to be considered when writing the EIS.	Guidelines for the Mannum Waters development were issued in November 2005
3	Proponent prepares an assessment document	Proponent prepares an EIS that addresses the Guidelines. The document is released for public comment and is advertised. The public comment period is between four and six weeks from the date of publication.	This document, upon lodgement with Planning SA, will be placed on public exhibition for a period of 30 days.
4	Response to public comment	Proponent responds to each comment received during the public comment period. The Response document is released for information and is available through Planning SA, the Mid Murray Council and the Planning SA Major Developments website.	To be completed following receipt and analysis of comments.
5	Assessing the proposal	The Minister, with assistance from Planning SA, considers the documentation (EIS and response to public comments) and prepares an Assessment Report. The Assessment Report is a public document.	To be undertaken following receipt of the Response to public comments.
6	Decision	The Governor of South Australia, on the advice of the Minister and Cabinet, will make a decision on the proposal. This decision will be notified in the Government Gazette and on the Major Developments Website. The decision will also be conveyed to appropriate local media outlets. The decision is final and cannot be appealed by the proponent or any third party.	The decision may be: • approval • approval with conditions • rejection.

The assessment of the proposal will also be undertaken in relation to the current preparation of a marina strategy for the River Murray by the South Australian Government (due for public consultation during early to mid 2007).

1.3 OTHER LEGISLATION

In addition to the Development Act outlined in Section 1.1, there are a number of Acts and Regulations that apply to developments or projects in South Australia, particularly those that take place near the River Murray. These Acts and Regulations are both State and Federal. A full explanation of the implications of these Acts and Regulations is contained in Chapter 14.

1.4 COMMUNITY CONSULTATION

As part of the statutory approvals process, this EIS is required to be placed on public exhibition for a minimum of 30 business days. Within this process, the State Government (through Planning SA) will conduct a public meeting on the proposal during the exhibition period to assist the public in preparing submissions. In addition, the proponent is required to address all written submissions received during the public consultation period and respond to all comments in a Response document, which will be released for public information by Planning SA.

Photo 1.1 - Mid Murray Council Offices, Mannum

The proponent began consultation with the Mid Murray Council as early as 1999 regarding development of a smaller proposal on the current site. It was due to Council's encouragement that Planning SA considered the best way forward was for the proponent to cooperate with Council in the preparation of a new Plan Amendment Report (PAR) to potentially rezone the site for a marina and residential development.

In 2002 the Mid Murray Council commissioned consultants, Planning Advisory Services, to prepare a preliminary environmental assessment on the suitability of the proposed Mannum Marina. This assessment was carried out as part of the Mannum Township Plan Amendment Report.

In late 2002, Planning Advisory Services held a public meeting at Mannum to discuss the Marina development proposal and to determine design aspects that should be considered to take account of any community concerns. The proposal was well supported by those present at the meeting.

In December 2003 the Mid Murray Council resolved to accept the proposed PAR and held a second public meeting to discuss the Marina development proposal. Again the proposal received Council and community support.

The proposal was then increased in size and it was determined that it should be removed from the PAR and be considered for a Major Development Declaration as a more appropriate assessment pathway.

After the project received Major Development status in March 2003, the Major Developments Panel released an Issues Paper for public and government agencies comment, during the period September 2005 until October 2005.

In December 2005 the Mid Murray Council discussed and supported the relocation of the existing waste treatment plant away from the flood plain. SA Water is pursuing a satisfactory option with the proponent.

In September 2006 and January 2007, Tallwood made further presentations of the proposal to full meetings of the Mid Murray Council providing Council with updates of the EIS and development strategies.

During the life of the project other meetings or discussions have been held with SA Water, the Mannum Aboriginal Community Association Inc, the Golf Club representatives, the boating community and Friends of the Mannum Walking Trails Group. Consultations to date indicate that the project has the support of the local and wider community.

To enable the proposal to proceed with efficiently and with effect, formal working groups have been established by the proponent with both Mid Murray Council and SA Water. These and other working groups will meet on a regular basis to ensure the satisfactory delivery of the project once approval has been received.

1.5 ENVIRONMENTAL IMPACT STATEMENT

The EIS is presented as three volumes, they are:

- Volume 1 – the EIS report (this document)
- Volume 2 – Appendices
- Executive Summary

The EIS and the response to public comment will comprise the documents for final assessment by the Minister.

2 Development proposal

2.1 OVERVIEW

The Mannum Waters proposal is an integrated development combining a houseboat marina of 156 berths with a waterfront residential subdivision comprising 131 waterfront allotments, 30 villa waterfront allotments and 408 standard allotments. A commercial centre providing entertainment and leisure activities, accommodation, tourist facilities, interpretive centre and convenience type retail opportunities is also included in the development.

The proposal seeks to provide exceptional living conditions with maximum environmental protection and enhancement. It includes the removal and decommissioning of the existing waste water treatment plant and wastewater lagoons, the construction of a new waste water treatment facility and reclaimed water storage, the provision of revegetation areas and the rehabilitation of degraded dairy flats and previously farmed areas by the construction of a large wetland system. Land will also be made available adjacent to the Mannum golf course for its future extension from nine holes to eighteen holes.

Currently mooring of houseboats along the river is causing damage to riparian habitats and sanitary water discharges pollute the river. The proposal assists in addressing this issue by providing secure and serviced moorings off-river.

As part of the proposal, infrastructure works are proposed for the extension and augmentation of public utilities such as water, wastewater, telecommunications and power.

A full description of the development components is included in Section 2.2.

2.1.1 Location

The location of the development is immediately south of the existing Mannum Township. It is an appropriate and natural extension to the township.

The development is bounded by Belvedere Road on the north-west, the Mannum golf course on the north-east, the River Murray to the south east and dairy flats to the south-west. The southern extent of River Lane Road terminates at the existing SA Water wastewater treatment site which forms part of the development proposal.

The site may be accessed by vehicles from Belvedere Road at a point approximately 3 km from the Mannum town centre. Pedestrian access will be possible from River Lane Road at a point approximately 2 km from the town centre.

Figure 2.1 shows the location of Mannum within its regional context. It is situated 84 kilometres from the City of Adelaide and can be accessed from the South Eastern Freeway via Murray Bridge or through the Adelaide Hills.

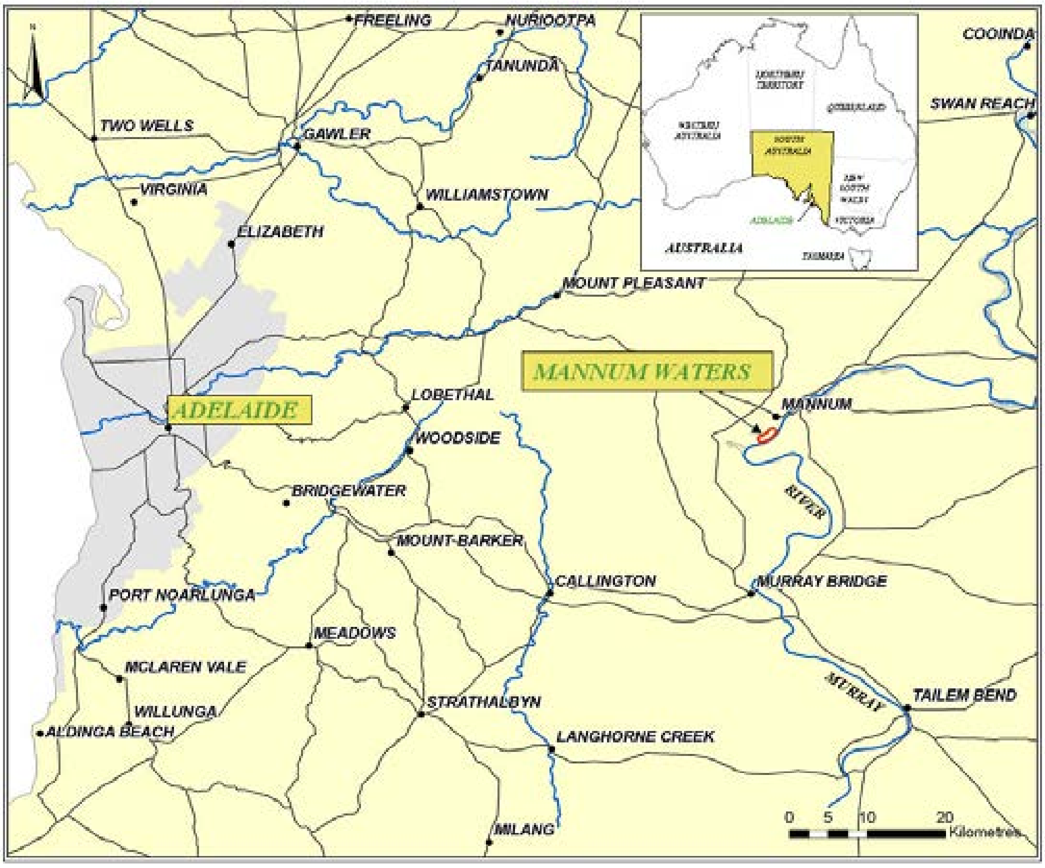


Figure 2.1 – Regional Context

Figure 2.2 is an aerial view of the development site in relation to Mannum and shows the boundaries of the Mannum Waters development with the existing township.

The existing SA Water wastewater treatment lagoons can be clearly seen located near the river bank. They represent a significant impediment to the growth of the township due to the large separation distances required between the treatment plant and new residential areas.

The existing golf course can also be seen and the vacant area south of the course. This has been purchased previously by the club to enable the course's future expansion.

Near the site is an existing Council waste disposal depot which is programmed for closure in the year 2010. The Mannum cemetery is surrounded by the golf course and Council has additional land on its southern boundary for future expansion.

The River Murray traverses the whole of the development site's south-eastern boundary with much of its length separated from the river by the existing riverine wetlands. These were created as a result of the construction of the levee banks that protect the retired dairy flats on the site. Irrigated flats are still active for agriculture on the opposite side of the river.

Site access roads to and from Adelaide via both Murray Bridge and the Adelaide Hills do not pass through the town centre and therefore do not unnecessarily impact on the existing township.

Figure 2.2 – Development site in relation to Mannum

Photos 2.1 to 2.4 are four views taken from the air and looking approximately north, east, south and west. These four photos give a further appreciation of the surrounding land uses and the proximity of the township, River Murray, wastewater lagoons, golf course and rural areas.

Photo 2.1 – View of the site looking north

Photo 2.2 – View of the site looking east

Photo 2.3 – View of the site looking south

Photo 2.4 – View of the site looking west

The following figures provide details of the development proposal:

- Figure 2.3 shows the development proposal
- Figure 2.4 shows the development proposal as an overlay to an aerial photo

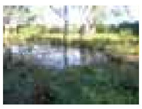
Figure 2.3 – Development proposal

Figure 2.4 – Development proposal on aerial overlay

2.1.2 Summary of provision

A summary of the areas associated with the various elements of the proposal is given in Table 2.1, although the exact areas of some items, such as the wetlands, are subject to final design. A full description of each item is discussed within the following sections of this chapter.

Table 2.1 – Summary of development areas

	Items	Area (hectares.)
	**Marina**	
	Water body	8.28
	Road reserve	3.23
	**Residential**	
	Standard allotments	31.19
	Waterfront allotments	12.52
	Waterfront villa allotments	0.92
	Waterways	15.10
	Road reserves	10.85
	**Commercial area**	0.68
	**Reserves**	
	Parks	7.91
	Aboriginal heritage areas	1.38
	Golf course extension	7.01
	Revegetation areas	23.15
	Landscaped embankments	6.53
	**Constructed wetlands**	
	Water bodies	19.10
	Islands and riparian areas	24.55
	Total Area	**172.40**

2.1.3 Staging

Figures 2.5 to 2.8 show the staged development of Mannum Waters. It can be seen from Figure 2.5 that substantial elements of the development will occur in Stage 1. This includes a significant proportion of the waterfront allotments and waterways, some of the high ground allotments, work on the revegetation areas, landscaping on the cliff face areas and the whole of the marina and commercial area. New augmentation works for water supply, power supply, wastewater treatment and reclaimed water storage will be undertaken as required. The construction and development of the wetland will also commence in Stage 1.

Stage 1 will ensure that all the essential elements will be in place early in the development so that the environmental issues are settled prior to occupation of the residential areas. Also, during Stage 1, work will be undertaken to ensure the preservation of the Aboriginal Cultural Heritage areas identified within this report.

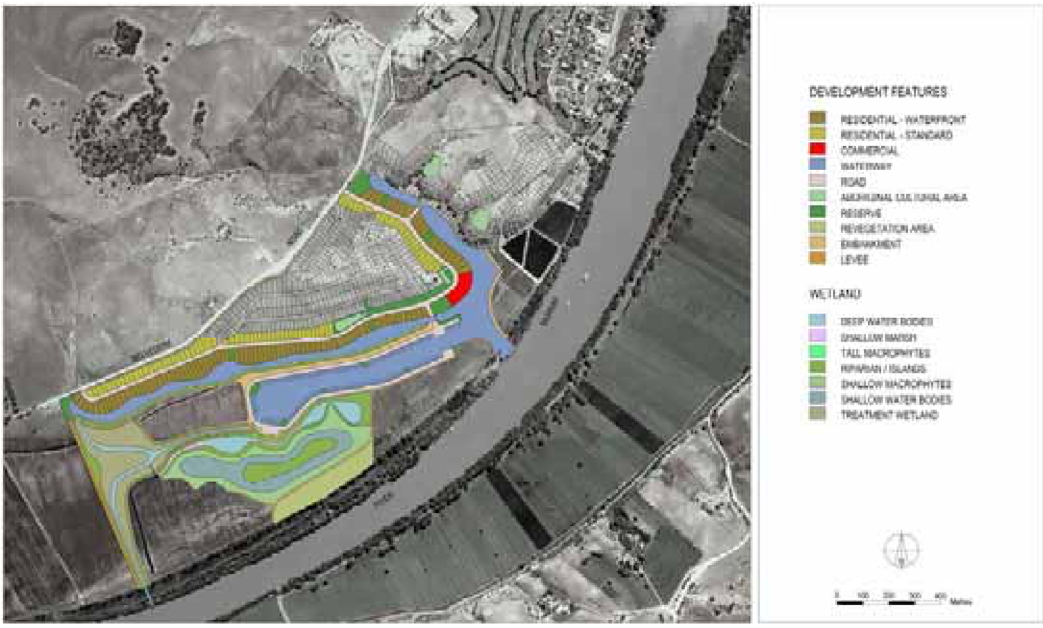


Figure 2.5 – Stage 1 of the proposed development

Stage 2 can be seen in Figure 2.6. It will proceed on completion of Stage 1 and the satisfactory commissioning of the new wastewater treatment plant. Early in the construction of Stage 2, the existing SA Water site will be decommissioned.

All remaining waterfront allotments will be developed during Stage 2 together with some further high ground allotments.

The wetland will continue to be developed during Stage 2. The progressive development of the wetland areas is to ensure the establishment of new plants and the efficient use of water. The whole of the wetland should be completed prior to the end of Stage 2.

Figure 2.6 – Stage 2 of the proposed development

Stage 3 onwards will see the gradual infill of the high ground allotments. Figure 2.7 shows the development on the northern hill slopes adjacent to the golf course extension. It is likely that this will be undertaken in four separate stages.

Figure 2.7 – Stages 3 to 6 of the proposed development

Figure 2.8 shows the continuing development of the high ground allotments. The releasing sequence of allotments will be according to market demand and take up rates.

This approach would allow sequential and logical construction ahead of demand without over supplying the market at any one time.

Work will continue on revegetation throughout all stages. In Stage 1, in addition to the wetlands, emphasis will be given to developing vegetated buffers between the development and conservation areas and waterways including:

- a five metre strip along the frontage to Belvedere Road
- the area between the waterway to the southern waterfront allotments and the wetland
- buffer strips between the existing riverine wetlands and the development areas.

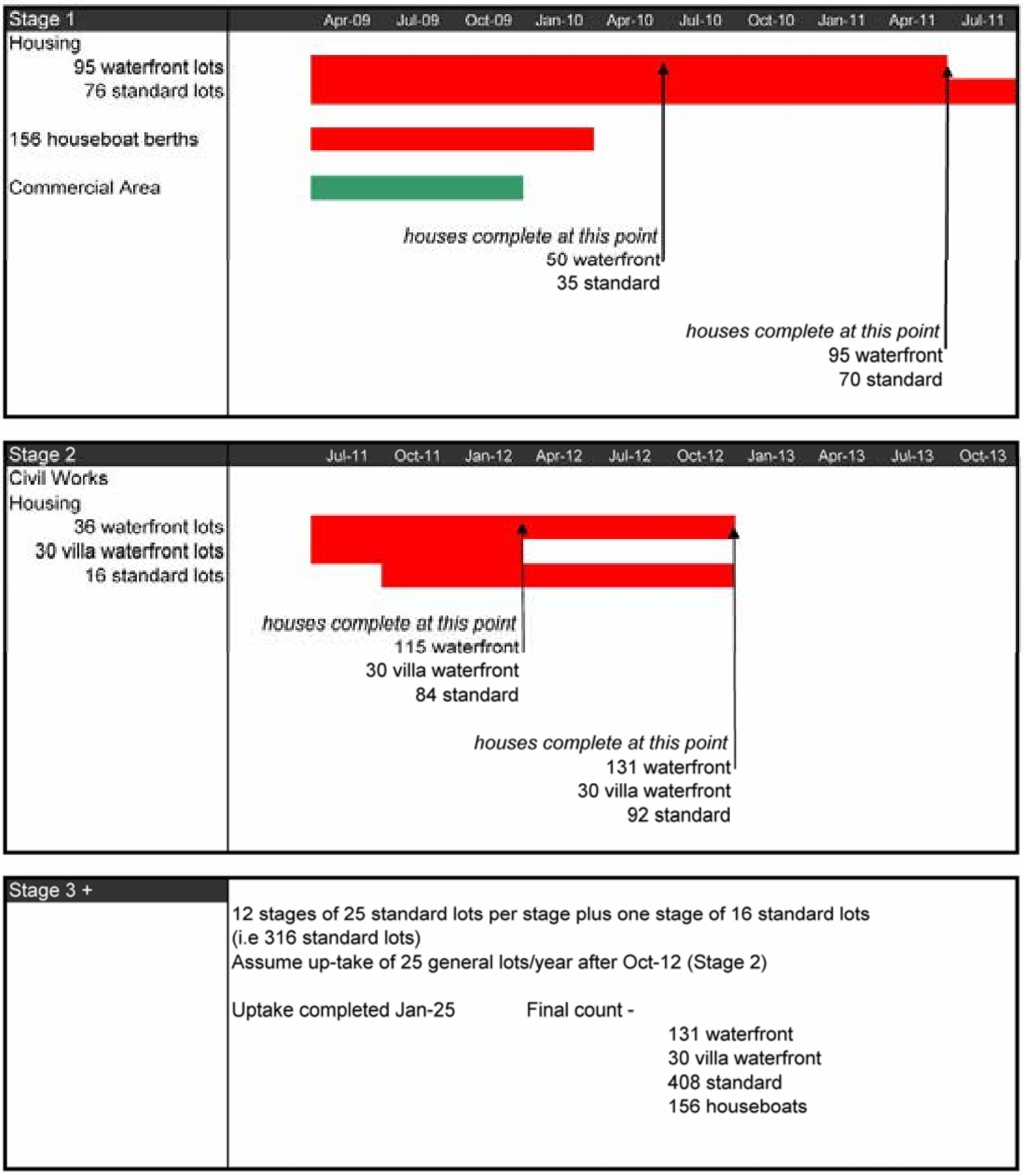
The buffer strips will provide protection to the riverine wetlands from the marina and from the constructed wetland during on-going developments.

Figure 2.8 – Stages 7 + of the proposed development

An assessment of the availability of allotments and the projected uptake of the residential areas was prepared by the proponent to assist service organisations in their consideration of augmentation works. This is presented in Table 2.2. Overall the major components of the development are expected to be completed within three years from commencement of construction and the final development of the residential allotments completed within sixteen years.

In all stages, the final layouts of the residential areas will be subject to final design and the requirements of the various authorities. The current proposal is realistic and the final arrangement of the roads and allotments is not expected to vary greatly from that currently shown.

Table 2.2 – Housing uptake projections



2.1.4 Best practice guidelines

The proponent is committed to ensuring that the design and construction of all aspects of the development will create a new benchmark for marina and residential developments along the River Murray in South Australia. Where appropriate the development will incorporate recognised best practice guidelines which will be adopted, in consultation with the State Government and Mid Murray Council, to ensure that this vision for the site is achieved.

In particular, protection of the river and associated wetlands, protection of heritage areas, water sensitive urban design, water/energy conservation and comprehensive management and monitoring plans are goals that have been set by the proponent and discussed within this report.

As well, the proponent will control the building process through a charter and design guidelines that will incorporate best practice ecologically sustainable development (ESD) in design and building techniques throughout the development.

The proposal also incorporates a number of specific innovative and important features. These include the relocation of the existing SA Water treatment lagoons from the flood plain and the construction of a new waste water treatment facility to service the entire township of Mannum. The construction of a treatment wetland area has also been included. The wetland will ensure that water quality from the marina and waterways is of high quality prior to the water's return to the river system.

The proponent believes that these initiatives provide a unique opportunity to create a best practice model for future developments of this type.

2.1.5 Modifications to proposal since issues paper

Since the production of the Issues paper and consequent EIS Guidelines, a number of changes have occurred in the Mannum Waters development proposal. Key changes are as follows:

- the waterfront residential areas have been more confined to the high ground in the north-west of the site and occupy less space overall. The road network has been reconfigured to accommodate the changes
- the marina has been redesigned to provide a more informal layout. The new area will be less intrusive in the final landscape and allow vegetation to surround it. Previously the marina area was capable of mooring 100 houseboats and 100 small craft. The current design allows for 156 houseboats or large craft and is not intended for small craft
- the new wastewater treatment plant and reclaimed water storage will be relocated off the main development site and become a part of the augmentation works to be undertaken by SA Water. The separation area previously provided around the treatment plant has been relocated adjacent to the golf course, allowing for the future extension of the course
- Aboriginal cultural heritage areas within the site have been defined more accurately in consultation with the Mannum Aboriginal Community Association (refer Chapter 10)
- the constructed wetlands and revegetation areas have been modified to give protection to the existing riverine wetlands by providing a buffer between the River and the marina/residential development. The wetland also includes a specific treatment area for polishing flows from the waterways
- boat entry to the marina and waterways has been confined to the central entrance. Boat entry at the northern end of the site will not be permitted. Similarly no boat entry will be permitted at the outlet of the anabranch.

Figure 2.9 shows both the previous and current development plans. It enables a comparison of the principal changes. Overall the substance of the changes is small. In each case, it is considered that an environmental improvement on the original plan has been achieved.

Figure 2.9 – Changes in the development proposal

2.1.6 Artist's impression

An artist's impression of the development proposal is included as Figure 2.10.

Figure 2.10 – Artist's impression of the development

2.2 RESIDENTIAL AREAS

2.2.1 Overview

The development comprises a total of 569 allotments proposed for residential living. Of these 131 are proposed for waterfront allotments, 30 for waterfront villa allotments and the balance for standard allotments. Each of the residential allotments is to accommodate a single dwelling.

The waterfront and standard residential allotments will have areas suitable for building of at least 400 square metres. The waterfront villa allotments will have areas suitable for building of at least 240 square metres. All dwellings must be constructed with the living areas above the 1956 flood level and comply with all River Murray Zone building regulations as required by the Council Development Plan. Waterfront allotments will be accessed from a public road on the property boundary.

The waterfront allotments will have water access. Land titles will extend 10 metres into the marina waterway allowing direct access to vessels via a landing and mooring arrangement.

2.2.2 Urban design

Preliminary designs have been prepared for the development, demonstrating the style of housing that the proponent envisages for the site. These are shown as architectural sketches in Figures 2.11 to 2.16.

For the purposes of documenting the master plan for the project, the waterfront housing has been divided into two broad categories:

- Northern villa waterfront residential
- Southern waterfront residential

The northern villa waterfront (refer figures 2.11, 2.12 and 2.13) has been set aside for higher density style living on courtyard size allotments. The proponent has selected the style of housing in this location to ensure that a mix of housing options are available, and in particular that allotments are available which reduce the human footprint yet provide an attractive and desirable outcome.

To reduce the footprint per allotment, the northern villa waterfront allotments would typically comprise two storey dwellings in groups of 3 to 5, with public open space zones available between the groups to provide access to the linear walking and cycling trail that follows the water's edge along this zone. The natural topography of this part of the site lends itself to this style of development, as a large cliff is located behind these allotments which will reduce the visual impact of higher density two storey dwellings.

At this stage the development depicts all of the villa allotments in a single group. In final design of the allotments the arrangement will be developed bearing in mind a number of more detailed design considerations such as public access, local aesthetics and amenity.

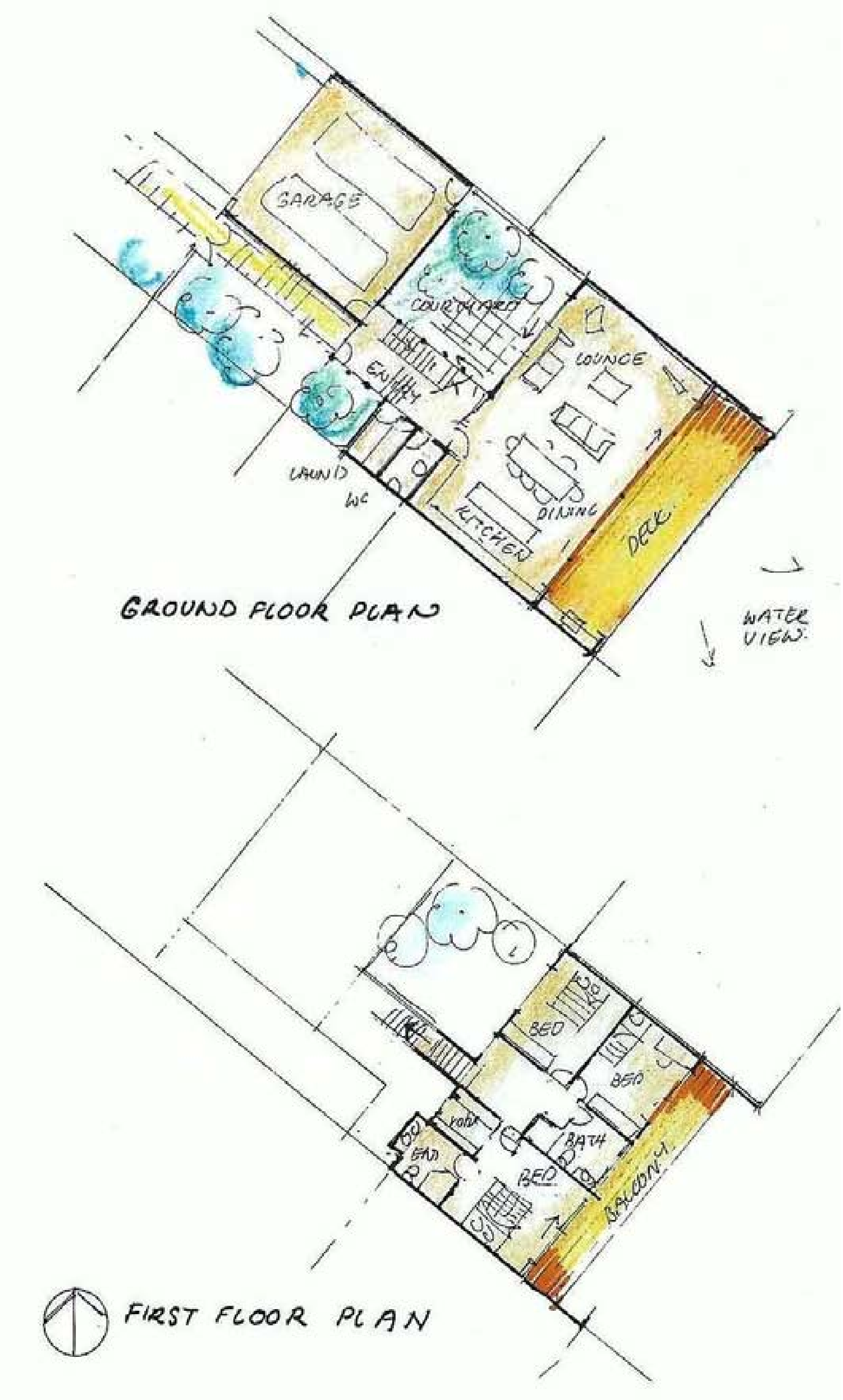


Figure 2.11 – Northern villa waterfront, typical floor plan (1)

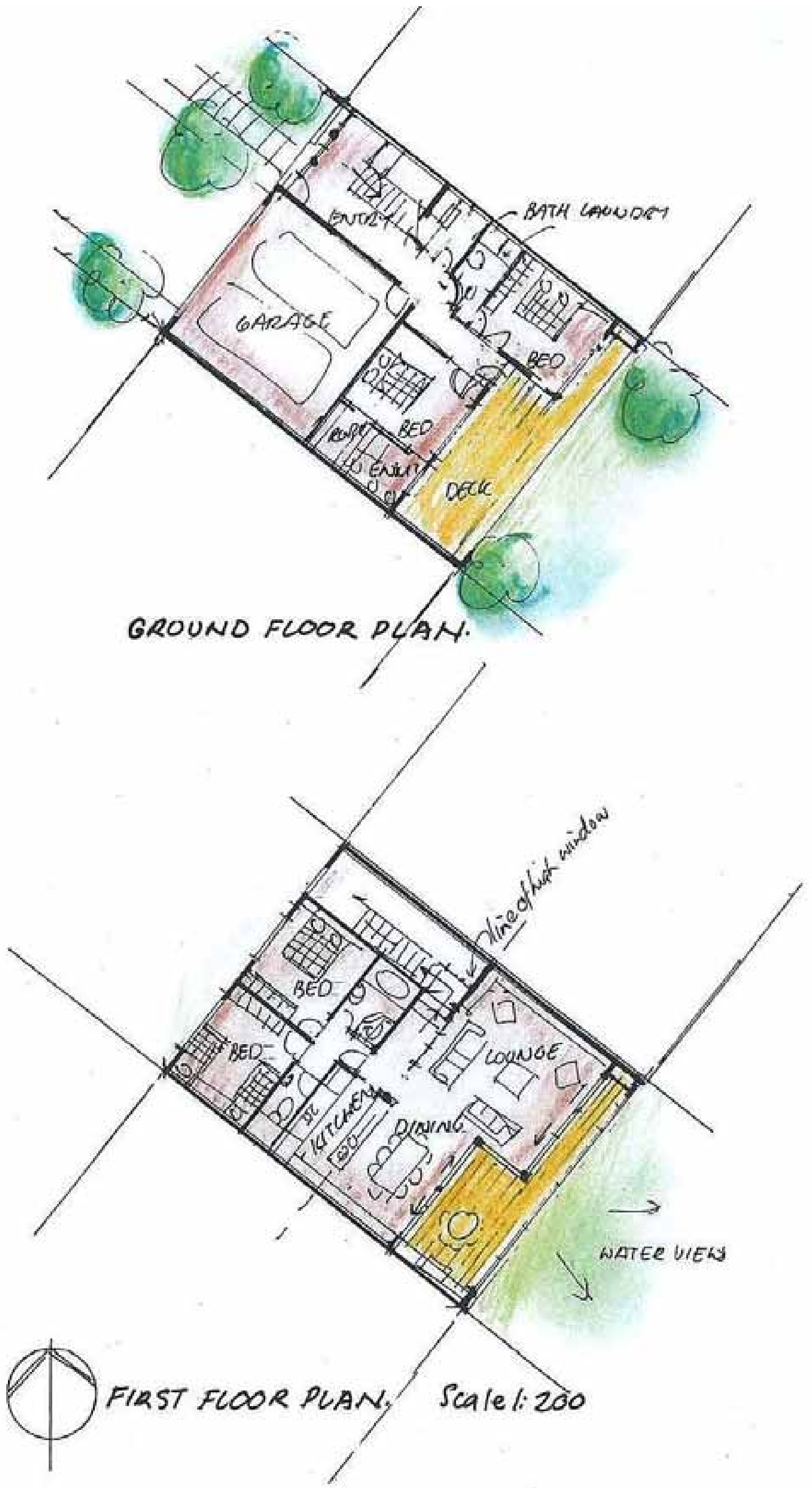
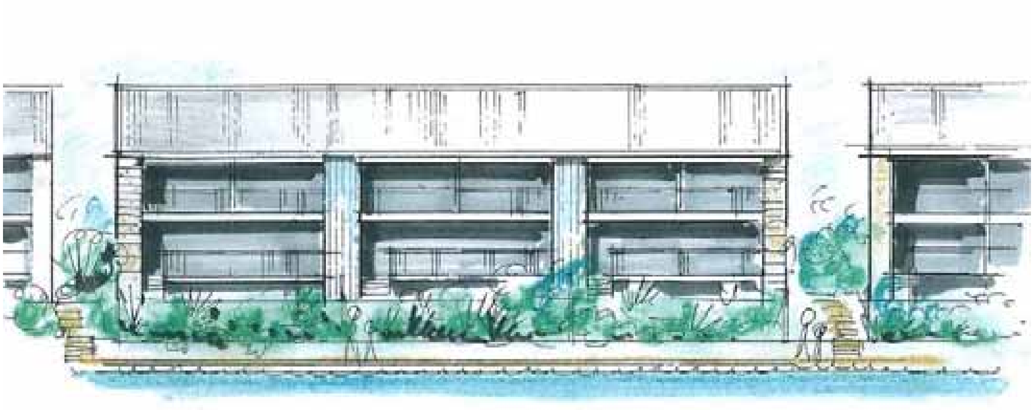
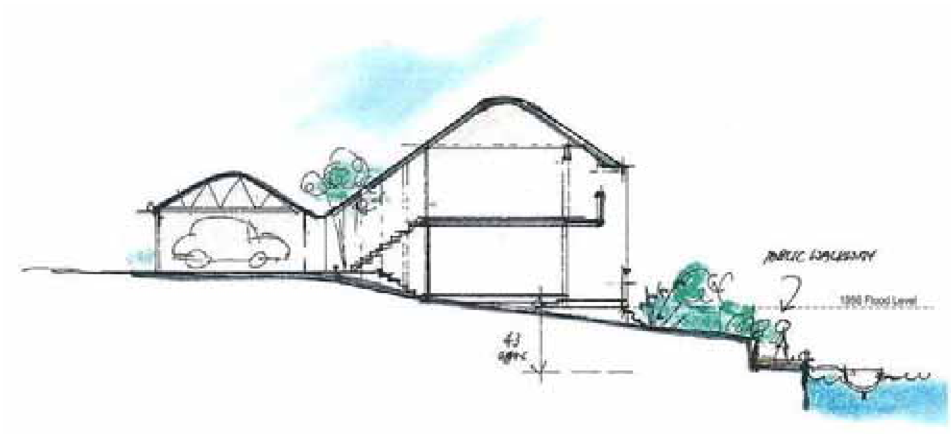


Figure 2.12 – Northern villa waterfront, typical floor plan (2)



View from waterway



Typical section

Figure 2.13 – Northern villa waterfront, typical floor plan (2)

The southern waterfront housing is typically comprised of larger allotments with single stand-alone dwellings. By utilising building designs which include saw tooth roof structures and internal courtyards, the benefits of passive solar gain into the homes can be achieved. Examples of these design techniques are shown in Figures 2.14, 2.15 and 2.16.

Particular attention has also been paid to ensuring that the benefits of passive heating and cooling can be achieved by selecting appropriate housing envelopes relative to the solar orientation of the homes. An example of creating internal courtyards within these homes to capture northern sunlight is shown in Figures 2.14 and 2.15.

The setback for all dwellings is to be a minimum of 15 metres from the normal pool level (AHD 0.75M) of the waterway, and six metres from the property boundary frontage to a public road. Dwellings are to be also set back by 1.2 metres to any side property boundary.

A height limit of two storeys is to apply to detached dwellings.

Figure 2.14 – Southern standard, typical floor plans, single storey

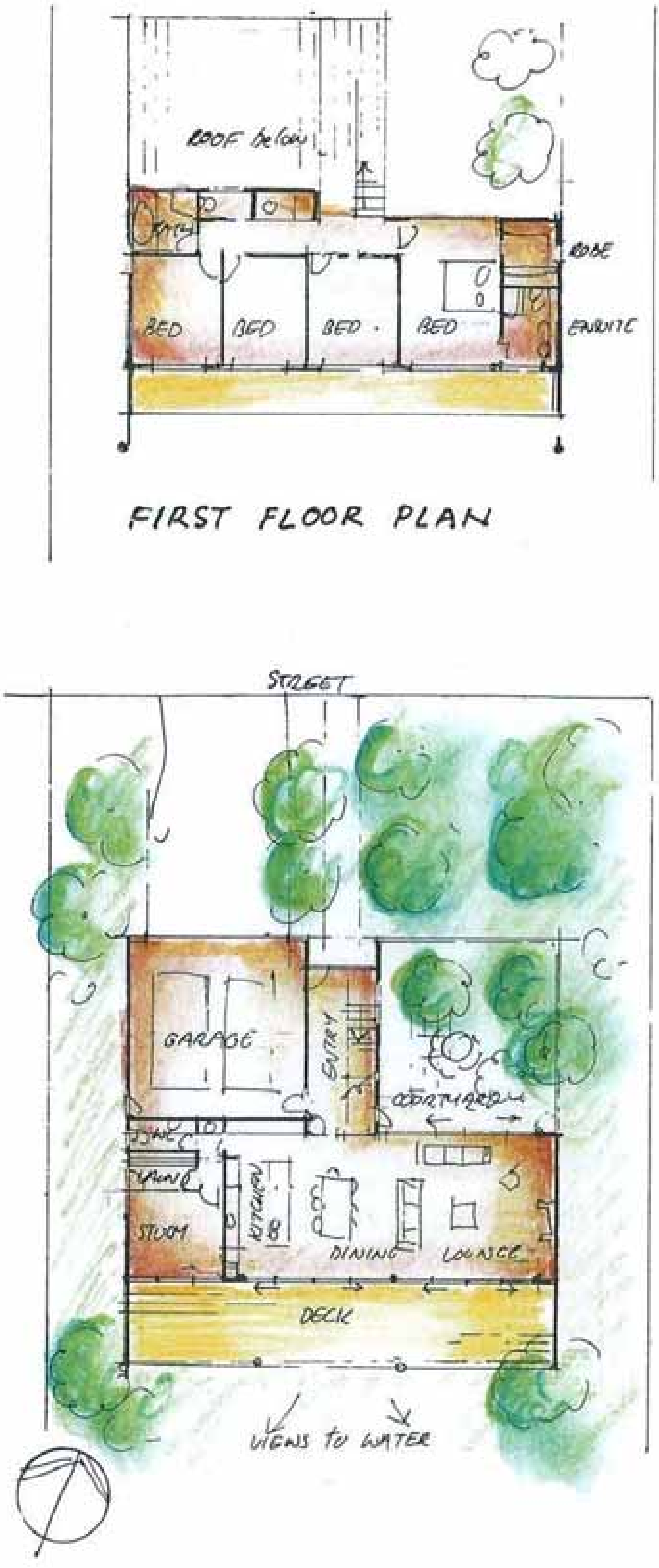
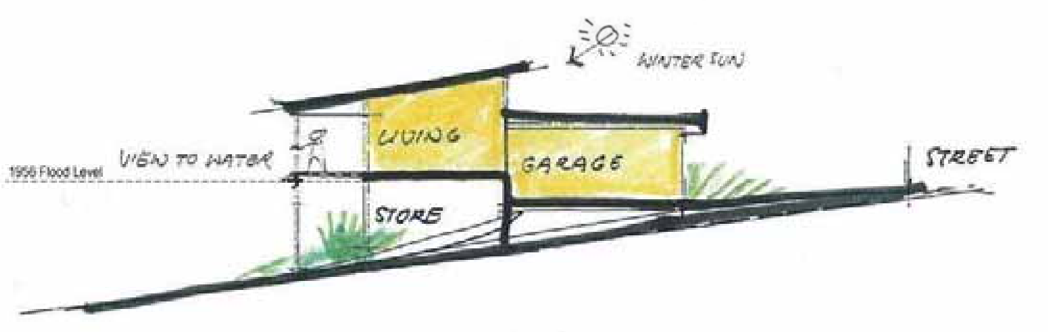
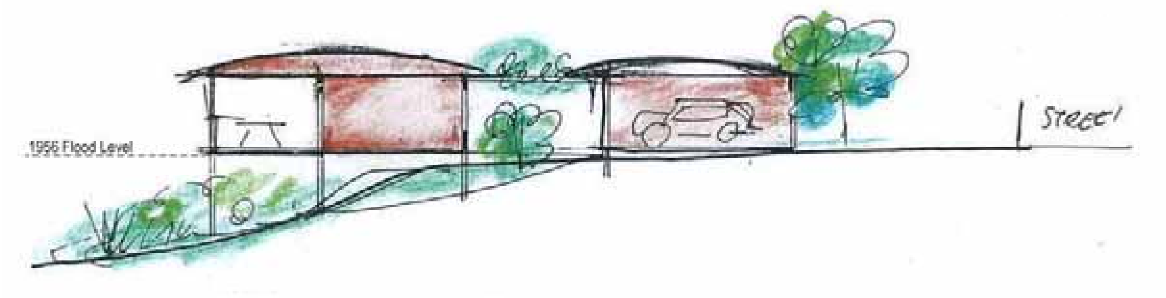


Figure 2.15 – Southern waterfront, typical floor plan, two storey



Typical section



Typical section

View from waterway

View from street

Figure 2.16 – Southern waterfront

2.2.3 Waterfront easement

The waterfront allotments will have a long form easement 15 metres wide from the boundary adjoining the waterway reserve. This will equate to 5 metres of land and 10 metres of water surface as shown in Figure 2.17.

The purpose of this easement is to:

- regulate the design and construction requirements in respect to landing and mooring facilities associated with waterfront allotments
- permit access to the waterfront areas by the proponent or its agents should it be required for any reason, including times of higher river levels
- restrict building and construction within the long form easement other than that required for the individual landings.

The long form easement will be held appurtenant to an allotment in the development area. A "long form" easement is an easement that is not a standard easement (known as a short form easement). The easement will allow access to the proponent or its agents, servants and workmen:

- at any time to inspect, alter, maintain and repair the interface between the land and water
- to use land or water based vehicles for any of those purposes
- and to enter the land at any time for any of those purposes.

An allotment, with the rights to the easement, is to be held by the proponent.

Figure 2.17 – Long form easement

2.2.4 House Owner's Charter

A House Owner's Charter will be prepared by the proponent for all residential allotments offered for sale within the development. A typical House Owner's Charter is included in Appendix B. The Charter will cover items including building design and materials, planting species and fertilisers, and owners obligations in respect to a range of planning and management issues. The House Owner's Charter is discussed in 11.4.6.

2.2.5 Design guidelines

In addition to the charter, design guidelines will be put in place to ensure that development across the whole project is consistent and of a high quality. The guidelines would be prepared and disseminated by the proponent and would be consistent with the aims of the Charter. Unlike the Charter, the guidelines would be advisory rather than mandatory. The design guidelines are discussed in Section 11.4.6.

2.3 MARINA AND WATERWAYS

Facilities that will be available to moor houseboats and riverboats off river in a controlled environment are a feature of this development.

The development will include a range of mooring types, including:

- permanent living houseboat moorings
- general houseboat and large craft moorings
- casual moorings
- small craft residential moorings.

It is proposed to provide serviced mooring facilities for up to 156 houseboats (including large vessels) within the Marina, as shown in Figure 2.18. As EPA authorisation is required for marina facilities of 50 moorings or more, final design will be subject to EPA approval.

Moorings for small craft will be available to waterfront land owners who construct landings within the frontages of their properties (refer to Section 2.2). Other casual visitor small craft moorings will be available at the commercial area (refer to Section 2.4). Houseboats will be prohibited from mooring in the waterways, the river bank and at waterfront allotment landings.

The serviced moorings will have a vacuum sewer connection point at the mooring for vessels to discharge waste water. Greywater can contain a number of contaminants such as food scraps, milk residues, oils, fats, soaps, detergents, household chemicals and microbial pathogens. In general, greywater is regarded as posing a significantly lower health risk than black-water due to bacterial numbers being lower. However, fats and phosphorus contained in black and greywater are comparable, and so direct discharge of greywater to the River represents a potentially serious contamination issue.

Figure 2.18 – Marina mooring layout

At present, there is a legislative[1] requirement for houseboats to only collect blackwater onboard and discharge it at an approved pump out facility. As a consequence, most houseboats are currently configured to discharge greywater into the river as storing or filtering the volume of greywater onboard can pose cost and/or capacity constraints. The EPA Guideline: Greywater Management Systems on Vessels provides information on the correct handling of greywater. In addition the EPA Draft Code of Practice for Vessel and Facility Management: Marine and Inland Waters addresses the issue of greywater. This Code of Practice will be in place prior to the occupation of the marina and all boats will be expected to comply with the code.

As an additional water quality safeguard, the marina and waterways have been designed so that water flowing from the marina basin and the waterways receives treatment through a wetland area before returning to the river.

A boat refuelling facility will be available in the commercial area (refer Section 2.4).

Houseboat and vessel maintenance activities will be subject to strict controls which are detailed in chapter 13. Again, these controls are to minimise the risk of pollutants or contaminants entering the waterways as well as maintaining the peaceful amenity of the area.

2.3.1 Permanent living houseboat moorings

As indicated, it is proposed that a total of 156 moorings be developed within the Marina. Of these, 150 moorings will be constructed for permanent living and general houseboat moorings, with the balance available for use by short term visitors including overnight stays.

It is anticipated that permanent long term occupation will comprise around 45% of the houseboat moorings. If the permanent occupation exceeds this estimate, the marina controls and design features will cope with adverse environmental impacts resulting from higher occupancy.

The permanent living, general houseboat moorings and casual moorings will all be configured as “drive in reverse out” berths around the edge of the marina basin. A range of mooring sizes will be configured to accommodate different shaped vessels. Bay sizes will vary from 9m x 20m, 10m x 20m, 10m x 25m and 11 x 25m (refer Figure 2.18). Each bay will be provided with front and rear mooring piles. The piles will have facility for extension during floods (refer Figure 2.19).

The service facilities for permanent living, general houseboat moorings and casual moorings will be identical so that no changes will be required to the mooring connections should the owner decide to use the mooring for permanent living.

All houseboat and riverboat moorings within the marina will be serviced with connections for potable water, telecommunications, a 240 volt power connection and vacuum discharge of black and grey-water.

[1] *Environment Protection (Water Quality) Policy 2003*

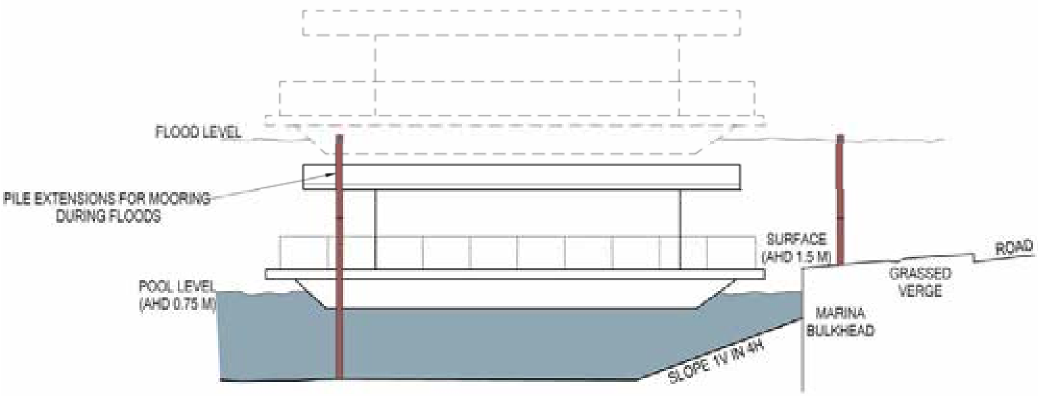


Figure 2.19 – Typical houseboat mooring

2.3.2 General houseboat moorings

The general houseboat moorings will have the same specifications as the permanent living houseboat moorings (refer Section 2.3.1). It is anticipated that the number of moorings used for general houseboat moorings will comprise around 55% of all moorings.

Photo 2.5 – Typical houseboat mooring

2.3.3 Casual moorings

Casual moorings will have bay sizes of 10m x 20m. Six berths are located near the Commercial Area outside of the marina’s secure area. General houseboat moorings may be allocated by the Mariner Manager for casual moorings for short term visitors as necessary to facilitate river traffic.

2.3.4 Small craft household moorings

Owners of waterfront allotments will be permitted to construct a landing to moor their own small craft on the waterfront land adjoining their allotment. It is unknown how many owners will construct a landing. A total of 161 waterfront allotments (including Villas) have been planned and each allotment will be permitted to have a single landing (refer Figure 2.20). The landings constructed on waterfront land will be subject to a title charter and construction will be subject to development approval.

Small craft landing moorings will not have sewer or power connections.

Permanent or casual living on vessels at this type of mooring will not be permitted.

Mid Murray Council has identified typical landings for waterfront allotments in the Council Development Plan. Figure 2.20 shows the details of typical fixed landings. Hardwood is the material identified by Council within the Development Plan. Other suitable materials have been developed for this use and are being investigated by the proponent. Final selection will be agreed with Mid Murray Council.

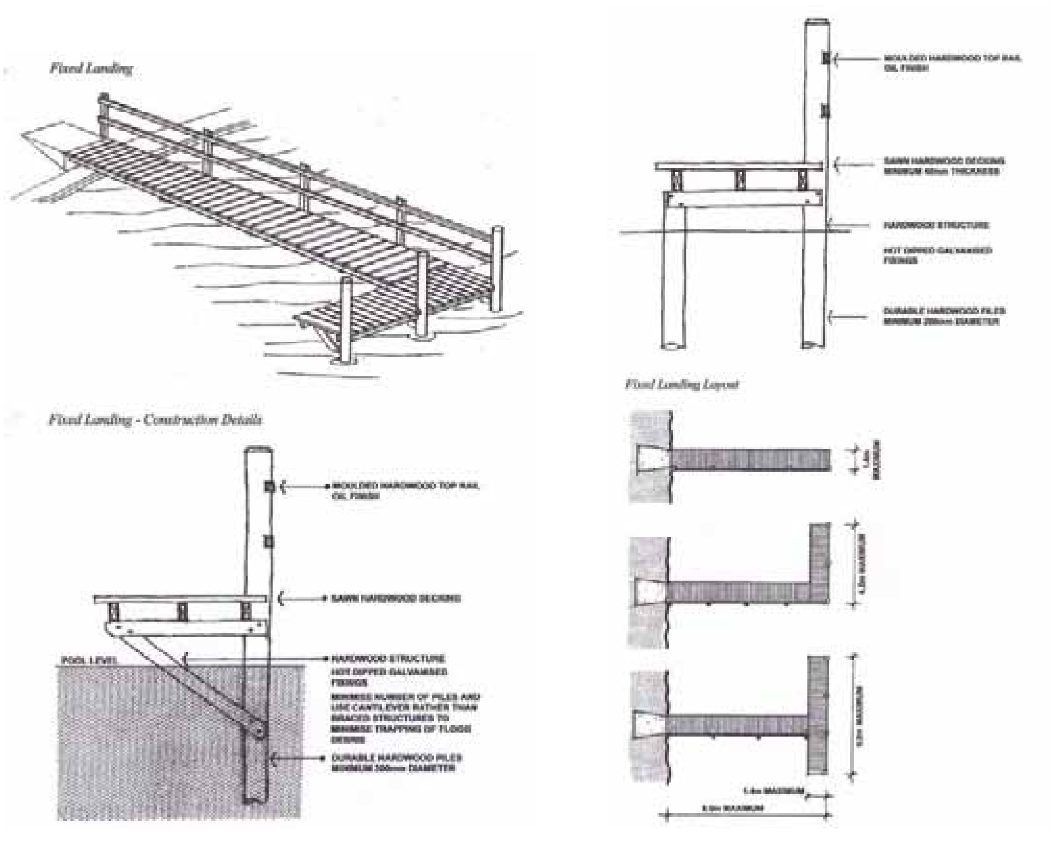


Figure 2.20 – Fixed landings - Mid Murray Council Development Plan

Photo 2.6 – Typical waterfront allotment mooring

Owners will not be permitted to allow their moored vessel to intrude into the public waterway beyond the property boundary. This will restrict the size of the vessel that can be moored. Consequently, houseboats will not be permitted to moor at the front of waterfront housing.

2.3.5 River entrances

Three water inlets/outlets are proposed from the River Murray to the water bodies within the development. Only one entrance will be constructed to allow boat movement. This entrance is located centrally to the development and in easy reach of the casual mooring berths and the commercial area. Two other entrances will facilitate water movement for water quality management of the internal waterways.

The main entrance is planned with dual passages. This will facilitate boat movements in and out. The entrance has been located where access already exists from the river to a small mooring area and where vegetation is sparse. The dual waterway allows preservation of existing trees by including a small island within the entranceway.

At the dual entrance, bank slopes will be increased from 1 vertical to 4 horizontal within the internal waterways to 1 to 1. This will minimise the impact on vegetation at the entrances. The bank slope and protection will be achieved with a combination of geotextile fabric and rock rip-rap.

Each waterway of the dual entrance will be 16 metres wide at the water surface. Navigational markers will identify the safe passage area. Immediately beyond the dual entrance the bank slopes will revert to the standard slopes of 1 in 4 in the river (or as appropriate) and in the waterways.

Photos 2.7 and 2.8 show the site of the proposed entrance and the existing break in the river bank. In particular Photo 2.8 shows a view towards the levee. Figure 2.21 depicts the actual location of the proposed boat entrance as viewed from the river. Only one dead tree is required to be removed. This will be utilised within the constructed wetland or revegetation areas to provide habitat for native fauna.

Photo 2.7 – Location of main entrance looking north east

Photo 2.8 – Location of main entrance looking north at the existing levee

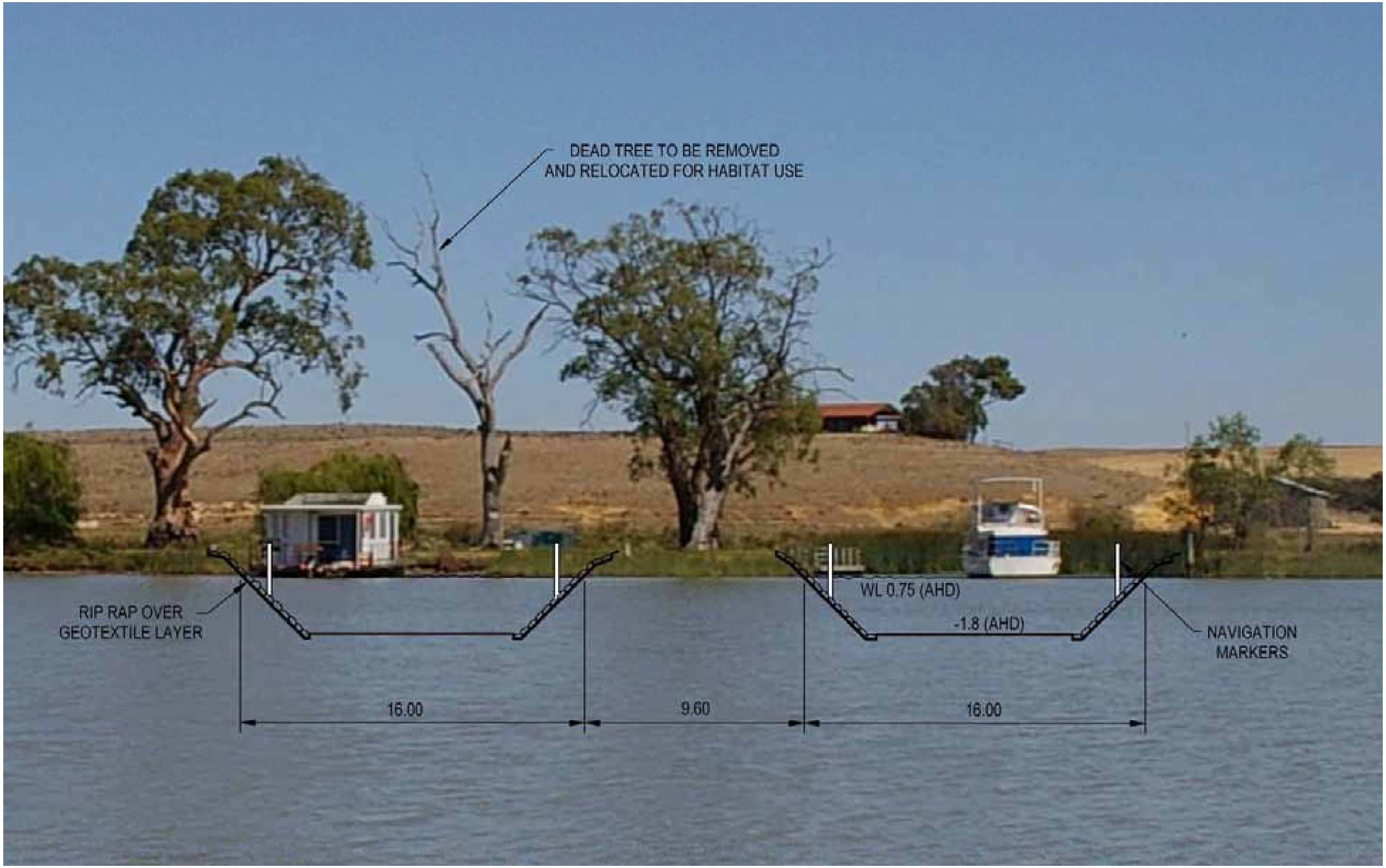


Figure 2.21 – Marina entrance bank treatment

Two channels are proposed for the northern and southern entrances to allow water flows to and from the river. Photo 2.9 shows the northern location and Photo 2.10 shows the location of the southern entrance.

Photo 2.9 – Location of northern inlet channel

Photo 2.10 – Location of southern anabranch outlet channel

Both locations have been chosen to avoid existing native trees.

The northern inlet will be connected directly to the development's northern most waterway. As its location is up stream from the other entrances, it will facilitate natural flow through the marina during times of river flow.

The entrance will be 7 metres wide with vertical sides. The sides will be constructed in the same material as the marina bulkheads and supported by earth embankments. Top of walls will be set at AHD 1.5M.

It is anticipated that the southern wall of the northern entrance may be extended into the river to divert flow along the edge of the river bank. The provision of this diversion will depend on final design, safety requirements and possible signage to ensure the safety of with river users. Although this facility is not essential for water change within the marina and waterways it should assist in reducing water transfer pumping energy use.

The southern anabranch outlet will be connected directly from the river to the constructed wetland to provide a passage for water returning to the river. The channel will be 3m wide. Sides will be mounded to prevent flow into the existing riverine wetland and to ensure all flow is directed to the river.

Excavation of the entrances from the river side of the existing levee bank will traverse approximately 36m at the main entrance, 26m at the northern inlet and 65m at the southern. The quantity of material to be removed within these distances is approximately 920m^3, 360m^3 and 280m^3 respectively.

The proponent will consult with the Department of Transport to ensure that appropriate signage is installed at the marina entrance to obtain safe passage for all incoming and outgoing boat traffic and at the northern inlet and southern outlet to alert users of their presence

2.3.6 Marina bulkheads

Bulkheads are proposed within the marina. These involve vertical sheet piling and braced away from the water to anchors located below the adjacent surface.

The preferred material is vinyl sheet piling with anchors and hardwood timber capping and protective rails and the preferred colour is "clay". Other materials such as hardwood, alloys and composites are available for the structure and a final selection will be made during detailed design. Chemically treated or creosoted timbers will not be used.

Typical installations of vinyl sheet piling are shown in Photos 2.11 and 2.12

The Marina bulkhead walls will be near vertical. Beyond the bulkhead wall will be a grassed and landscaped area, approximately 7.5 metres in width, where the parking of two cars will be possible for each berth. The grassed landscaped area will stretch between the marina bulkhead and the marina access road. All services (water, vacuum sewerage, power and telecommunications) to the marina berths will be contained within this strip.

Figure 2.22 shows the extent of the vertical sheet pile bulkheads

Dedicated service points will be available for each berth. The points will be designed to withstand inundation and located high enough (AHD 3.25 m) to avoid floods with a return frequency greater than 1 in 50 years. During flooding all services will be isolated. Supply will be renewed when the infrastructure has been restored to operation capability.

Photo 2.11 – Typical vinyl sheet piling with concrete capping

Photo 2.12 – Typical vinyl sheet piling with timber capping and protective rail

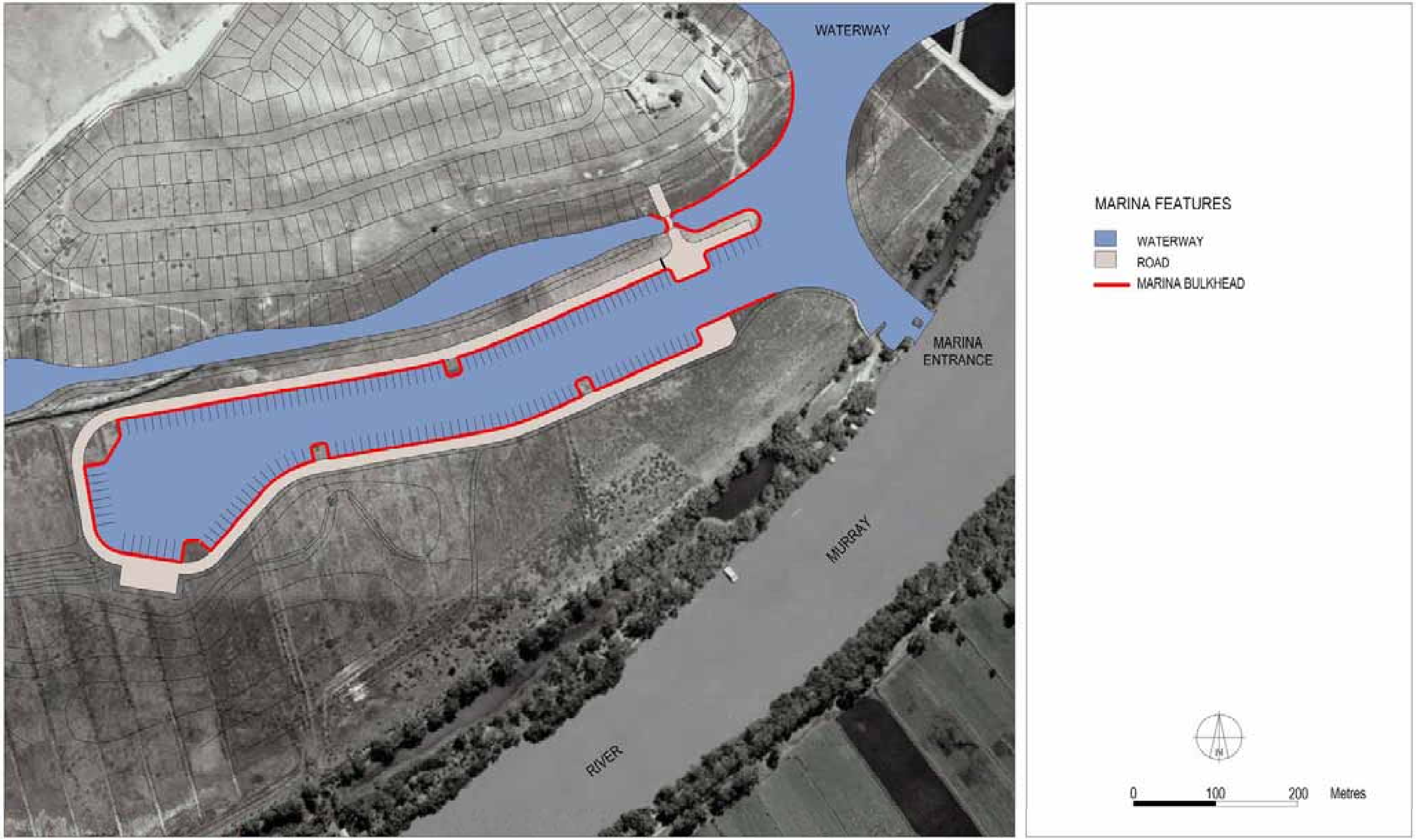


Figure 2.22 – Marina bulkheads

2.3.7 Marina Owner's Charter

The proponent would establish a Community Corporation under the provisions of the *Community Titles Act 1996* in respect to marina berths, with the Scheme Description and the By Laws covering the operation and management requirements in respect of the use of these berths. The Marina management and details of the Marina Owner's Charter are discussed in Section 11.4.6. A typical Marina Owner's Charter is included in Appendix C.

2.3.8 Riparian buffers

Riparian buffers are proposed on the embankments adjacent to all waterways. They will comprise native grasses, shrubs and trees.

The buffers will assist in the following:

- as a safeguard against pollution of the waterways by,
  - filtering out sediment
  - trapping pollutants and providing a nutrient sink
- stabilising the banks by slowing run-off velocities
- improving amenity
- providing additional habitats

The waterfront allotments have been planned with depths ranging from 40 to 70 metres to enable owners to develop substantial and sustainable riparian buffers. These will reinforce the plantings for erosion protection provided with the initial development by the proponent. Although buffers of 5m should be adequate (refer Section 11.2.1), buffers of 15 metres depth from the river should be possible on all allotments with others being possible up to 40 metres deep.

A fact sheet will be prepared for home owners to address riparian buffers on typical waterfront land. Waterfront allotment owners will be expected to landscape their sites in accordance with the project standards. Assistance will be given by the proponent to the owners in allotment development.

During the course of the development of Mannum Waters, the proponent intends to maintain an on-site nursery with a selection of plants available for site development works and for purchase by individual owners.

All banks apart from those forming the main river entrance and those to the sides of the Marina will have a maximum slope of 1 vertical to 4 horizontal. Within the waterfront allotments this will slacken to at least 1 vertical to 5 horizontal to provide a slope suitable for mowing in these areas.

Bank stabilisation will begin progressively as soon as practicable after earthworks have been completed.

2.3.9 Water use and transfer

Considerable attention has been given to the water demands for the development. To assess this, water balance calculations and water-modelling on water transfer rates have been undertaken.

In order to ascertain the necessity for water imports from the River Murray, a water balance was created for the proposed marina and waterway area. Pre- and post-development scenarios were investigated in average rainfall conditions plus a 1 in 10 dry year rainfall conditions for the post development scenario. This is discussed in Section 11.2.2.

Two water transfer pumping stations (WST 1 and WST 2) are proposed between the waterways and the constructed wetland. One will be located at the southern end of the southern waterway and the other at the southern end of the Marina. Each station will have the ability to allow direct water flow via weirs to the wetland. Also they will have the ability to close the direct connection via the weir and be equipped with pumps to transfer the flow from the waterways to the anabranch at rates equal to the EPA requirement of once in 10 days turnover. Closure of the weirs will occur automatically to prevent short-circuiting when the pumps are functioning. The estimated volume of the water within the waterways and the Marina is 520,000 m^3 and the total pumping capacity to achieve the turnover is 690 litres/sec.

Prior to entering the river, water will pass through a treatment wetland providing reduction in pollutants, including sediments, nutrients and faecal micro-organisms.

Currently an existing pumping station provides river water to the golf course under licence for irrigation of the greens. Golf course fairways are watered with reclaimed water but river water is preferred to reclaimed water for greens due to the lower incidence of nutrients that cause growth of the greens to be too rapid. A replacement pump for this purpose will be located within the proposed western waterway. This will have the capability of delivering water for the greens and also emergency water for the fairways if required.

A third water transfer station (WST 3) is proposed at the location of the existing pumping station to deliver river water to the head of the north-western waterway. This will ensure adequate turn-over within the reach. The pump will utilise the existing suction pipe from the river and have a capacity of 60 litres/sec. The pump will discharge water through a water feature to provide an enhancement at the main road access to the development.

Water modelling results are discussed in Section 11.2.3

2.3.10 Water quality monitoring

A water quality monitoring programme for the marina waterways and wetlands will be developed in consultation with State Government agencies. The objective will be to characterise the quality of water entering the marina and waterways and water being returned to the river and quality within the development with regards to the two important environmental values, the protection of aquatic ecosystems and recreation (primary and secondary).

The collection of samples and field measurements will be undertaken by qualified personnel and be supported by field monitoring stations. Water quality monitoring is discussed more fully in Section 12.3.1

2.4 COMMERCIAL AREA

The proponent has incorporated an area of 6,800m^2 within the proposal for the establishment of small-scale commercial activities that will complement the development and provide the necessary services required to ensure the successful ongoing operation of the marina.

The areas allocated for each facility are shown in Table 2.3

Table 2.3 – Floorspace provision in the commercial area

Facility	Floorspace proposed (m^2)
General store boat chandlery/refuelling and service areas	1,500
Restaurant/café/tourist accommodation (two levels)	1,500
Marina office	110
Commercial boat operators office	180
Interpretive centre	70
Public areas (incl. public toilets, boat ramp and parking)	3,440

An important aspect of this area will be the provision of attractive public open spaces that have direct visual access to the waterway and which will provide a significant central meeting place for the community to utilise. An area of reserve comprising 3,800m^2 has been located adjacent to the commercial area to be integrated with the area during final design.

The intention of commercial area is not to compete with the existing services offered within the Mannum township, but instead to add to them, ensuring that there is sufficient capability to provide the essential services required by the local users of the marina.

The final form and layout of the various facilities that will be provided within this area will be the subject of future development proposals and will be designed and planned following further research and discussion with the local council and the community.

The proponent envisages that the architecture of these building will be in keeping with the overall theme of the development of providing low visual impact, environmentally sensitive buildings.

2.4.1 General store/boat chandlery

To ensure that the needs of the local community and in particular the users of the Marina are met, it is proposed to establish a small general store and boat chandlery. This facility will be equipped with essential food and beverage supply items such as bread and milk along with supplying boating related products to the marina users.

2.4.2 Restaurant/café/tourist accommodation

In addition to the general store, it is proposed to establish a restaurant and café which would have views of the water and further reinforce Mannum's identity as an important tourist destination. In conjunction with this, it is proposed to offer tourist accommodation facilities within this area.

2.4.3 Marina office

To ensure the successful operation of the marina, it is envisaged that a small office facility will be provided within the area that would be occupied by the management and staff responsible for the ongoing operation of the marina. This facility would most likely be integrated within the boat chandlery and general store building.

2.4.4 Commercial boat operators' offices

Given Mannum's position as the pre-eminent houseboat town in South Australia, provision has been made within the commercial area for commercial operators to establish their businesses. This is not seen by the proponent as an integral part of the development, as many of these operators are well established in their current location.

2.4.5 Interpretive centre (indigenous culture/eco-systems, etc.)

Within the commercial area it is envisaged that a local interpretive centre be established for educational purposes and advice concerning the indigenous sites and the wetlands area within the development. It is envisaged that the centre will be a resource for schools, walkers and community bodies.

2.4.6 Public toilets

Public toilets will be included within the building envelope of the general store with external access.

2.4.7 General concepts and building guidelines

As noted above, the final design and configuration of buildings within this area will be the subject of further development proposals in conjunction with the local council. The proponent's vision for this area is to provide a central hub that will offer prime views and passive recreational access to the entire community.

2.4.8 Refuelling facility

This will be the only authorised refuelling method for vessels in the Marina waterways. Operators will be prohibited to refuel any vessel in the water using cans, drums or similar hand refuelling methods. This restriction is intended to minimise the risk of fuel spills in the Marina.

The facility will be bunded to the requirements of the EPA and covered by a Spill Contingency Plan (refer Section 12.3.3). A roof will cover the bunded area and provision will be made to control ingress of rainfall. It is also to be noted that the layout of the waterways and water through-flow by pumping enables any spillage to be isolated, allowing time for adequate clean-up.

2.4.9 Car parking

Provision for car parking will be made in accordance with normal Council requirements for various building and public facilities (refer Section 2.5.6).

2.4.10 Boat ramp and trailer parking

A boat ramp and trailer park will be constructed within the commercial area and adjacent to the boat chandlery service area. The ramp will be similar to the one that exists on the Mannum river front (refer Photo 2.14). Twenty trailer parks will be provided.

The ramp will provide river access for the non-waterfront home dwellers in the development.

Photo 2.13 – Mannum boat ramp

2.5 PUBLIC RECREATION FACILITIES

A large percentage of the total development area has been set aside for open space, including 43.7 hectares of constructed wetlands, 23.2 hectares of revegetation areas, 6.5 hectares of landscaped embankments and 16.3 hectares of dedicated parks.

The combined areas represents over 52% of the total development and are shown on Figure 2.23. In addition there is approximately 12.1 hectares of public waterways available for small craft use under strict controls. The total area represents approximately 59% of the site.

Figure 2.23 – Public areas

2.5.1 Playground and picnic areas

Dedicated play and picnic areas will be provided within the parks. Typical examples of these facilities are shown in Photos 2.14 and 2.15 below.

Photo 2.14 – Typical playground area

Photo 2.15 – Small reserve

2.5.2 Walking and cycling trails

A master planned network of walking and cycling trails is proposed as part of the development (refer Fig. 2.24). These trails will provide public access to areas, and in keeping with the environmental initiatives proposed in the development they will encourage cycling and walking in lieu of motor vehicles. In addition to this, the trails will promote outdoor activities and improve the sense of community, whilst also discouraging crime and unlawful activities via the casual surveillance provided by public access throughout the development.

As outlined within the residential description, the zone designated as Northern Waterfront will incorporate a public boardwalk style walking and cycling trail that follows the line of the waterway. This will provide an important public amenity that will allow all members of the community access to an attractive trail along the edge of the water and also provide a pedestrian and cycle linkage to the township of Mannum.

Preliminary contact has been made with Friends of Mannum Walking Trails Group (FMWTG). The group is currently planning extensive trails throughout Mannum and has indicated a willingness to participate in the planning of the extension of the trails throughout the Mannum Waters development. The trails will pay particular emphasis to the Aboriginal cultural heritage and the environment.

Photo 2.16 – Typical walking path

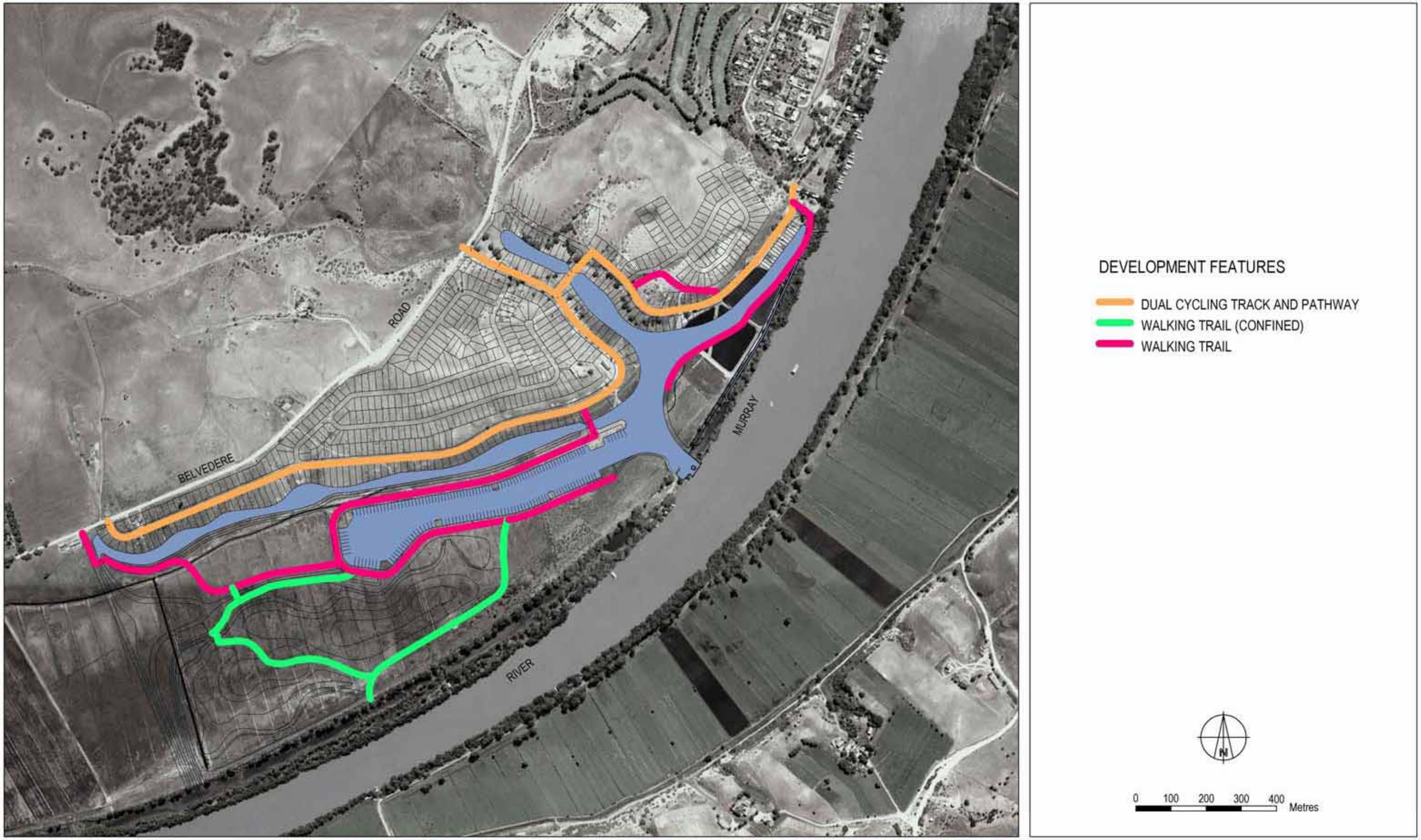


Figure 2.24 – Walking trails cycling tracks

Photo 2.17 – Typical boardwalk across water

Photo 2.18 – Typical boardwalk adjacent water

2.5.3 Golf course extension

The existing Mannum Public Golf Course directly adjoins the proposed development site on the northern side. The proponent initiated discussions with the Club to ensure that future plans for the course were incorporated into the development plan for the site. A key outcome of these discussions was learning of the Club's desire to increase the size of the course from the existing 9 holes to a more commercially viable and attractive 18 hole course.

The proponent has proposed an area of land within the development to assist in the expansion of the course. As part of this expansion, it is envisaged that the residential precincts adjacent to the course would be designed to ensure interaction by neighbouring residents with the open space provided by the course. This interaction with the improved golf course will not only provide an important recreation and tourism facility for the town of Mannum but will also adds to the large areas of open space proposed within the development. While the proposal facilitates the future expansion of the golf course, it does not in itself form part of this EIS.

2.5.4 Wetland reserve

An extensive constructed wetland is proposed in the development. This is separately discussed in Section 2.8.

2.5.5 Revegetation areas

Revegetation areas are proposed throughout the development. These are not generally for public access but add to the overall amenity of the development. They are discussed separately in Section 2.9

2.5.6 Car parking

Residential allotments will all be required to provide parking for vehicles as per the local council requirements and the details outlined within the charter document. Parking will be provided in the marina area for houseboat owners at 90 degrees to the road on the grassed verge and adjacent to the relevant houseboat berth.

In addition to this additional parking will be provided around the marina road and within the commercial zone. Provision will be in accordance with normal planning requirements.

It is anticipated that the following car parks will be required:

- Commercial area – 50 spaces
- Adjacent to casual houseboat area – 20 spaces
- Off the marina road at southern end of the marina – 50 spaces (secure long-term)
- At cul-del-sac the end of the marina road – 20 spaces
- Marina berths – two per berth on grassed verge
- Boat ramp – 20 trailer spaces

2.6 ABORIGINAL CULTURAL HERITAGE AREAS

Aboriginal cultural heritage areas for preservation are shown on the Development Plan on Figure 2.3. The areas were located by heritage consultants and subsequently confirmed by representatives of the Mannum Aboriginal Community Association Incorporated (MACAI). A final accurate identification was made by detailed survey. A description of the studies undertaken and the degree of consultation are included in Chapter 10.

Six midden sites have been included within the preserved areas and one further area of general cultural interest has also been included as a preserved site. In addition three scarred trees have been located and will be protected. All sites have been shown on the Development Plan and are highlighted on Figure 2.3.

Each cultural area for preservation has been included within proposed public reserves. Preservation techniques have not been determined but various solutions have been discussed with MACAI representatives. Procedural agreement has been reached with MACAI representatives for appropriate actions during the design and construction development of the project to ensure that the most suitable protection will be undertaken for each site.

2.7 PUBLIC INFRASTRUCTURE AND UTILITIES

Comprehensive infrastructure will be provided to support the development. Normal standards required by approving authorities will apply.

2.7.1 Roads

The road system is shown in Figure 2.25

(A) Belvedere Road access

The main access to Mannum Waters is via the existing Belvedere Road and is located approximately 500 metres from the existing Mannum waste disposal depot as shown on Figure 2.25. A secondary access is located a further 1500 metres south along Belvedere Road. No other vehicular access is proposed for the site.

Access from Mannum is from the north and passes residential areas, rural living areas, the golf course, cemetery, existing waste disposal depot and rural lands. Belvedere Road continues along the northern boundary of the development, and provides an alternative route to Murray Bridge, linking with the Murray Bridge/Mannum Road. Belvedere Road is sealed from the north to the waste disposal area. Thereafter it is unsealed (refer Photos 2.19 and 2.20).

Near the proposed main entrance, Belvedere Road crosses a creek. A culvert exists to transfer stormwater from the western side of Belvedere Road to the east. Flooding of Belvedere Road is experienced on rare occasions. Consideration will be given to a new design of Belvedere Road at the main entrance to avoid future flooding at this point based on a 100 year return frequency storm event, management of flows to the development site and traffic movements at the new intersection.

Figure 2.25 – Road layout

Photo 2.19 – Belvedere Road looking south from the northern site boundary

Photo 2.20 – Belvedere Road from the air

In Stage 1 of the development, the seal on Belvedere Road will be extended to the main entrance. Further extensions to the sealed surface on Belvedere Road will be subject to Council requirements as other stages proceed.

The new entrances have good sight distances on Belvedere Road and normal township speed controls will prevail. Entrance design and signage will be in accordance with good practice and Council requirements.

(B) **Main access road**

The Mannum Waters main entrance road follows the contours along the western edge of the gully from the marina entrance to the commercial area. It will be sealed, with a road reserve of 18 m and dual carriageway widths of 5 m (entry) and 6 m (exit) and a 3 m wide median for the first 50 m of internal road. At the junction with Belvedere Road, a 6 m wide exit lane will be provided, in order to permit both a left and right turn lane to be developed on the approach to this T-junction.

A dual carriageway will also be provided adjacent to the proposed commercial area. There would be 5 m wide carriageways and a 3 m wide median at this location.

The main circulation road, between the above two sections of dual carriageway will be 8 m wide (without a median), with tapered sections of road where the pavement widens and narrows.

There will be a footpath and cycle track on one side of the main collector road.

The main access road joins the secondary access road at the intersection with the marina road and provides a collector road system for the development. Consideration will be given to traffic control measures on this collector road. For example, roundabouts will be located at proposed T-junctions along this collector road in order to control vehicle speeds.

The dual road will be located at an elevation to allow access to housing at all times other than floods which exceed the 1956 flood level. The road will be provided with roll-over kerbs and stormwater collection drains. Services will be located at agreed locations within the road reserve in accordance with standard South Australian practice. Street lighting, street signs and road traffic signage will be provided as required by the approving authorities

(C) **Secondary access road**

This access road will have a single 7.2 m wide carriageway from the southern Belvedere Road entrance to the proposed dual carriage to the west of the commercial area site. It will act as a collector road for the traffic generated from the western allotments and particularly for drivers wishing to use Belvedere Road (west) to travel to Murray Bridge and avoid Mannum.

As in the case of the main access road the secondary access road will follow the contours at levels which will facilitate access to houses above the 1956 flood level.

The road will be provided with roll-over kerbs and stormwater collection drains. Services will be located at agreed locations within the road reserve in accordance with standard South Australian practice. Street lighting, street signs and road traffic signage will be provided as required by the approving authorities.

(D) **Internal residential roads**

Roads within the subject site, excluding the above collector carriageway road, will have road reserve widths of 15 m and pavement widths of 7.2 m. This will permit drivers to park along the kerbs of these roads. However, generally residents will be expected to park off-road on allotments to normal Council requirements.

Where culs-de-sac are provided, a turning circle area will be constructed, with dimensions suitable for the turnings of a waste pick-up vehicle and fire truck (25 m turning circle).

The maximum grade on these roads will be no more than 10%, with lesser maximum grades being sought during the design phase of the project

Although pedestrian and bicycle access will be provided to the existing River Lane, vehicular access will not be allowed. This will preserve the characteristics of River Lane from being affected by traffic entering and exiting Mannum Waters.

Street lighting, street signs and road traffic signage will be provided as required by the approving authorities.

The development to the north-east of the gully and to the marina will be accessed via bridges spanning the waterways. Bridge heights will allow passage of small vessels along the waterways but houseboats will not be permitted beyond the marina casual berths and the refuelling station in the commercial area.

The residential roads are indicative only and subject to more detailed planning and design. However, the roads shown on the development plan are considered to provide a fair representation of the final development.

(E) Marina road

The marina road reserve will be 15 metres wide and have a sealed pavement width of 6.5 metres. The road will not be kerbed and stormwater run-off will be directed away from the waterways across grassed verges to the revegetation areas. There will be sufficient distance between the pavement and the houseboat access paths to allow two car parking spaces per marina berth.

Road access to the marina will be controlled by a security gate.

The marina road will terminate in a cul-de-sac, with the turn around facility being able to service the turning of a large rigid truck or fire vehicle (25 m turning circle). All vehicular access to the riverine wetlands area and river bank will be prevented by suitable barriers.

The Marina road will be located at a level approximately 1.3 m above mean river level i.e. approximately 2.05 AHD) and will be subject to infrequent flooding. The 1993 flood level reached 1.85m AHD (1 in 20 year flood level) at Mannum and would have been contained within the marina. Only the floods of 1931, 1956 and 1974 have exceeded the proposed road level.

(F) Road design

Standard road design practices will be used for pavement thickness and material selection, road profiles, traffic calming and traffic control. The design practices will be subject to normal Council controls.

2.7.2 Stormwater

(A) Site run-off

At Mannum Waters, apart from measures to retain water within the household allotments, it is considered, that the best practice for preserving stormwater falling on the roadsides, is to return that water as cleanly and as quickly as possible to the waterways that will form an extension of the River Murray. Consequently a comprehensive underground stormwater drainage system is proposed for the residential and commercial areas.

The residential areas comprise a number of small catchment areas. Drainage in each of these areas will be designed on the basis of a 10 year return frequency storm. Roads and reserves will be capable of carrying flows from 100 year return frequency storms without flows surcharging to the allotments.

Each drainage system will terminate at a gross pollutant trap with a self cleansing screen. Flow from the pollutant traps will discharge to small wetland detention ponds located in public reserves prior to entering the waterways. Normal return flows to the river from the waterways and Marina will be via the constructed wetland.

A typical arrangement for a small detention pond within a localised reserve is shown in Fig. 2.26. Fig. 2.27 shows a conceptual layout of the stormwater system which will be subject to final design. Photos 2.21, 2.22 and 2.23 show details of a gross pollutant trap with self-cleansing screen.

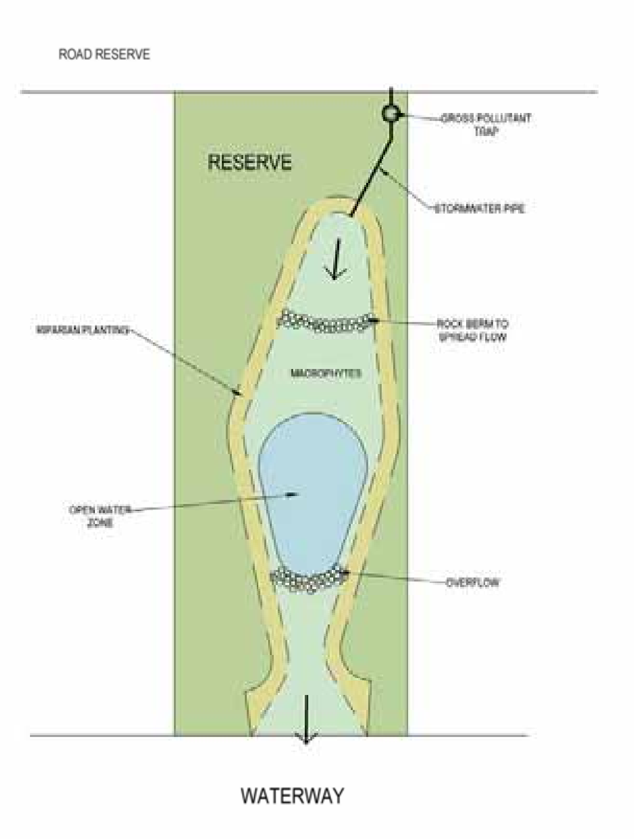


Figure 2.26 – Typical layout of small detention pond

Figure 2.27 – Typical stormwater drainage system

Photo 2.21 – Typical self-cleansing gross pollutant trap

Photo 2.22 – Surface cover to gross pollutant trap

Photo 2.23 – Showing effectiveness of gross pollutant trap

(B) **Creek flows**

A creek enters the site from the north-west through a culvert under Belvedere Road. The creek's catchment area is approximately 31 km^2. As indicated previously in Section 2.7.1, the redesign of the culvert beneath Belvedere Road will be subject to careful consideration during the design stage to balance entrance flows, entrance velocities and retention levels west of Belvedere Road.

Some very minor run-off enters from the high ground of the golf course but it is of little consequence and can be handled within the internal drainage system.

2.7.3 Wastewater

Wastewater will be discharged from various facilities within the proposed development. Although some commercial facilities involving retail, dining and tourist accommodation are proposed within the development, the nature of the wastewater can be categorised as domestic sewage with minimal industrial discharge.

(A) **Existing situation**

The Mannum township is currently served with a sewerage system constructed and operated by SA Water. Treatment is undertaken on Crown Lease land occupied by SA Water with final polishing and storage of the treated effluent occurring within open storage lagoons. The storage lagoons are located on the River Murray floodplain delineated by the 1956 flood level. The details of the existing plant are discussed in Section 6.5.4.

(B) **Wastewater development proposal**

It is the intention within the Mannum Waters development to undertake the following:

- provide a comprehensive wastewater collection system to all new allotments, marina berths, commercial facilities and public toilets and deliver the wastewater to a new wastewater treatment plant
- provide a new pumping station and pumping main to deliver all wastewater from the existing township to the new wastewater treatment plant
- provide a new wastewater treatment plant during Stage 1 to serve the existing township and the whole of the proposed development on a site located above the 1956 floodplain level
- treat all wastewater to a Class B quality standard for reuse and distribute the reclaimed water in accordance with the Department of Health and EPA guidelines
- as required, provide winter storage or alternative disposal sites for the reclaimed water during times when normal irrigation is not appropriate on recreational and amenity areas
- provide a new pumping system for the supply of reclaimed water to the Mannum Golf Club and other sites where the use of Class B reclaimed water is possible
- provide a new pumping system for the supply of river water for watering the Mannum Golf Club greens
- transfer the ownership of the existing Crown Land, currently occupied by SA Water, to the proponent after completion of the new wastewater treatment system
- rehabilitate the area occupied by the existing lagoons for use within the development.

(C) **Sewer collection system**

The existing sewer system comprises gravity drains from each of the township allotment connections, terminating at several pumping stations along the river front and ultimately discharging sewage to the existing SA Water treatment plant through a 200mm pumping main.

It is proposed to terminate the main in a new pumping station and provide a pressure main to the new wastewater treatment plant to deliver the sewage to the plant.

Wastewater from a portion of the north-eastern section of the proposed development may also discharge to this pumping station if final design confirms this as an appropriate solution. Otherwise sewage flows from this area will be directed to new strategically located pumping stations for delivery to the new wastewater treatment plant. As the proposed development is separated from the existing township by the golf course and a deep gully, the new collection systems will be independent of the township's existing gravity drains.

Two collection systems to suit the various facilities are proposed for the new development (refer Fig. 2.28). As houseboats traditionally rely on suction for wastewater disposal, a vacuum disposal system is proposed for the Marina. Elsewhere the development will be served by gravity drains.

Figure 2.28 – Typical wastewater collection system

All roads adjacent to the waterways will be approximately 4.3 metres above mean water level. It is anticipated that gravity drains will be possible in all residential roads. If the final design indicates that this is not the case, the Marina vacuum system would be extended along the lower residential roads.

The vacuum system has advantages in regard to leakages as the pipes are subject to negative pressure. Final design will be determined by SA Water and the proponent will undertake the work in accordance with the accepted design standards of SA Water and the SA Department of Health.

A preliminary proposal for the collection of sewage and delivery to the proposed wastewater treatment plant has been prepared as shown in Figure 2.28. A number of pumping stations are proposed along the lower collector roads. Each pumping station would be equipped with an emergency standby generator to automatically start during times of power supply failures. Their presence would prevent overflow from the systems.

Telemetry systems and alarm diallers will alert operators to unforeseen emergencies. Emergency storages at the pumping stations would also be included as required. Generally there would be at least a 30 m buffer between the pumping stations and the waterways and this is occupied by the small stormwater detention ponds.

(D) **Reclaimed water**

The proponent has also considered the further treatment of a portion of the reclaimed water to a Class A quality standard. This would be used for distribution to high ground residential areas by a second pipe system. The use of reclaimed water in the residential areas would reduce winter storage requirements and the areas required for Class B disposal. Up to 240 homes, located beyond the required separation distance from the river, could be served in this way.

In the interest of energy efficiencies, treatment to Class B quality standard would have first priority where its use is a genuine benefit to the community and provides savings of other water which would normally be extracted from the river.

(E) **SA Water**

SA Water has advised the proponent of its willingness to develop a satisfactory solution with the proponent believing that a mutually beneficial outcome is both desirable and possible. SA Water will carry out its own probity processes for the new treatment plant to ensure that it reaches a high level of confidence that the proposed wastewater treatment plant provides a long term, reliable wastewater service for the Mannum Community.

There is no serious impediment to a satisfactory solution being determined.

2.7.4 Water supply

Potable water will be delivered to the development through an extension of the existing SA Water supply lines in Mannum. Typical water supply connections will be made to each new allotment and also to each houseboat mooring within the Marina. Fire hydrants will be included in the water supply system in accordance with normal land division standards. Hydrants will also be included within the marina area.

All water reticulation within the development will form part of the land division development costs.

Augmentation of the existing water supply will be required and SA Water has provided a detailed response to the proponent outlining the Corporation's requirements.

Recommendations by SA Water comprise contributions by the proponent for:

- an upgrade of the Water Treatment Plant to increase capacity by 1.4 ML/day to give a new total capacity at the plant of 5.5 ML/day
- a contribution of 60% of the cost of a new Low Level variable speed pumping station. The total station will have a capacity of 72 L/sec at 58 m head with a total power requirement of approximately 64 kW.
- a contribution of 75% of the cost of a new 2.1 ML treated potable water storage.
- laying of approximately 2.35 km of 200 mm diameter main from an existing supply point.

Timing of the augmentation will depend on the housing uptake and will be subject to agreement by SA Water. SA Water's recommendations have been based on several assumptions pertaining to water usage and population growth rates in Mannum. During the detailed design the implications of reclaimed water reuse and better assessments of demand will be possible to ensure augmentation occurs in sufficient time to meet the growing community's need.

2.7.5 Electricity supply and public lighting

Electricity supply to Mannum Waters was discussed with representatives of ETSA Utilities. A response setting out ETSA Utilities expectations was received by the proponent.

Electrical reticulation and lighting within the development will be undertaken by the proponent as a normal part of and to the normal standards of land division developments. The electrical services will be laid within the common service trenches which are standard in SA for all land divisions.

Electrical reticulation and lighting within the marina area will be owned by the Community Corporation. A supply point from ETSA Utilities for the marina will be located near the bridge entrance to the Marina and above the 1956 flood level.

Based on assumed housing uptake rates, representatives of ETSA Utilities have prepared estimates of cost for augmentation works at the Mannum sub-station and upgrading of supply lines. The augmentation works can be arranged in stages and there are no impediments to prevent the work proceeding.

2.7.6 Telecommunications

An advanced telecommunications network is proposed for the development. The details are yet to be developed with Telstra. Telstra have advised that extension of their services to the site is available.

Telstra cabling will be contained within the common service trenches.

Preliminary discussions have been undertaken with Telstra in regard to establishing Mannum Waters as a ‘Telstra Smart Community’. The Telstra Smart Community is a new concept that involves an agreement between the developer and Telstra to provide improved, integrated services to the end consumer.

2.7.7 Gas

The proponent has had discussions with Origin Energy in December 2005 regarding providing Natural Gas for the development.

Origin Energy advised that the existing gas main is located about 7 kilometres from the development area. The proponent was advised that a contribution of approximately $500,000 would be required in augmentation costs to service the development with Natural Gas. This does not include the cost of laying the gas mains within the development area. The proponent has no plans to service the development with Natural Gas and will encourage the use of solar water heating.

2.7.8 Embankment and levees

Much of old dairy flats are currently protected by a levee between the river bank and the flats (refer Photo 2.24). The dairy flats have a low surface level approximately 1.3 metres below normal river level (i.e.-0.65 metres AHD). When the levee bank is breached, water will flow from the river to the new waterways and, without the protection of new embankments, would flood the whole of the dairy flats on the development site and also flow to adjacent neighbouring sites in the south. A series of embankments are proposed around the waterways, marina and wetland areas to contain the water in the various facilities as shown in Figure 2.29.

Photo 2.24 – Dairy flats separated from the river by levee embankment

Figure 2.29 – Embankments and levees

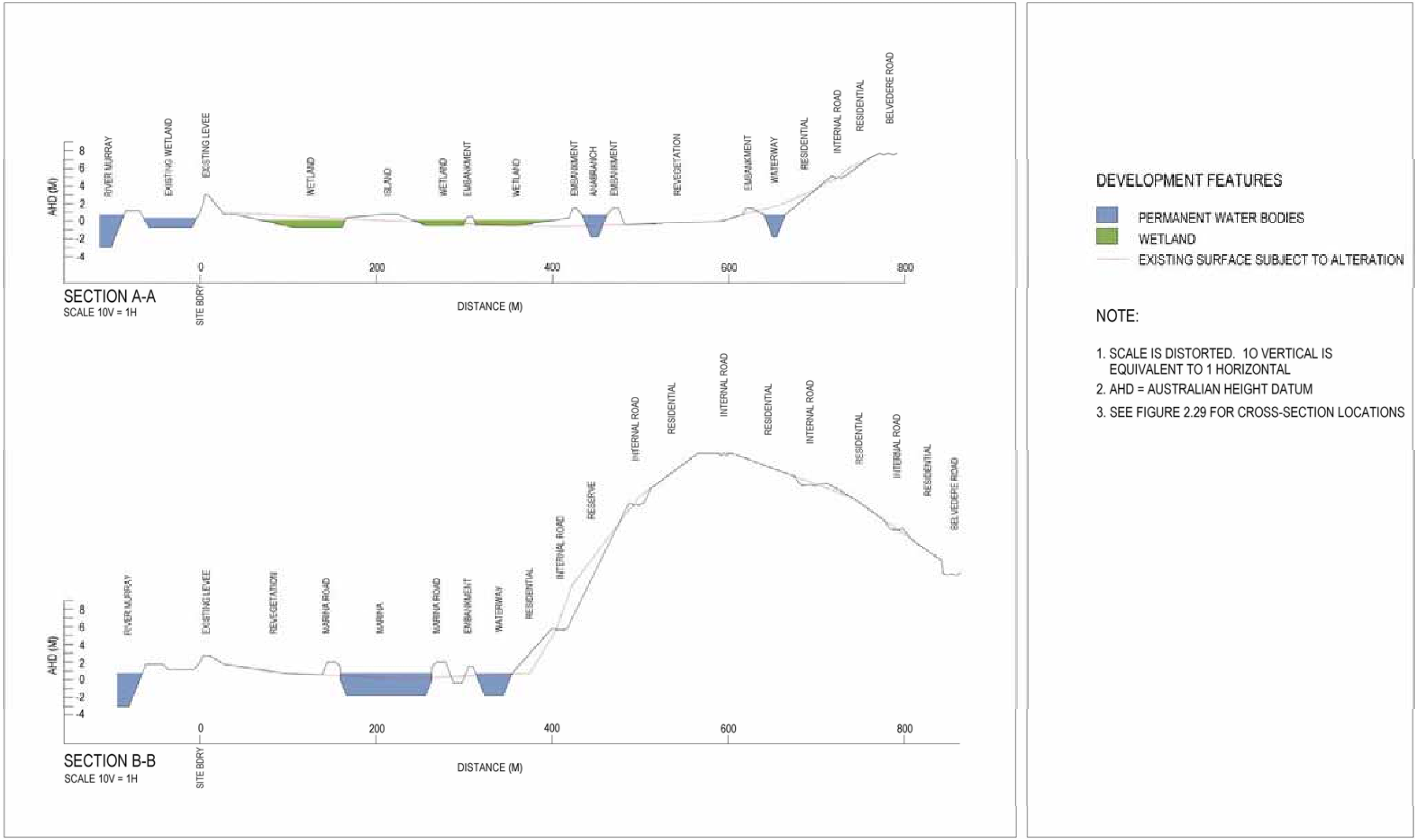


Figure 2.30 – Cross-sections through the site

The top of the embankments will be constructed to a level of 1.5 metres AHD. The Marina Road will be approximately 550 mm above this level. Cross-sections, with their locations shown in plan view in Fig. 2.29, have been drawn and detailed in Fig. 2.30 with the vertical scale exaggerated 10 times.

To provide protection to the neighbouring properties, a new levee bank will be constructed along the southern boundary of the site (refer to Figure 2.29) to the height of the existing levee bank (approximately 3.0 metres AHD).

The geotechnical report (refer Appendix D) has identified the available soils and their characteristics. Side slopes to the embankments will not exceed 1 vertical to 4 horizontal when the slopes are unprotected. Revegetation of the slopes will be undertaken to stabilise the soils. Apart from the internal Marina edges which are described in Section 2.3, the recommended slope will only be exceeded at the entrance to the marina and at the inlet and outlet channels. In these instances protection will be provided by the installation of appropriate geotechnical fabric and rock rip-rap except where sheet piling is used in their construction.

2.7.9 Waste management

Mid Murray Council operates a waste management program in Mannum which consists of a wheelie bin domestic garbage collection service for residences in the township and for holiday home areas. These residences are serviced on a weekly basis.

The proponent has preliminary discussions with the Mid Murray Council on this aspect of the development. It is envisaged that the residential allotments, marina and public areas will be serviced via the Council's existing waste management service.

2.8 CONSTRUCTED ANABRANCH CHANNEL AND WETLAND

2.8.1 Concept design

An important component of the project is the construction of marina waterway outlets that develop the characteristics of natural anabranch channels, a wetland area along the channel with the design characteristics and hydraulic capacity to provide a water quality treatment function for marina waterway through-flows and the rehabilitation of a large area of the retired former Baseby Irrigation Area as a wetland area. The total area of the channels and wetlands will be approximately 20 ha surrounded by 24 ha of wetland riparian areas, depending on final detailed design.

The concept plan for the wetland system is shown in Figure 2.31. The main features are described below.

(A) New outlet channels from the marina, waterways and treatment wetland

The channels are to be constructed and landscaped so that they eventually have the characteristics of a more natural anabranch of the river. Key features are as follows:

- the anabranch channels and wetland area are formed by the construction of levees.
- within the levees, the banks are laid back, providing for the establishment of a corridor of red gums, with lignum understorey and other associated vegetation, refer Figure 2.32.

Figure 2.31 – Concept plan for anabranch channel, treatment wetland and ephemeral wetland

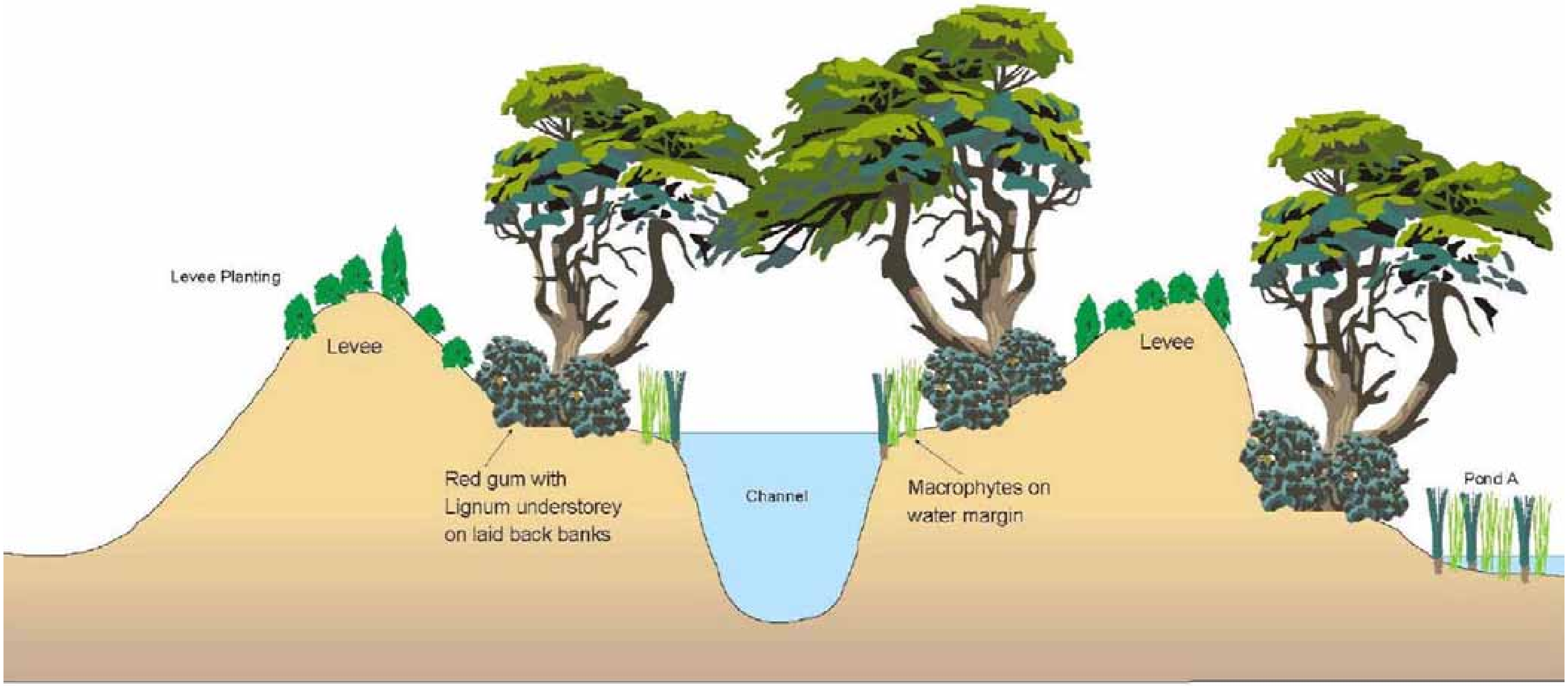


Figure 2.32 – Anabranch channel concept cross section

- the top of the levees, while providing the opportunity for a pathway and/or vehicle access, will also be vegetated with bushes and shrubs.
- the levee bank fronting the ephemeral wetland will also be laid back to provide for riparian red gum association establishment, refer Figure 2.32.
- the levels of the new levees within the wetland will be the same as the proposed embankments to the marina. The configuration and levels of the banks within the channel will be similar to those of the existing riverine wetland. This will also be varied along the channel, as in the existing riverine wetland, to facilitate habitat diversity. The levels of the riparian zone within the channel and associated plantings will be based on existing river levels, level variation and frequency of inundation required for their development and maintenance, refer Section 2.8.2 below.
- a single diversion culvert will be constructed, which will supply water to the ephemeral wetland from the anabranch.
- within the levees a wetland lagoon area of approximately 6 ha will be constructed, which also provides an important safeguard in the event of spillages in the marina waterways, refer Spill Contingency plan in Section 12.3.3.
- the anabranch channel wetland lagoon is shown separately on Figure 2.33, which includes some images from the existing riverine wetland area to illustrate the intended appearance along the channel.

(B) **Ephemeral wetland**

Key features are as follows:

- the wetland consists of two separate basins, each with two ponds referred to as Pond A and B on Figure 2.31.
- there is a single diversion from the channel to the wetland. Water can be separately supplied to each pond in each basin. In each basin, the physical attributes of Pond A are to be similar to the ephemeral wetland basins in the existing riverine habitat in that:
    - there is a range of depths when full from approximately 25 - 75 cms, resulting in a number of smaller depressions, each with different periods of inundation and drying.
    - different degrees of shading when the riparian plantings are developed. Some sections of Pond A will be narrow, allowing effective shading when closed canopy finally develops. Some of the larger depressions will have partial shading.
- these factors will provide a variety of conditions suited to different aquatic flora, resulting in increased habitat diversity, ranging from shallow marshy conditions to more open water conditions. The initial plantings of species will also aim to establish diversity.

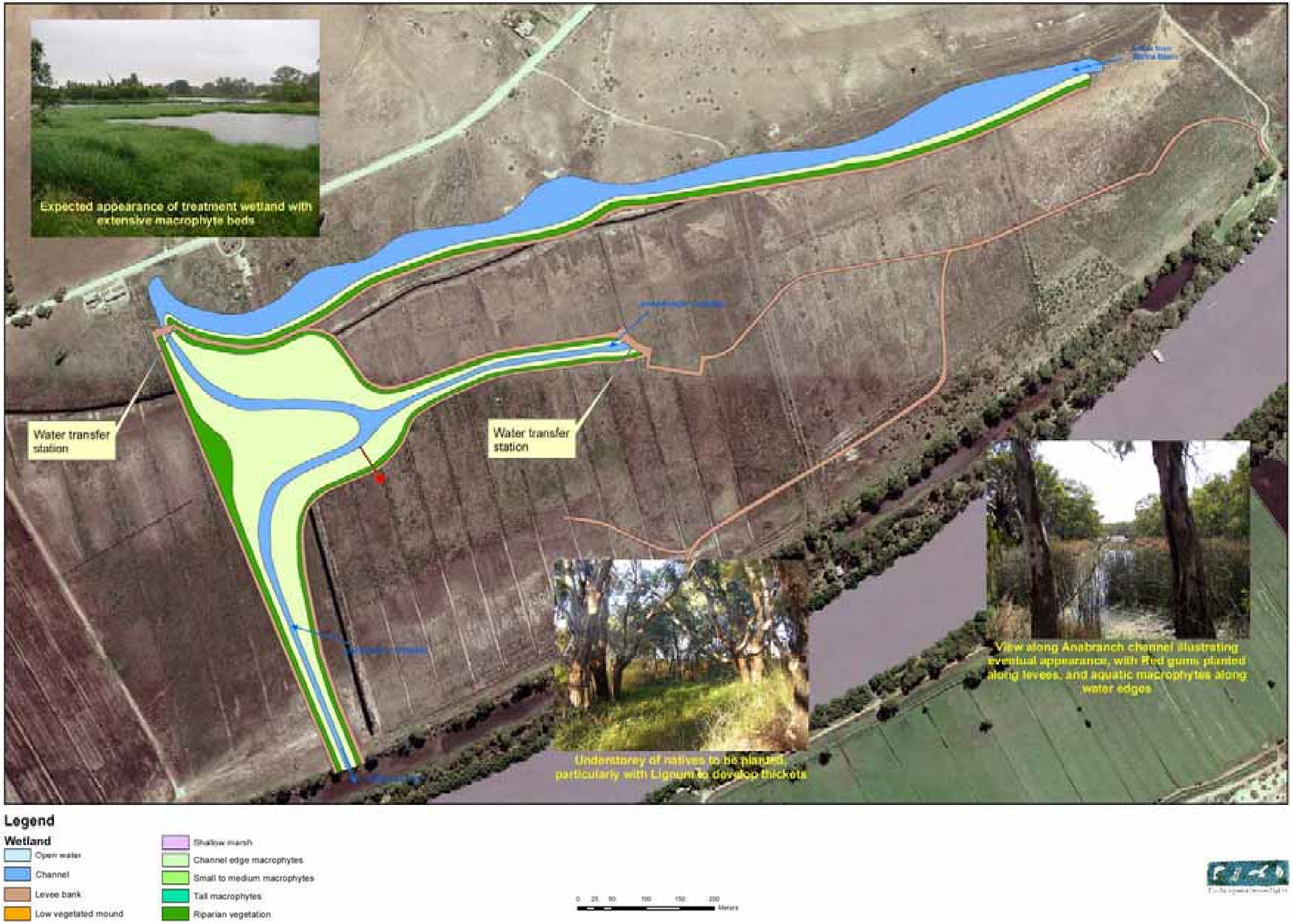


Figure 2.33 – Concept plan for anabranch channel and treatment wetland

- the embankments defining the ponds and basins will, as shown on Figure 2.31 have different heights. The outer embankments of Ponds B will be approximately one metre to allow for the establishment of low riparian and terrestrial flora. They will also be wide enough, between three and five metres, to establish a dense cover both for habitat and amenity. This will also be achieved by differences in the suite of species used along different sections of the embankments. The embankments defining Ponds A will be up to 2 m and between 5 - 10 m in width. This is to allow for larger species such as red gums and to allow for these ponds to be periodically flooded to a greater depth, as required for the maintenance of riparian species, see Section 2.8.2 below.
- ponds B will have large shallower areas, grading down to 40 – 50 cms depth when full, to allow for the establishment of swathes of small to medium height emergent macrophytes. Initial outplantings would include *Bolboshoenus sp* and *Eleocharis* (shallows). Selectively in the margins, taller thicket species such as *Schoenoplectus* and *Phragmites* will be planted. A range of other species will be introduced along the margins, including *Juncus sp, Carex sp, Cyperus sp.* etc.
- larger open water areas will be provided, as the macrophyte growth is controlled by depth, which will suit some bird species.
- the single diversion to the wetland will have a fish screen, to reduce the impact of larger carp entering the ephemeral wetland. The drying cycle will benefit native fish over carp. This is discussed further in Sections 2.8.3 (detailed design development) and 12.3.1 (long term wetland management plan).

The concept plan (Figure 2.31) identifies the main features. The site issues, which had to be considered in the development of the concept, are outlined below. The detailed design will identify the depth profiles in more detail, including the periods and depths of inundation. The initial planting plan for the aquatics will take into consideration these factors and aim to include a wide variety of species. The development of the wetland will occur progressively. This is to ensure that each area has adequate maintenance and the desired aquatic species establish cover as soon as possible. This is important to prevent the establishment of invasive species such as *Typha.*

The concept for Ponds A is shown separately on Figure 2.34 together with some images from the existing riverine wetland, which illustrate the design and landscaping intent. Similarly, the concept for Ponds B is shown separately on Figure 2.35, together with some images taken from the Laratinga Wetland at Mt. Barker, constructed in 2001, to also illustrate the design and landscaping intent.

2.8.2 Site issues for channel and wetland design

(A) Land and river water levels

Actual water levels for this section of the River Murray are shown in Figure 2.36 based on data from Murray Bridge for the period January 1988-June 1998. Over the period, water levels varied between approximately 0.4 –1.75 m AHD. Land levels for the reclaimed former dairy flats are generally around -0.6 m AHD (refer Figure 3.1). Using daily records, for the ten years of observations, the proportion of time for each month that various water levels are exceeded are shown in Figure 2.37.

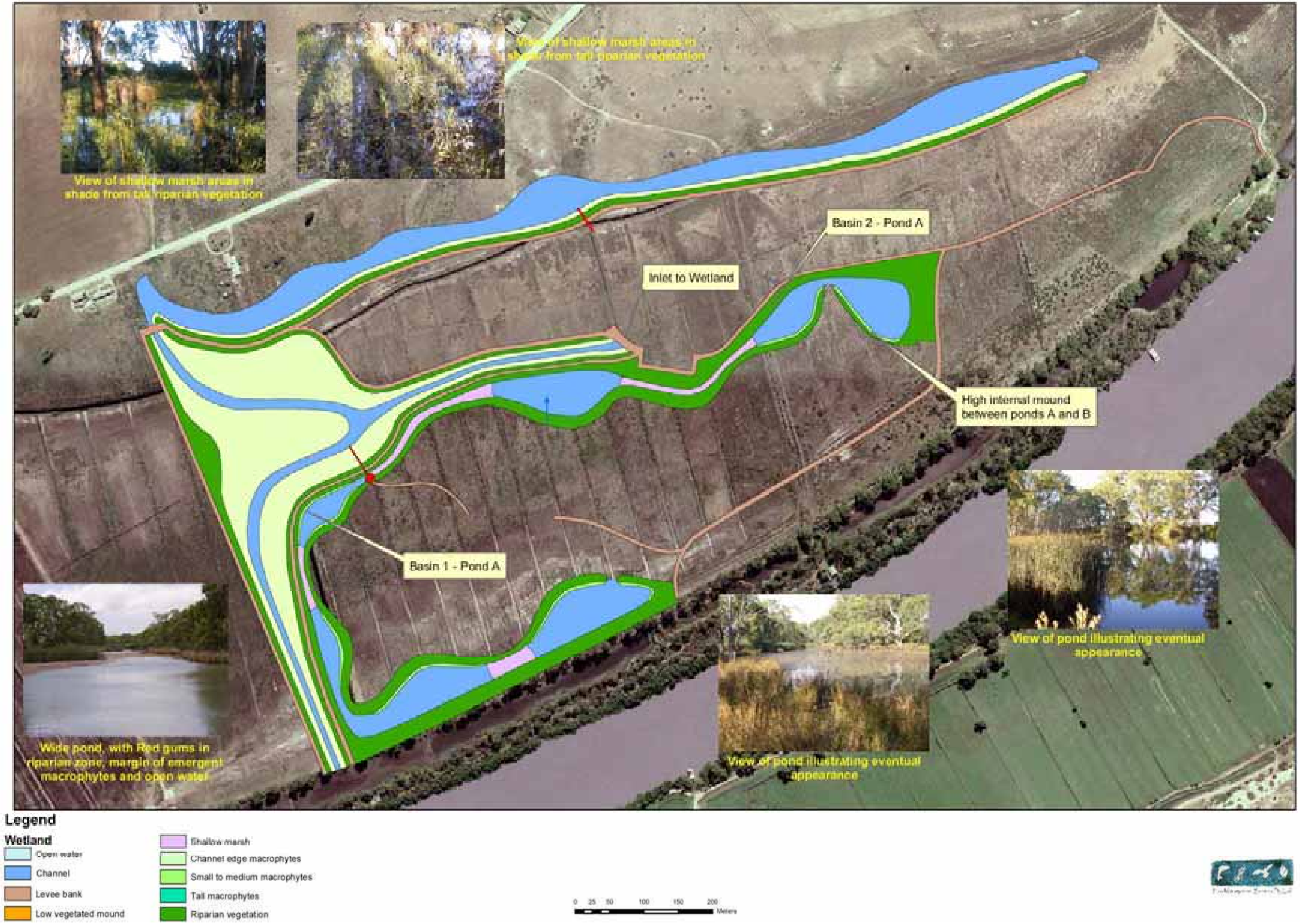


Figure 2.34 – Concept plan for Pond A

Figure 2.35 – Concept plan for Pond B

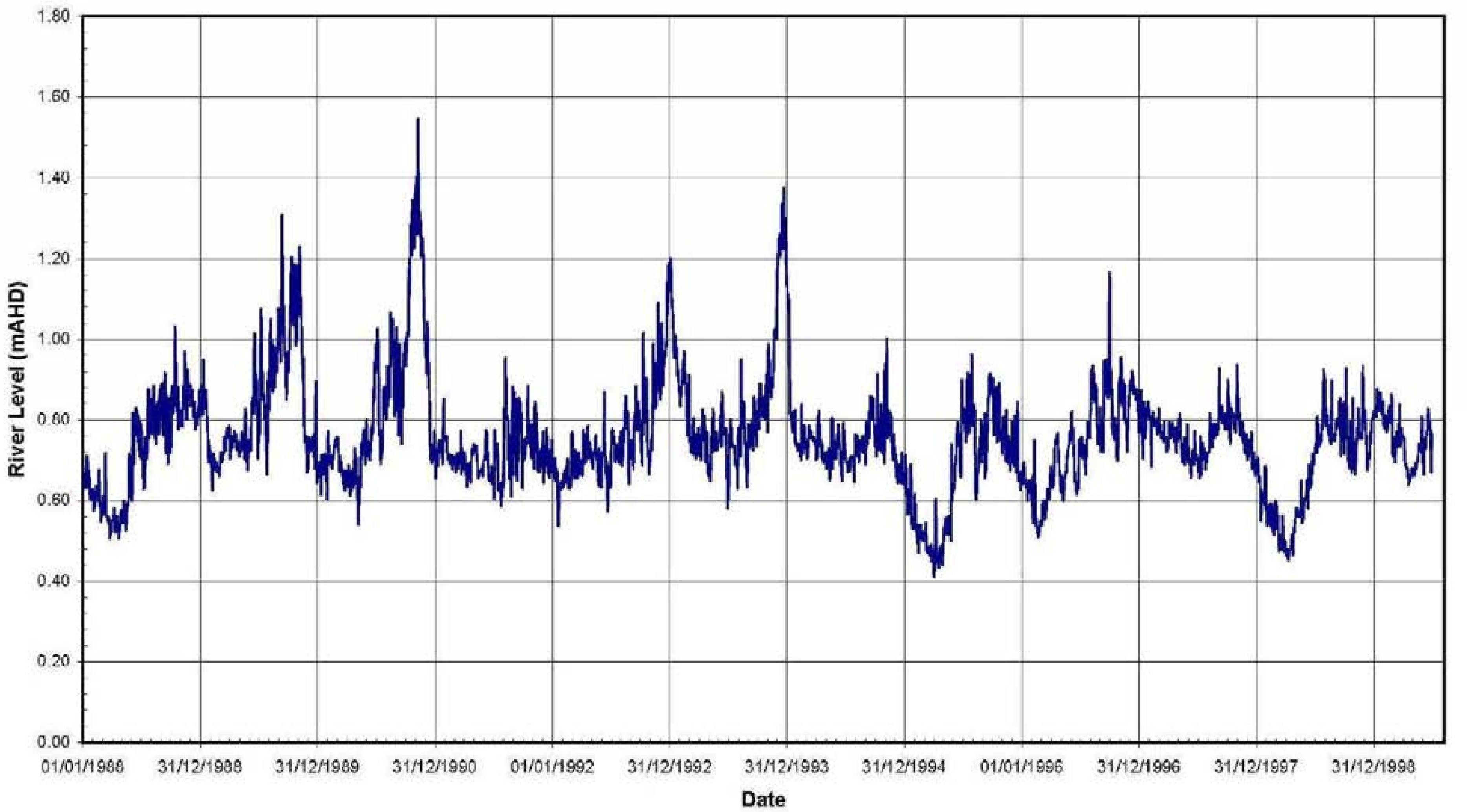


Figure 2.36 – Murray Bridge river levels (mAHD) 1998-1999

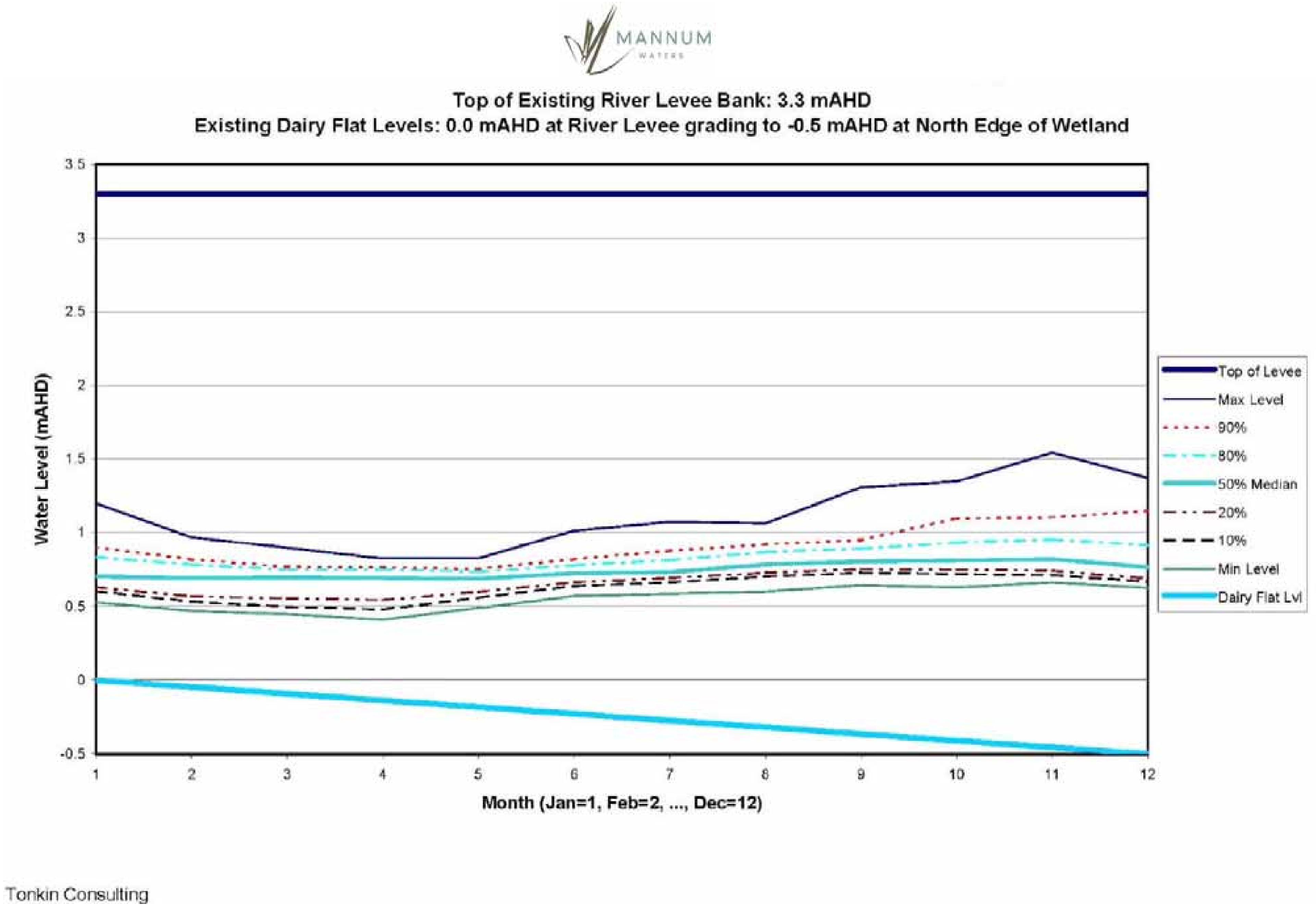


Figure 2.37 – Murray Bridge daily water level

(B) **Hydrological regime and wetland habitats**

A shallow ephemeral system is proposed, which mimics the natural water levels experienced in the flood plain in this region of the river. Important considerations are:

- to develop a wetland concept, which keeps to a minimum the volume of water required each year for its ecological maintenance
- based on the Guidelines for hydrological management (Tucker et al 2003), the inundation patterns and ecological benefits are:
    - because of the existing levels on the former dairy flats, the ephemeral wetland cannot have a gravity outflow to the river. Water level variation will be by diversion from the channel for inundation and water level reduction by evaporation
    - a range of water depths of approximately 0-25, 50 and 75 cms will be developed by a cut and fill construction, with the excavated material used to create mounds in the wetland
    - the wetland should have its maximum inundation during the October-December period and the lowest water levels in the May-August period

Each year the wetland will receive water by diversion. However to mimic more natural patterns the system will be managed on a two year cycle, with an extended wet period, up to approximately 12 months in the deeper areas in one year, and an extended dry period of up to 6 months in the second year. The ecological benefits are briefly summarised as follows:

- the dry period, from late summer to early spring, will extend up to 6 months on a two yearly cycle. This will enable the development of a range of dry wetland bed plants, allowing them to complete their life cycle and the build up of a seed bank. Complete drying for an extended period will also enable the consolidation of sediments, minimising re-suspension during inundation
- the annual and seasonal water level variation will facilitate the development of emergent macrophyte beds, which require fluctuating water levels as part of their growth cycle
- The dry period will also assist in the management of carp, which are likely to enter the wetland from the river
- the period of full inundation, early spring – late summer, allows the germination and development of the submerged aquatic macrophytes (pondweeds), algae and biofilms on surfaces. These, together with the emergent macrophytes, support a diversity of macroinvertebrates, fish, amphibians and other species higher in the food chain e.g. birds etc.
- periodically, a flooding regime is managed (see below), when the riparian zone is inundated. It is intended to establish red gums over much of this zone with a dominant lignum understorey. Over time, the intent is to achieve a similar riparian habitat as that of the existing riverine wetlands, described in Section 7.5. Periodic inundation is a requirement for the maintenance of this vegetation. It also encourages the establishment of emergent macrophytes up the banks into the riparian zone. This

includes species such as the common reed (*Phragmites australis*). In some areas of the existing riverine wetlands it has developed dense stands as an understorey under the red gums, refer Section 7.5. This period of higher level inundation will be maintained for 4-7 months, every 3 years. The period of high level inundation will be followed by a drying phase, allowing the root zone of the riparian vegetation to become aerated, which is also required for their maintenance.

(C) **Wetland design and water level management**

Examining Figure 2.31, points to note are:

- the ephemeral wetland consists of two basins, each with two ponds. Each basin and pond can be independently supplied with water.

  Advantages are:

  - the water levels in each pond can be independently manipulated.
  - the annual patterns of extended inundation and drying can be alternated for the two basins.
  - having an extended period of inundation in some part of the system each year has benefits in maintaining a freshwater lens under the area.

  There is a single diversion from the anabranch channel to the wetland, with a flow control structure enabling inflows to the wetland to be diverted to all or any one of the four ponds.

- within each of the two basins, ponds A and B can operate at the same level, by means of a box culvert in the embankment separating both ponds. This culvert can be closed, allowing pond A to fill to a higher level, inundating the riparian zone, simulating natural flooding patterns. This is illustrated in Figure 2.38.

- the inflow and box culvert design will allow the rate of inundation to be controlled. Water draw down will occur as a result of seepage losses and evaporation. This will need to be compensated by additional diversions from the anabranch channel to ensure the required period of wet and dry conditions. Consequently, there will be a low draw down rate.

- although a flooding inundation of the riparian zone is facilitated by the embankment heights and water level manipulation in the individual ponds, it could also be achieved by totally inundating the area during occasional flooding in the river, taking advantage of these events. This would allow a large volume to enter the wetland and the interchange of biota. The inundation would also flush the area, minimising the risk of salinity increases. The period of inundation would need to be minimised to a few weeks at most to avoid losses to vegetation. This would also minimise evaporative losses. Water would need to be pumped back to the river.

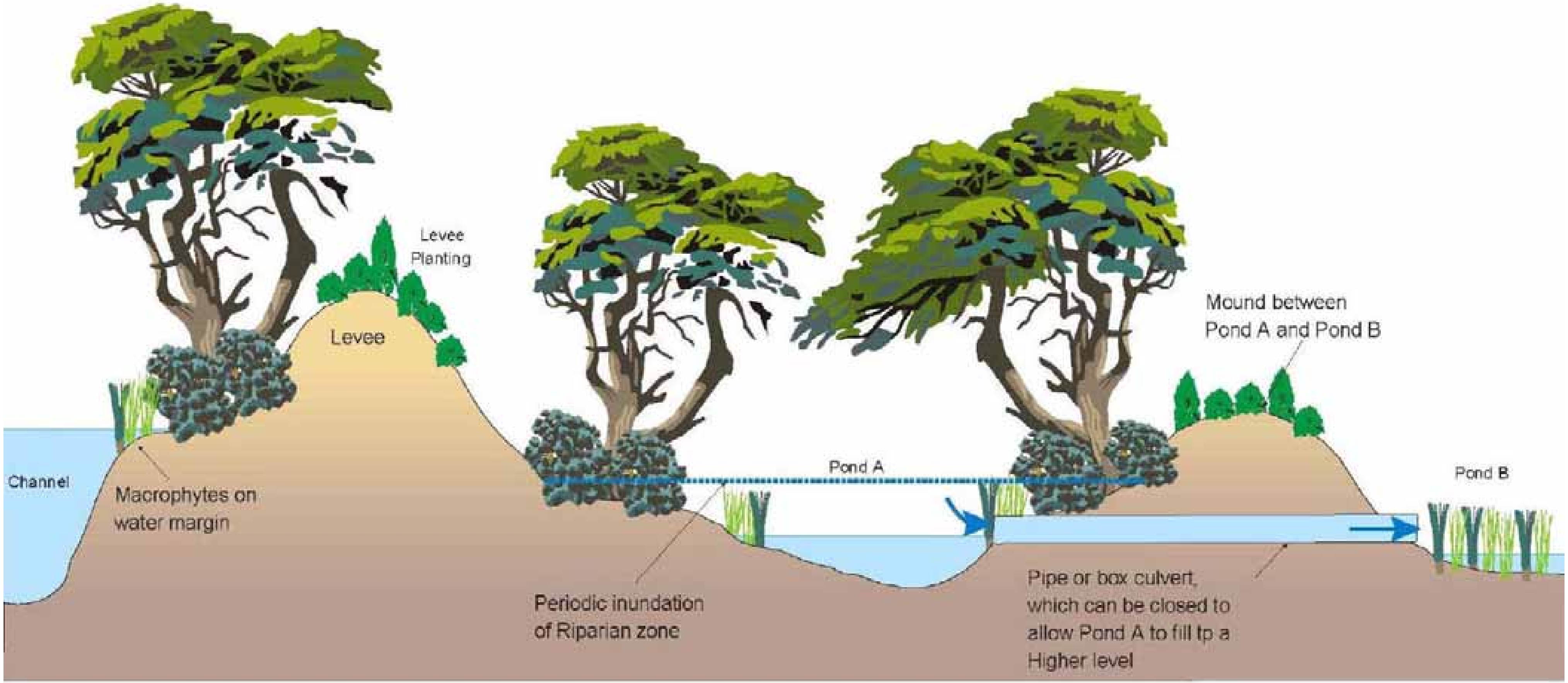


Figure 2.38 – Flooding of Pond A concept cross section

(D) **Water volumes**

The total area of the anabranch channel and ephemeral wetland area is approximately 19.1 ha. The wetland water requirements are presented in the water balance in Section 11.2.2

Without irrigation, these retired dairy areas would gradually become more saline, particularly if the groundwater drainage system is not managed.

The average annual net evaporation from the wetland areas is approximately 1472.6 mm (without pan correction). The average monthly evaporation is given in Section 6.2.5 where it is shown that there is a considerable seasonal variation from approximately 208 mm in Jan. to approximately 48 mm in June.

To control the rate of drying out of the shallows through evaporative loss and provide the preferred duration of inundation, some additional water will be required. Without additional water to compensate for the evaporative losses and seepage the wetland would dry out too quickly and may not achieve its ecological objectives. This additional water will be provided by an Environmental Land Management Allocation (ELMA). For disused or retired areas, in order to control salinisation, ELMA's are available on application. Currently the allocation for this purpose for Baseby is approximately 6.0 ML/ha/yr. DWLBC have indicated that portion of the site (Sec 743, refer Table 3.1) occupied by the wetland and some revegetation areas (34.8 ha) is eligible for an allocation. An application will be made by the proponent for this water in accordance with the ELMA requirements.

(E) **Groundwater**

Underlying the site is a shallow groundwater table. The details are discussed in Section 6.4.

The wetland will be constructed so as to avoid intersecting the groundwater table. Water will seep from the wetland by unsaturated flow, which is likely to be very slow.

The positive head created by water in the wetland and downwards seepage is important in creating and maintaining a freshwater lens under the wetland allowing the establishment of a diversity of aquatic biota, preventing salinity build-up.

2.8.3 Detailed design investigations

In the development of the detailed design, the following investigations will be undertaken:

(A) **Groundwater**

The following will be determined:

- depth to water table and
- permeability of sediments.

This information will be required to determine the depth of excavation of the ponds and to assist in the design of a subsurface groundwater system.

(B) **Earthworks and final design**

It is intended that this be a balanced cut and fill operation as much as possible, although some excess material may be available from the excavation of the marina waterways. It will be a balance between the quantities available from the excavation of the anabranch channel and ponds and the requirements for the levees and pond embankments. This information and the quantities available from the marina basin will be used to finalise the design.

(C) **Survey information**

Detailed surveys have been undertaken across the irrigation flats to determine heights (AHD datum) and will be extended along the river front. This will be required for the civil engineering aspects of the design. The data collected from the river front area and the information available on river water level variations will assist in the development of the landscaping and planting plan for the various pond areas. It is intended to simulate as close as possible the hydrological regime of the existing ephemeral wetlands.

(D) **Anabranch channel outlet**

The outlet to the river will be placed and designed so as not to alter the existing hydrological regime of the riverine ephemeral wetlands.

(E) **Maintenance access**

Future maintenance will require vehicular access to key locations, including the diversion structure on the anabranch channel, culverts between Ponds A and B, groundwater interception system (pump or windmill) etc. The civil design and landscaping will allow for this access.

(F) **Landscaping plan**

A detailed landscape plan will be prepared as part of the design of the wetland (refer Section 2.9). It is not a case where the civil works are designed and implemented and then consideration given to vegetation. Rather the civil design is developed with regard to the requirements of the vegetation and the landscaping objectives.

For example, the depths, frequency and period of inundation for various aquatic macrophyte species intended for outplanting in the ponds will determine basin bathymetry.

(G) **Public access**

Public access to the new wetland is desirable, but will be controlled.

The landscaping plan will incorporate a path and boardwalk route through the wetland and anabranch channel area. While viewscapes will be provided over most of the area, it is likely that access to some areas will be prevented, probably by the establishment of thickets of prickly species, such as lignum. The path could also incorporate part of the riverine wetland area (refer Section 12.3.1 on the Baseby linear wetland).

(H) **Carp control**

The diversion structure will be designed to incorporate a fish screen. The intent will be to intercept larger specimens. Smaller native species will be able to enter. It will be possible to remove the screen enabling the removal of debris, which otherwise would cause blockages. While smaller juvenile carp can enter the ephemeral wetland ponds, the wetting and drying cycle provides a means of control. During the drying phase carp can be removed.

2.9 URBAN LANDSCAPE DESIGN AND REVEGETATION

2.9.1 General character

(A) **Objectives**

The landscape objectives are to encourage:

- the design process to reflect local character and existing conditions
- the retention and enhancement of naturally occurring vegetation and other natural features
- the designs to provide for the needs of the community by ensuring public space is functional, accessible and safe for intended purposes
- quality design that contributes to the built and natural environment and the special character of the development in a sustainable, aesthetic and cost effective manner and
- sustainable design through plant species selection and water wise garden/landscape design.

(B) **The vision for Mannum Waters**

The vision for the landscape of the Mannum Waters Development will be to design a subtle and responsive landscape to complement the river environment, to develop designs for reserves that reflect the river, its history and provide the development with a landscape that is unique and sustainable. This will be further reinforced with the constructed wetland and revegetation.

2.9.2 Urban design landscape guidelines

A comprehensive list of design guidelines has been prepared for the project and are included in Appendix E

Categories addressed in the guidelines are:

- paths and paving
- play equipment
- earthworks
- lighting
- street furniture

- planting
- residential streetscape
- turf and grasses
- riparian buffer zones

Photo 2.25 – Typical main entrance road streetscape

2.9.3 Revegetation

Substantial areas are to be revegetated, as shown in Figure 2.39. In all approximately 23.1 ha will be revegetated, including much of the area currently occupied by the existing wastewater treatment lagoons (approximately 5 ha). This revegetation will be undertaken progressively throughout the development stages.

Revegetation will follow the current “Revegetation and Vegetation Guidelines” prepared by the Mannum to Wellington Local Action Planning Committee. This is detailed further in Section 11.3.4. Currently, much of this area is salinised since dairying and irrigation ceased.

Figure 2.39 – Revegetation areas

The revegetation programme will have regard to this including:

- The use of low level mounds (up to 1 m) to facilitate leaching
- The use of ELMA water to leach salt. Approximately 6 ML/ha is available for this purpose and will be used
- The use of salt tolerant species.

There are a number of elements from the existing landscape to assist design. Natural floristic communities that make up the existing landscape are identified in Section 7.3 and include:

- the riparian/wetland zone that is immediately alongside the watercourse between the levee bank and the river.
- flood plain/swamp zone
- riverfront wetlands
- levee vegetation
- cliff-face zone
- samphire low shrublands
- chenopod low shrublands and
- nitre bush open and very open shrublands

The importance of these landscape types is that they dictate the species that should be used to complement the revegetation.

2.10 FENCING

Animal proof fencing is proposed at two locations to link between water-bodies and prevent stock, domestic and feral animals entering the wetland areas. One of the fences will be located along the southern boundary of the site. The other will include the security gate at the entrance to the marina.

In addition a secondary fence is proposed around the south-eastern side of the marina to restrict access from the marina area to the wetlands. This will be located below the embankment surrounding the marina and will be generally unsighted from the residential areas.

Controlled access will be permitted through the fences at the intersection of the walking trails with the fences and for vehicles at the security gate. The walking trails were discussed in Section 2.5.2 and shown on Figure 2.24. Fencing locations are shown in Figure 2.40.

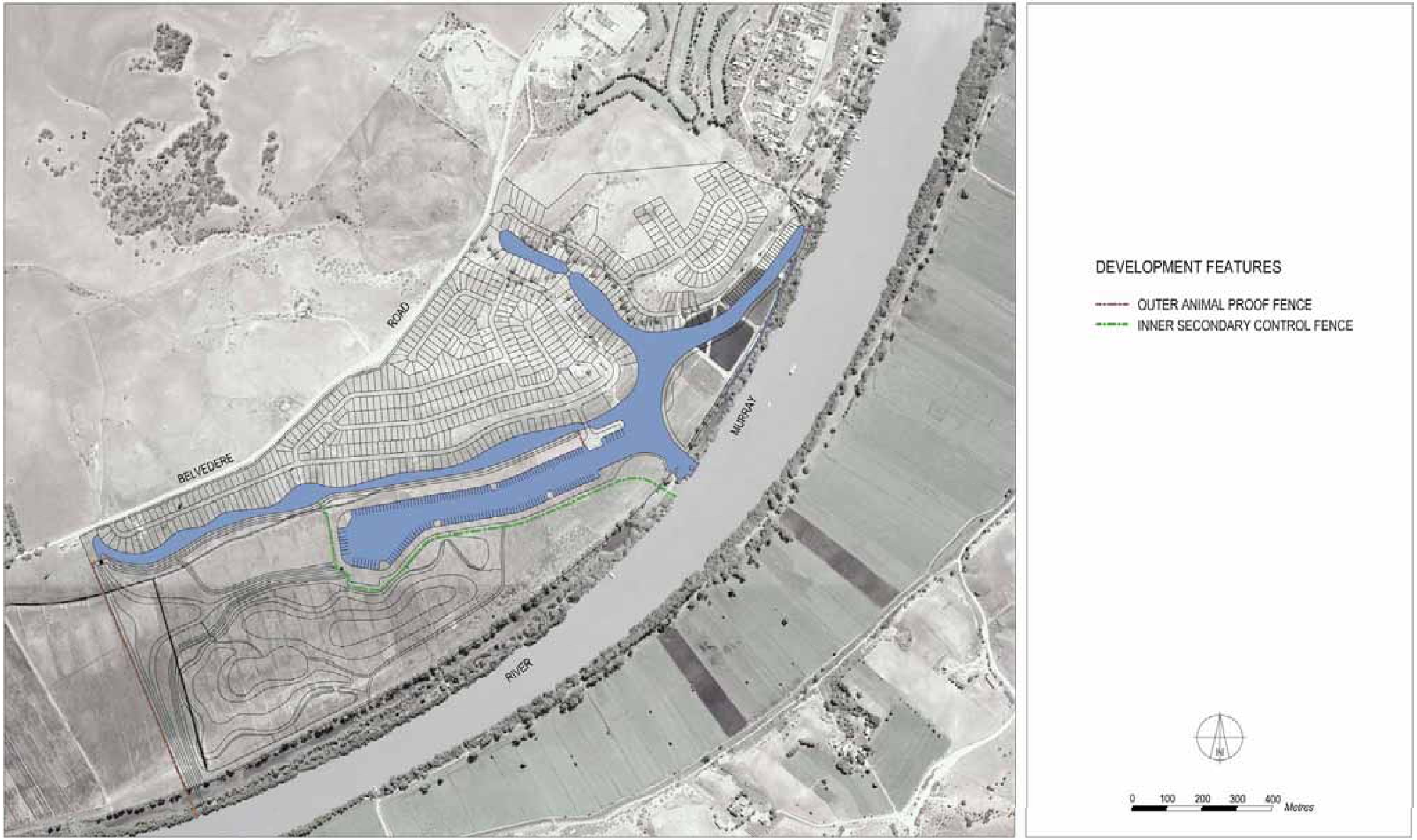


Figure 2.40 – Fencing locations

3 Subject land

3.1 DESCRIPTION

3.1.1 Existing land use

The existing land uses are discussed in Chapter 6 (refer Figure 3.1) and comprise:

- abandoned irrigated river flats (flood irrigated pasture) formerly used for grazing
- former irrigated areas (fitted sprinklers) of around 10 ha
- SA Water Sewage Treatment plant, lagoons and associated buildings and infrastructure, with vehicular access via River Lane
- five existing houseboat berths and an existing houseboat shed (refer Photo 3.1)
- a brick dwelling and outbuildings
- rural buildings (packing shed and hay/implement shed)
- private access tracks connecting Belvedere Road to the river.

3.1.2 Existing environment

Four main topographical zones represent the development area. They are:

- riparian/wetland zone
- floodplain/swamp zone
- cliff face zone, and
- highland zone.

These are discussed in detail in Chapters 6 and 7. The existing contours are shown in Figure 3.2.

The highland zone comprises two distinct land forms delineated by the extent of the river flood plain. The low areas extend into an east/west gully which rises from the river bank to Belvedere Road by five metres and effectively dissects the high ground into two land units.

The land has been extensively cleared for dairying and kept under pasture both on the floodplain and the highland zones. With subsequent salinisation of the soil throughout the development site, dairying has been abandoned and a limited amount of native vegetation has recolonised the area. The flood plain has extensive boxthorn infestations.

The flood irrigated areas and highland areas have not reverted to freshwater species but rather species adapted to high soil salinities.

Figure 3.1 – Existing and former land uses

This section of the Baseby Irrigation Area, when operating as a dairy area was a significant pollution source to the river, particularly for nutrients and faecal micro-organisms from stock. This is discussed in more detail in Chapter 7.

Photo 3.1 – Existing inlet at the boat shed

3.1.3 Previous marina proposal

In June 1979 a permit was granted by the Government of South Australia for works to allow the construction of a development which included a mooring basin, holiday village and associated facilities. Two new sections were created from Part Section 743 viz Section 903 and 904.

The development was to have been located on Section 904 which was Crown Lease land. The Crown Lease, registered under Volume 1575 Folio 42, specifically identified the land for "Marina and Boat Mooring Purposes". The development did not proceed.

3.1.4 Adjoining uses

The major adjoining land uses are:

- North-east - urban residential development
- North - Mannum golf course fairways
- West - dryland farming
- South - former irrigated dairy flats, now grazing
- East: - River Murray riverine wetlands and river channel.

Adjoining land uses are identified in Figure 3.2.

Figure 3.2 – Existing site contours and neighbouring uses

Photo 3.2 – Mannum Golf Course

Photo 3.3 – Neighbouring dairy flats

Photo 3.4 – Waste disposal depot

Photo 3.5 – Riverine wetland

3.2 TENURE

The following (Table 3.1) is a list of land titles in the development area.

Table 3.1 – Land titles within the proposal site

Lot / DP	Owner	Land area (ha)
CT 5913/469 - Section 743 Hundred of Finniss	Tallwood Pty Ltd	52.13 ha
CT 5792/113 - Allotment 2 DP 17430	Tallwood Pty Ltd	11.03 ha
CT 5977/589 - Allotment 500 in DP 70381	Tallwood Pty Ltd	30.37 ha
CT 5871/733 - Allotment 61 DP 56840	BW & KJ Reschke—(Contracted to Tallwood Pty Ltd)	63.12 ha
CR 5267/641 - Section 770 Hundred of Finniss	Minister of Infrastructure—(under negotiation with Tallwood Pty Ltd)	15.28 ha
CR 5749/38 - Section 856 Hundred of Finniss	Minister of Environment & Heritage – Annual licence to BW & KJ Reschke (Under contract to Tallwood Pty Ltd)	0.79 ha
CR 5749/39 - Section 857 Hundred of Finniss	Minister of Environment & Conservation– Annual licence to Tallwood Pty Ltd	6.60 ha

During the development construction phase, tenure to the land currently held by the proponent will remain with the proponent.

Titles to land within the development area not currently owned by the proponent will be transferred to the proponent prior to commencement of the construction of the relevant stage.

In regard to land required for the new wastewater treatment plant and transfer of land for use in extension of the golf course, the final details are subject to on-going discussions with SA Water and Mid Murray Council (refer sections 2.7.3 and 2.5.3 respectively).

Copies of the Land Titles for each of the development areas are contained in Appendix F. Fig. 3.3 shows the location of the land shown on the Land Titles.

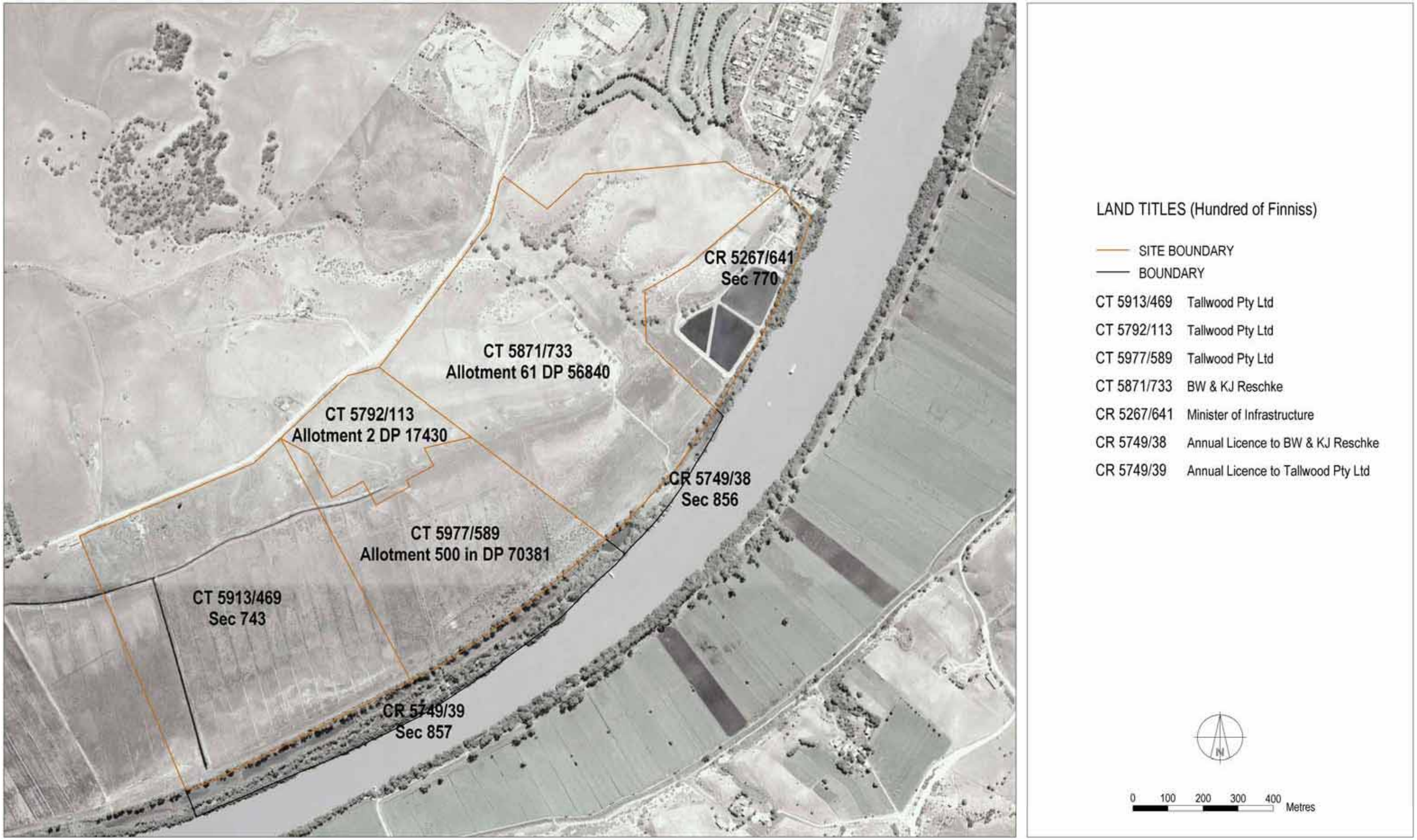


Figure 3.3 – Definition of land areas

4 Need for development

4.1 DEVELOPMENT OBJECTIVES

Although Mannum is the major urban centre in the Mid Murray Council area, and the Council area incorporates a very substantial part of the River Murray (220 km), there is no marina directly associated with the town. The Mannum Waters proposed marina and residential development project is a commercial enterprise based on satisfying a need for such facilities adjacent to the river.

This need is for the provision of facilities to cater for existing use, tourist/recreational expectations and at the same time to reduce local and regional environmental impacts on the River Murray. As such the objective of the proposal is to develop a facility that sets environmental benchmarks for future developments of this nature.

These objectives will be achieved by:

- developing a facility that will safeguard the river by mooring houseboats and riverboats off river in a strictly controlled environment.
- removal of the existing houseboat berths located on the river channel itself immediately adjacent the site
- causing water to flow from the marina basin and waterways to be treated through a wetlands area before returning to the river
- removing existing wastewater storage ponds from the sensitive river flood zone
- ensuring that existing natural wetlands and habitats are preserved and protected for future generations
- rehabilitating and restoring degraded river flood plains by extensive new wetlands and revegetation
- protecting Aboriginal cultural heritage sites
- establishing a Marina Owner’s Charter with environmental controls and use obligations
- expanding the residential living and commercial options in Mannum
- establishing a House Owner’s Charter with guidelines emphasising environmental sustainability and restrictions on plant species and the use of fertilisers
- providing valuable new recreation, educational and tourism opportunities
- providing new employment opportunities
- providing economic development opportunities for the State of South Australia.

4.2 STRATEGIC DIRECTIONS

Tallwood has identified the following environmental objectives for the development and adopted planning, design and operational strategies to obtain those objectives:

- facilitate measures to protect the water quality of the river
- encourage the development and rehabilitation of natural habitats
- secure the preservation of cultural heritage items
- ensure the sustainability of recreational activities
- enable community involvement through networking and interpretive information.

These strategies are in general accord with Government initiatives which are discussed in detail within Chapter 14.

4.3 BENEFITS

4.3.1 Strengthen regional centre

It is considered that the Mannum Waters development will strengthen the position of the town as a central place by:

- increasing the town's population (holiday homes, tourism and retirement) in a way that current growth could not achieve
- catering for both a retirement and working population base
- opening up the capability to improve other adjacent and existing facilities such as the golf course
- building on its existing and strategic river activities focus with the development of a new marina that will locate houseboats off river and provide pleasant mooring for overnight and longer-term stays
- strengthening the local economy and employment at the construction stage of the project and in providing employment in the marina and ancillary uses over the longer term.

Whilst the town is within the regional shadow of Murray Bridge, particularly in relation to retail, community and public services, the continued development of Mannum will justify better links with Murray Bridge, particularly for public transport. In addition, the higher threshold population will increase the likelihood of agencies or Government services and private sector activities locating in the town. The population of Mannum (2160 persons at the 2001 Census), and its significant fluctuations in population over the past twenty years coupled with a decline of its local industry base has not assisted its position as a centre.

The development of Mannum Waters can, because of its amenity and location, attract new residents to the town, which will be a major advantage in stabilising the town's future.

Photo 4.1 – Mannum main street

A strategic review of residential land availability and demand[1] (Mannum Residential Review 2002) considered both the Mannum Township and rural areas in the vicinity. A Plan Amendment Report (PAR), resulting from the review, sought to adjust the strategic plan to reflect the fact that land currently available for development in Mannum township was not particularly attractive to the growing number of people deciding to retire to regional centres. Allotments that are not close to or related to the River Murray do not attract either retirees or people seeking to take advantage of river frontage for recreational or scenic purposes.

While the average annual development of land for residential purposes within the Township has been between ten and twenty allotments, it is considered that this could be substantially increased if more water-related land were made available. Discussions with real estate businesses in the town (pers comm. Mr Wayne Chadwick-First National Real Estate 24/2/06 and Mr Adrian Davis Raine and Horne 24/2/06) indicated that there is a very buoyant market in the town for housing, particularly for allotments that are close to the water or waterfront locations.

The elevated nature of the proposed land and the opportunity to design for views gives an advantage in this regard. Although the proposal contains no rural living land this type of allotment is also in demand in the area and assists in focusing attention of the overall development of the town.

The local real estate market is significantly influenced by retirement and business growth in the region and both of these influences have been very active in recent years. It is likely that the proximity of the town to Adelaide and Murray Bridge will continue to reinforce it as a retirement and tourism focus.

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[1] Mannum Residential Review (Planning Advisory Services, 2002)

The proposal will offer direct access to the marina and waterways of the development for approximately one-third of residential allotments. Moreover, these allotments will not impact directly on the visual, environmental or recreational amenity of the River Murray, since they will be located off the river.

Residential allotments, without direct access to a water frontage, are projected to develop over the longer term of between twelve and sixteen years, with releases of land determined by demand.

With water as a significant resource the proposal will not only be a sustainable project but will have major positive externalities by causing the removal of the current effluent ponds from the river flood plain and the establishment of a new wastewater treatment plant which will be able to cater for the future growth of Mannum and the re-use of water from the plant.

4.3.2 Orderly growth

It is considered that the development area of the proposal is a logical and contiguous extension of the town of Mannum and builds on connections to its transport infrastructure through Belvedere Road and to its hydraulic services through the significant replacement and augmentation of the existing water and wastewater functions. Where it has been necessary, any actions that can lead to a breakdown in function or loss of amenity to the existing town have been addressed. This is evidenced by care being taken in regard to impact on local street traffic. In the case of River Lane vehicular access to the site will be stopped.

The orderly growth of the proposal will follow some particular stages:

- Stages 1 and 2 will include initial works to provide new infrastructure including the new wastewater facilities and to rehabilitate the existing effluent ponds. Included within these stages will be the construction of the marina, associated wetlands, commercial site and the waterfront allotments.
- It is expected that the remainder of the residential land division (stages 3 to 7) will be undertaken in accordance with the accepted engineering standards for roads and services provision and will come on stream as commercial opportunity and demand takes place.

The development of every allotment and house in the development will be governed by a “House Owner’s Charter” as described in Section 11.4.6 which will govern all matters of residential construction and landscaping at Mannum Waters.

4.3.3 Improve environmental controls for houseboat mooring

Mannum Waters will supply an additional 156 fully-serviced marina berths. Moreover, these will be supplied on a stretch of the River Murray where the need is greatest as this area has a large number of houseboats moored on river and is the location from which Adelaide draws it water supply. Mannum is within easy driving distance of Adelaide and is a well-established base for recreational and tourist embarkation.

At present, houseboats on the River are permitted to discharge grey water to the River while black water is stored on board for disposal to sewer. The proposal would require all boats using the facility to cater for both black and grey water disposal in accordance with the EPA Draft Code of Practice for "Vessel and facility Management: Marine and Inland Waters". As such, each berth will be equipped with full service provision including wastewater connection points for all liquid waste. The berths will be located in a controlled water environment with facilities to contain water pollution, regulate water flows and monitor water quality (refer Section 11.2).

4.3.4 Provide environmentally sensitive waterfront housing

A number of aims have been identified and described within Section 2.2 for achieving efficient house design within the residential areas and ensuring adequate riparian buffers between the houses and the waterways.

4.3.5 Remove wastewater lagoons from floodplain

The existing wastewater lagoons are situated within the flood zone and well below the 1956 flood level. This location no longer conforms to current government policy[2]. The lagoons' proximity to the river is seen in Photo 4.2

Photo 4.2 – Wastewater treatment lagoons adjacent to the River Murray

Other negative aspects of the lagoon are an existing overflow to the River Murray and significant evaporation losses of potential reclaimed water which could be used for other purposes.

Under the development proposal, the lagoons will be replaced by a new wastewater treatment plant on high ground beyond the required separation distances from the river.

[2] Environment Protection (Water Quality) Policy, Environmental Protection Authority 2003

Evaporation losses can be reduced and full use of the reclaimed water can be made on recreation and landscaped areas.

4.3.6 Provide water use advantages

The existing site has a number of wasteful attributes in regard to water availability. The current site behaves like a large evaporation basin all year round. Water, migrating to the site from the river, falling on the site from natural rainfall or arriving at the site from creek discharge, is lost through evapo-transpiration with no current benefit to the community. Left as it is, the land will also continue to degrade as a result of increasing salinity, through evaporation and precipitation of salt in ground water. Isolation from the river by the levee and with no irrigation there is insufficient downward leaching.

Environmental allocations are available to prevent this happening and at least maintain condition. For this area the allocation is approximately 6.0 ML/ha. With an area of 34.8 hectares being eligible, the proponent is seeking a total allocation of around 200 ML.

Under the development, the stormwater discharge from the creek and treated run off from the development will discharge directly to the river water body.

Hence, the development achieves water economies in the following ways:

- provides an increase in water discharged to the River
- discharges a quality of water to the river which, when further treated through the constructed anabranch and wetland, is anticipated to be better than water within the main stream
- maximises the use of reclaimed water and therefore minimises the extraction from the River
- provides a water body for sustaining extended habitats for native flora and fauna and also for human enjoyment.

Although the evaporation from the extended water surface area offsets the water gains the extent of this loss is less than the water licence currently held for the Reschke property and the ELMA entitlement for the proponent’s land.

As Adelaide is River Murray water dependent, populations choosing to locate at Mannum (a location of one of Adelaide’s supply lines) will require less energy use to receive water from the River than those communities located further away.

4.3.7 Upgrade infrastructure

To proceed with the development a number of infrastructure facilities will require augmentation. The development offers the opportunity for these to be undertaken in an orderly and known way with appropriate contribution by the proponent during staged development.

The project will facilitate augmentation works as follows:

- development of a new wastewater treatment plant to serve the entire town and future population locating in the proposed development
- upgrading of the existing water treatment plant, water storage and distribution network

- upgrading of the electricity supply to meet the growing demand
- provision of stormwater discharge systems that will treat the stormwater beyond normal standards through the use of gross pollutant traps and localised detention ponds.

4.3.8 Preserve Aboriginal cultural sites

Aboriginal cultural heritage sites which are currently suffering continual degradation will be preserved. Specific conservation methods approved by the local Aboriginal community will be adopted to safeguard the identified heritage sites. In addition, construction techniques (discussed in Section 10.4) will ensure the preservation of any significant new discoveries whilst work is proceeding. Aboriginal cultural heritage is discussed fully in Chapter 10.

4.3.9 Provide interpretive facilities

In addition to the preservation of Aboriginal cultural heritage sites an interpretation centre is proposed within the commercial area. The interpretive centre will combine Aboriginal and environmental interests and provide educational facilities and interpretive information for walkers who wish to explore the area on dedicated walkways.

4.3.10 Rehabilitate dairy flats

The existing dairy flats are described in Chapter 6 (Physical) and Chaper 7 (Biological). They are a degraded landscape with little effective use. The development seeks to establish the area with vegetation and wetlands to enhance the river environment and habitats and to rid the area of pest plants (e.g. boxthorn) which have spread through a large proportion of the area.

4.3.11 Conserve and create riverine wetlands

The riverine wetlands adjacent to the bank of the River Murray were formed as a result of the creation of the levee bank on the eastern boundary of the site. The wetlands are diverse and have become a valuable asset.

The proposal includes measures to conserve the wetlands and undertake considerable construction of new wetlands with the primary purpose of controlling salinity, improving habitats, and enhancing the quality of water returning to the river.

4.3.12 Revegetate degraded areas

Most of the site has been denuded of trees. A comprehensive revegetation scheme is proposed throughout the areas not otherwise developed. It also includes the wetland areas, embankments, reserves, buffer strips, the golf course extension and riparian areas of waterfront allotments.

More than 50% of the site will be subject to intensive revegetation.

4.3.13 Extend wildlife habitats

Revegetation works described in Sections 4.3.11 and 4.3.12 will create new wildlife habitats as an extension to those already existing on the river. Habitats will be provided within the waterways and anabranch of the wetland to encourage the development of native fish stocks. In addition, measures will be taken to control feral animals.

4.3.14 Provide for the extension of golf course to 18 holes

The existing Mannum Golf Course is a nine-hole course. Some additional land is owned by the Mannum Golf Club which will allow further expansion. However the additional land is insufficient for the extension to an eighteen-hole course.

It is the intention of the proponent to make available additional land for an integrated residential/golf course development. This will allow the course to be developed to a full 18 holes. The timing of this extension will be dependent on the availability of reclaimed water and golf course patronage.

4.4 COSTS

4.4.1 Provision of infrastructure to Government

The proposed development will require investment in infrastructure such as entrance road upgrades, electricity supply, remediation of waste water evaporation ponds, waste water treatment plant and water supply. Importantly, the development will provide for the extension and augmentation of existing infrastructure that will ultimately assist in achieving a sustainable delivery of water, electricity and road infrastructure services to the community as a whole.

Without the proposal, the full costs of infrastructure upgrades to the existing community would be borne by government with limited ability to pass such costs onto existing users. New development provides an opportunity to review the capacity of existing networks and plan for future demand.

Discussions will continue to occur with the State Government agencies in respect of assistance; as such investment would have significant positive multiplier effects within the economies of the local and wider community.

4.4.2 Increased rates income to Council

Council will be required to maintain in a good order and condition the waterway reserves and navigational structures upon the expiry of the initial maintenance periods. The scope of this work is currently subject to discussions with the Mid Murray Council. In regard to the general land division requirements, normal procedures will apply, with Council assuming responsibilities for items such as roads, footpaths, stormwater, waste management and public landscape following expiry of the normal construction Defects Liability Periods.

The rate revenue, at today’s values, from the fully developed site is expected to exceed an estimated $600,000 pa.

4.5 CONSEQUENCES OF NOT PROCEEDING

If the proposal were not to proceed an opportunity will be missed to construct a planned coordinated development with facilities and infrastructure that achieve significant environmental benefits for the River Murray and set the standard for future developments of this nature along the River Murray.

The social benefits and economic growth resulting from the development would be lost.

The following summarises the key consequences of not proceeding:

- houseboats and riverboats will continued to be moored on the River Murray with limited environmental controls unless new legislation is enacted
- government agencies will continue to have difficulty regulating houseboat moorings
- the River Murray will not get the water quality improvements that arise from a combined marina with off-river berths and wetlands treatment
- existing waste water evaporation ponds will remain on the sensitive river flood zone with overflow connection to the River Murray
- existing natural wetlands and habitats may not be preserved and protected for future generations and will remain in private ownership and subject to grazing
- degraded river flood plains will not be rehabilitated and restored into extensive new wetlands and habitats
- Aboriginal Cultural sites will not be protected and will remain on private land suffering further degradation
- residential living and commercial options in Mannum may not be expanded in an orderly way
- new recreation, educational and tourism opportunities may not be created
- significant employment opportunities will be lost
- significant income to the region from construction, building and ongoing service activities that are expected to result from the project will not be forthcoming
- the economic development flowing from the project to the State of South Australia will not happen.

5 Existing river environment

5.1 INTRODUCTION

The following sections outline the statistics for the River Murray at Mannum. Data from the Murraylands region is used where data is not specifically recorded for Mannum. The statistics provide an overview of the physical attributes of the river together with common recreational and commercial activities which occur on or around the river.

Photo 5.1 – Tourist boat Marion

5.2 RIVER STATISTICS

5.2.1 River flows

The River Murray System is in its sixth consecutive year of drought, with the floodplains in the lower reaches of the Murray under extreme environmental stress (MDBC 2006). Total flows across the SA border have remained well below average (2,050 GL/year compared with the long term average of 6,600 GL/year) (MDBC 2006). By late March 2007 flow to South Australia will be reduced to around 2,400 ML/day.

5.2.2 River levels

The water levels in the River Murray upstream of Blanchetown, the site of Lock 1, are regulated by a series of locks and weirs. From Lock 1 downstream to Lake Alexandrina the river pool level is regulated by the barrages

Mannum lies 150 km upstream of the River Murray mouth and within this section of the river. Construction started on barrages in 1935. They are located in the channels linking Lake Alexandrina and all river flows pass through the barrages into the Coorong and out to the sea through the Murray mouth. The barrages were completed in 1940.

The Murray Darling Basin Commission states that the purposes of the barrages are to:

- reduce salinity levels in the lower reaches of the River Murray and associated lakes
- stabilise the river level, and normally maintain it above the level of reclaimed river flats between Wellington and Mannum, so as to provide irrigation by gravitation rather than pumping
- during low flows, to concentrate releases to the ocean to a small area, and so scour a channel for navigation
- maintain pool water that can be pumped to Adelaide and the southeastern corner of South Australia.

Consequently in times of flow, the barrages regulate the river at Mannum to a water pool level of 0.75 m (AHD). A surface water monitoring site is located at Mannum, 149.8 km upstream of the Murray River mouth.

The water level in the River Murray has been recorded at the Mannum surface water monitoring site since September 1974. The fluctuation in daily readings is shown in Figure 5.1. These are similar to the levels used by Tonkin Consulting for the wetland study (refer section 2.8.2) which were recorded at Murray Bridge 1988 to 1998.

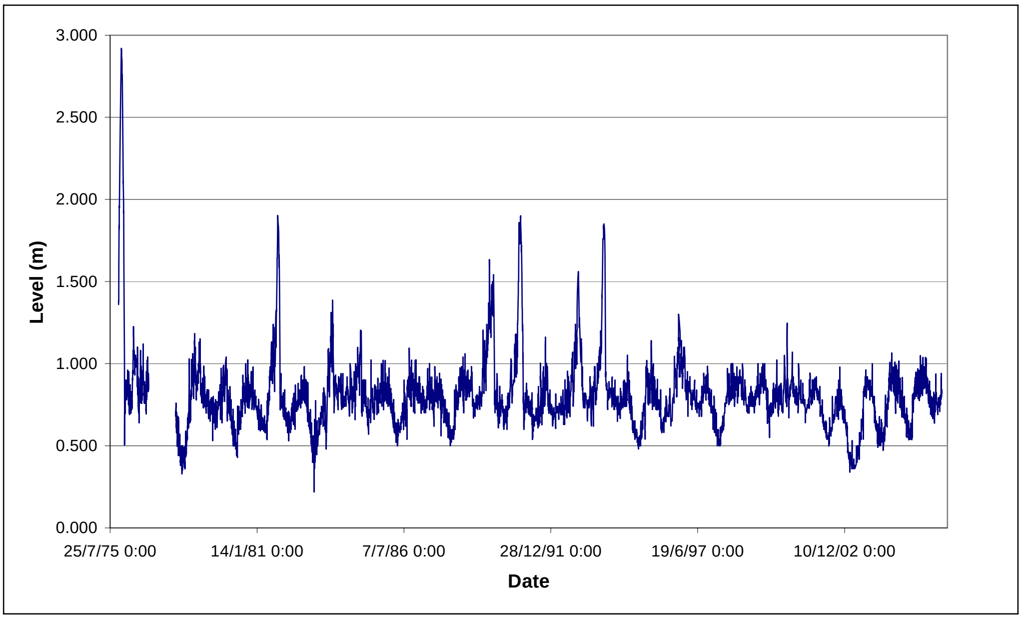


Figure 5.1 – Mannum (No. 1 Pumping Station) water level—daily readings

During the period 3rd September 1974 to 28th January 2004 daily recordings were taken on 65 per cent of all days. Since 18th December 2002 mean daily water levels (averaged across days where a level was not recorded) have been recorded. Between 18th December 2002 and 27th July 2006 the average daily water level at Mannum was 0.732 m, the maximum water level was 1.06 m (on 11th September 2004) and the minimum was 0.325 m (on 20th February 2003). This is slightly below the regulated level of 0.75 m.

Currently a temporary weir is proposed by the South Australian Government for construction at Wellington. The proposed weir height of 0.35 m (AHD) will assist in securing river levels upstream in times of severe drought. There has not been a final decision on the weir's construction.

5.2.3 River flooding

It has now been a decade since many floodplains and wetlands along the lower reaches of the Murray last experienced a beneficial flood (MDBC 2006; DWLBC 2004). Major Floods in the last century are shown in Table 5.1.

Table 5.1 – Major floods

Location	Normal pool m (AHD)	1956 m (AHD)	1974 m (AHD)	1931 m (AHD)	1993 m (AHD)
Mannum	0.75	5.38	3.24	3.52	1.85

The last significant flood at Mannum was in 1995, with flows peaking at 55,900 ML/day at Blanchetown 80 km upstream of Mannum (SA Water 1996), compared to a long term average flow of approximately 18,000 ML/day. The highest recorded flow was during the 1956 flood (1 in 200 year ARI flood event) when flows at Morgan (120 km upstream of Mannum reached 341,000 ML/day.

Mannum lies between Lock and Weir 1 and Wellington, for this section of the River Murray the area of inundation of the floodplain is presented in Table 5.2.

Table 5.2 – Area of inundation, lock and Weir 1 to Wellington

Flow (ML/day)	Cumulative Area of Inundation (ha)	Cumulative Area of Inundation (%)
10,000	7,001	31
20,000	7,789	34
40,000	8,772	39
60,000	10,103	44
80,000	10,520	46
100,000	12,166	53
> 100,000	22,763	100

Source: DLWBC 2006

The level reached by the 1956 flood on the proposal site is shown in Figure 5.2.

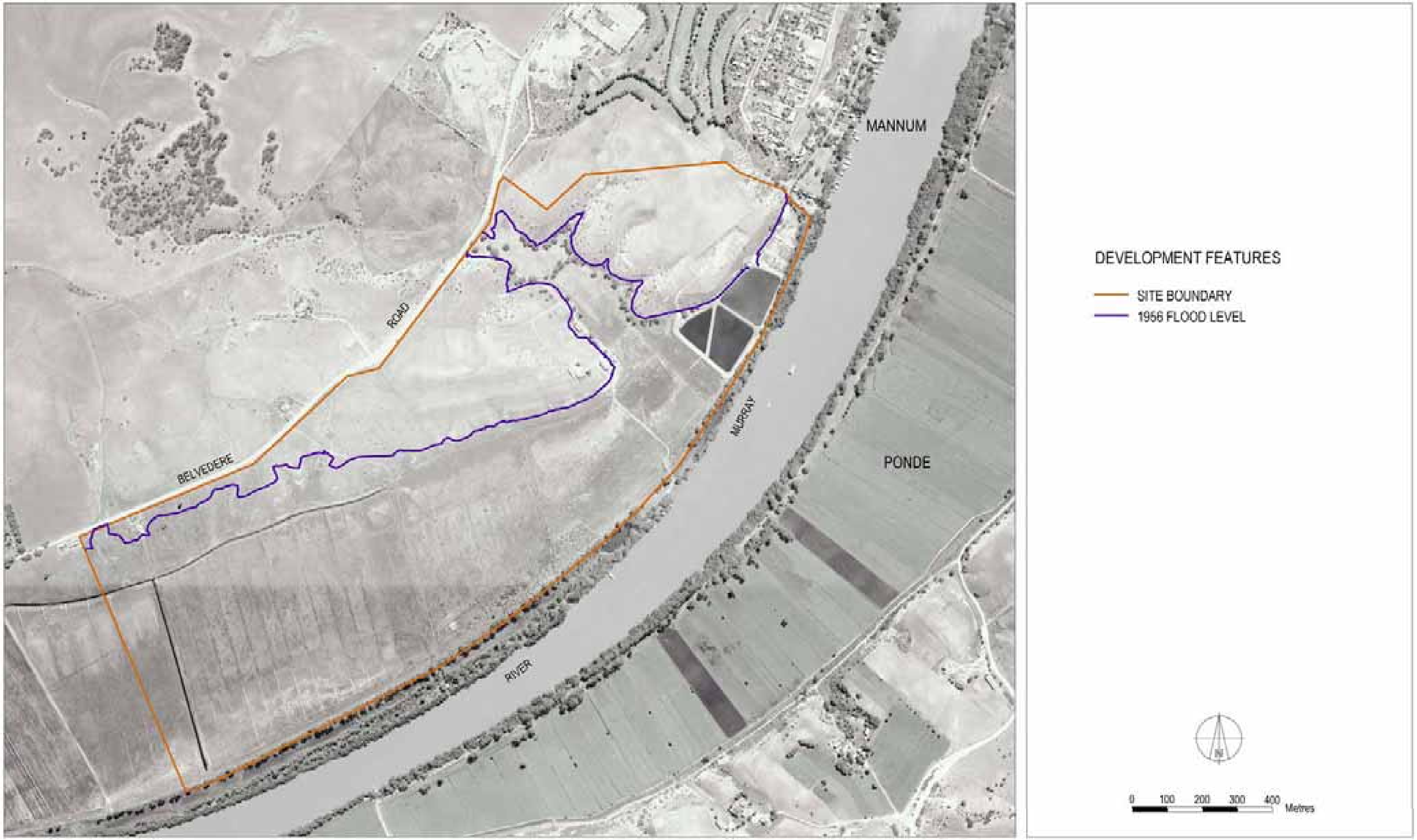


Figure 5.2 – 1956 Flood level

5.2.4 River water quality

Water quality is a major issue in the River Murray, because of the need to maintain its essential environmental values, the maintenance of aquatic ecosystems, recreation, agricultural and domestic water supply, particularly the supply to Metropolitan Adelaide. The conceptual design of the project has had a strong emphasis on the protection of water quality in the marina waterways and in the river. This has included Water Sensitive Urban Design (WSUD) measures for stormwater, including riparian vegetated filter strips, retention wetlands and a large 6 ha wetland for waterway through-flows (refer Section 2.8), cessation of existing grazing and irrigation of reclaimed water on high ground well removed from the river.

With these measures, described in Chapter 11.0, the retirement of this part of the Baseby Irrigation Area (development site) and the removal of the wastewater treatment lagoons from the floodplain, the net effect would be a reduction in pollutant loads. To ensure that this remains the case, there is also a strong commitment to monitoring, which is outlined in Chapter 12.0.

(A) Key water quality issues

The future wellbeing of South Australia is partly dependent on a healthy River Murray because of its importance as:

- a public water supply source
- a source of irrigation water
- a recreational resource
- an aquatic ecosystem.

Major water quality concerns were discussed by the EPA (2002) in a review of ambient water quality monitoring, and by Sinclair Knight Merz (SKM) (1999) in a working paper on water quality prepared as part of the River Murray Catchment Water Management Plan. These concerns included:

- salinity
- nutrients and algal blooms
- pathogens
- turbidity.

With respect to the lower Murray, some key points summarised by EPA (2002) were as follows:

- turbidity was high at all sites. Turbidity is caused by suspended matter in the water, particularly clay, giving it a cloudy or murky appearance. The high turbidity levels mean that the River Murray, like many other Australian inland rivers, has increased risks associated with swimming and related activities, as visibility is seldom more than 1.2 m., meaning that the river bottom and any hidden snags cannot usually be seen

- water quality deteriorated between Mannum and Tailem Bend. Nutrient concentrations (oxidised nitrogen and total phosphorus) and faecal coliform numbers rose over this stretch of the river. It is likely that this deterioration is due to irrigation return waters from dairy farms
- based on faecal coliform numbers, River Murray water in South Australia was unsuitable for drinking without treatment by boiling or disinfecting. It has, however, been recognised for some time that none of the rivers or streams in South Australia are suitable for drinking without such treatment, and the Department of Health has issued several warnings to this effect. The River Murray is no exception
- there was a notable deterioration in microbiological quality in the lower River Murray between Mannum and Tailem Bend. At times, the river water at both Murray Bridge and Tailem Bend failed to meet the Australian Guidelines for Recreational Use of Water (NHMRC 1990) for primary contact (e.g. swimming). The Department of Health has advised that, although the risk to human health from exposure to microbial hazards in the river is increased from Mannum to Tailem Bend, the risk of illness remains low
- salinity substantially increased down the entire length of the river, with large increases between Lock 9 and Lock 3, and between Lock 3 and Morgan. It is likely that irrigation practices, coupled with saline groundwater intrusion, evaporation and mallee clearance, all contribute to these increases
- there was no indication of a substantial rise in salinity at Mannum or other sites over the last 10 years. This indicates that salt interception schemes have been effective to date.

(B) General water quality at Mannum

Table 5.3 – Water quality at Mannum

Characteristics (mg/L) unless specified	Mean ± confidence interval	Median	N	Std Dev	Water quality classification
Oxidised nitrogen	0.097 ± 0.019	0.05	101	0.10	Moderate
TKN	0.855 ± 0.05	0.77	117	0.28	Moderate
Total phosphorus	0.136 ± 0.013	0.12	117	0.074	Moderate
Soluble phosphorus	0.110 ± 0.026	0.055	109	0.137	Moderate
Turbidity (NTU)	61 ± 4	51	482	44	Poor
Total cadmium	0.003 ± 0.00005	0.0002	93	0.0003	Good
Total copper	0.0125 ± 0.0020	0.007	117	0.011	Moderate
Total lead	0.0028 ± 0.004	0.002	92	0.0021	Good
Total mercury	0.0001 ± 0.00002	0.0001	86	0.0001	Moderate
Total zinc	0.021 ± 0.0038	0.017	92	0.018	Good
Faecal coliforms per 100 Ml	53 ± 5	41	402	49	Good
Conductivity (μS/cm)	582 ± 20	570	420	210	Good
Total dissolved solids	321 ± 12	317	395	118	Good

General water quality at Mannum is summarised by EPA (2002) in Table 5.3.

Mannum has one of the main pumping stations supplying water to Adelaide, and it is therefore an important location. General water quality at Mannum was described as good, based on the key parameters, as follows:

- nutrient levels were classified as moderate
- salinity was classified as good
- the heavy metals, copper (total) and mercury (total), were classified as moderate and cadmium, lead and zinc (totals) as good
- turbidity levels were described as high
- faecal coliform numbers (used as indicators of the potential presence of pathogens) were classified as good.

These parameters and the priority given to them by SKM (1999) in the catchment plan are briefly discussed further below.

(i) Salinity

Salinity was given a high priority classification by SKM (1999) and is seen as a long-term problem. Salinity is a major issue within the whole river system. Salt loads reaching the river have increased by 500 t/day as a result of irrigation. This is approximately a 50 per cent increase over the naturally occurring pre-development load. It is predicted that further increases will occur due to irrigation and dry land salinity over the next 100 years. This further increase will occur because salinity impacts from existing irrigation are still being released and will only peak over the next 50 years.

In general, salinity increases with distance from the source of the river and there is a strong inverse relationship between flow and salinity, with salinity increasing with decreased flow.

(ii) Nutrients and algal blooms

Nutrients and the related issue of algal blooms were given a high priority classification by SKM (1999) and are seen as a long-term to medium-term problem.

The nutrients of concern are nitrogen and phosphorus. Forms of nitrogen include organic nitrogen (i.e. contained within organic material), ammonia nitrogen, nitrate and nitrite nitrogen. Ammonia, nitrate and nitrite nitrogen are bio-available forms and are usually those which stimulate plant growth. Forms of phosphorus including soluble or orthophosphate phosphorus are particulate phosphorus (either attached to particles or contained within organic material).

High concentrations of nutrients are thought to provide the conditions that contribute to algal blooms. Blooms can consist of *Cyanobacteria* (also known as blue-green algae) and *Chlorophyta* (green algae). Their presence can affect taste and odour of domestic supplies, cause discolouration and produce unsightly scums on water surfaces. The *Cyanobacteria* are of greater concern as some are toxic. Blooms tend to occur during the December-February period, particularly when flows are low.

There are a number of variables which determine the extent and occurrence of blooms, including nutrient availability, low flow conditions, light availability, periods of thermal stratification and ecological controls (e.g. grazing by herbivores).

When blooms occur, the final biomass of algae is a function of the availability of the limiting nutrient (i.e. algae will continue to grow until the nutrients are used up). In freshwater aquatic systems, phosphorus is usually the limiting nutrient.

Higher concentrations of nutrients are found in the Mannum to Wellington area. The principal cause is considered to be irrigation drainage from the lower Murray reclaimed swamps. Generally the concentrations are above the values given in ANZECC (1992) and at levels that would rarely limit algal growth.

A recent study (EMS 2003) characterised the quality of the return water discharges for most of the irrigation areas for a wide range of Physicol-chemical parameters. With respect to nutrients, the main study findings were summarised as follows:

- although based on only one year of monitoring data, for the monitoring period, March 2002 – February 2003, approximately 64 t/annum of phosphorous and 185 t/annum were discharged to the river
- nutrient concentrations in return waters were relatively very high compared to in-stream concentrations. Importantly, the proportion of bio-available nutrients in return water is high compared to that in the river. Phosphorous has between 31-84% (median 60%) compared to approximately 46% in the river at Mannum. More significantly there is a distinct seasonal pattern in load discharges, with as expected the majority being discharged in the warmer months when irrigation diversions from the river occur. The discharge of large quantities of bio-available nutrients, particularly phosphorous, during these periods increases the risk of algal blooms.

The December-February period is usually when flows are low, water temperatures rise and thermal stratification occurs. Low flows and quiescent water favour *Cyanobacteria* over *Chlorophyta* because of their ability to maintain a positive buoyancy.

The discharge of nutrient rich irrigation returns largely occurs during the summer, when river flows are low, temperatures are high and sunlight is bright for long periods. These conditions, together with higher nutrient loads from irrigation returns, provide the ideal conditions for algal blooms.

(iii) **Pathogens**

Pathogens were given a high priority classification by SKM (1999) and are seen as a medium-term problem.

Faecal coliforms, *E coli* and faecal streptococci are usually used as indicators of the potential presence of pathogens. They result from faecal contamination from human and animal sources. Pathogens can include pathogenic bacteria, viruses and parasitic protozoa. Total coliforms are also often measured, but this can also include large numbers of bacteria that are not necessarily from faecal material.

Most points along the river have been impacted upon by animal or human waste. In the lower River Murray, numbers of faecal bacteria increase significantly and the primary cause is thought also to be irrigation drainage.

The most significant numbers of *E coli* occur at Murray Bridge and Tailem Bend, which is consistent with the occurrence of irrigation drainage from the Murray swamps. Waste from dairy cattle can contain relatively high numbers of *Salmonella* and *Cryptosporidium*.

(iv) **Turbidity**

Turbidity was given a medium priority classification and is seen as a long-term problem.

Turbidity, which is a measure of cloudiness or muddiness, is due to the presence of suspended particles including clay silt or phytoplankton. Turbidity can:

- be aesthetically displeasing
- reduce the effectiveness of disinfection
- affect recreational use for contact recreation (boating, swimming, etc.) by reducing visibility of underwater hazards (e.g. logs, rocks, etc.)
- directly affect ecosystems, e.g. by reducing light penetration.

Turbidity remains relatively constant and high along the length of the river. The major source is considered to be the Darling River System upstream.

(v) **Heavy metals**

Heavy metals are not seen as a major issue in the river. Most of the metals assessed were not a concern and did not increase significantly in the lower river (EPA 2002).

(C) Water quality improvement initiatives

Although the lower River Murray receives a considerable pollutant load from upstream, it is impacted on from local sources including:

- irrigation returns from the lower Murray irrigation area between Murray Bridge and Wellington
- stormwater run-off from agricultural and urban areas
- recreational activities, including houseboats.

In recent years significant steps have been taken to improve river water quality, including:

- diversion of the Murray Bridge wastewater treatment plant from the river to a wetland on the Murray Bridge army training area
- land disposal and reuse of reclaimed water at Mannum
- provision of pump-out facilities for sewage for boats along the river.

The EPA (2002), also summarised current measures being taken including:

- a number of irrigation districts have been rehabilitated, with replacement of old and inefficient infrastructure leading to salinity reductions
- on-farm irrigation practices have been improved through government support and funding for irrigated crop management services, resulting in salinity benefits
- better dairy shed waste management practices in the lower Murray have been implemented, with consequent nutrient reductions
- irrigation management practices have been improved in the lower Murray, resulting in reductions in nutrients and bacteria in drainage water

- a number of other initiatives have been taken in the lower Murray such as metering, water allocation, trials of improved irrigation practices, and rehabilitation planting
- salt interception schemes have been installed at Woolpunda and Waikerie, together with other salinity reduction actions under the Murray-Darling Basin Commission.

Additional initiatives are being implemented to improve water quality in the River Murray, with these including:

- in collaboration with dairy farmers and the local community, the State Government has committed $40 million to rehabilitate the lower Murray swamps. The five-year plan will see major infrastructure changes designed to dramatically improve irrigation efficiency and convert some of the irrigated land to wetlands. These initiatives are expected to reduce by 80 per cent the flow of polluted water from dairy pastures back into the River Murray
- salt interception schemes are being developed to prevent highly saline groundwater from entering the river
- a Water Quality Policy has been developed with provisions against the discharge of waste that causes pollution of a waterway
- industries, such as dairies, are required to comply with waste management practices aimed at reducing or eliminating run-off into waterways. In urban areas, run-off from streets is also addressed
- the Murray-Darling Basin Commission is charged with reducing nutrient and salt inputs throughout the catchment
- the River Murray Catchment Water Management Board has prepared a Catchment Water Management Plan and a Water Allocation Plan
- community-based programs, such as Landcare, have been implemented to assist revegetation and other works to improve water quality
- education and awareness programs about the issues facing the River Murray are being provided. These include addressing the dangers associated with swimming and related activities.

Seen in this context, the control of houseboats and pollution from recreational activities has considerable benefit. Sullage waste discharged directly to the river is a significant source of nutrients and faecal micro-organisms.

5.2.5 River water usage

Apart from the importance of the river aquatic ecosystems and recreation, the river is the most important water supply source for South Australia.

Water is pumped from the River Murray to Adelaide from the pumping station at Mannum via the Mannum-Adelaide pipeline. In August 2000, a cap was placed on diversion from the River Murray in South Australia, this included a requirement that the Government of South Australia ensure that diversions from the River Murray for water supply purposes delivered to Metropolitan Adelaide or associated country areas through the Mannum-Adelaide, Swan Reach-Stockwell and Murray Bridge-Onkaparinga pipelines do not exceed 650 GL over any period of five years (MDBMC 2000).

Water in the Mannum region (incorporating the townships of Mannum, Tailem Bend, Murray Bridge and Wellington) is also used for (Wellington to Mannum LAP Committee 1999):

- irrigation of dairy production land, including 5,000 ha of flood irrigated pastures (reclaimed swamps) mostly used for dairy production and 1,300 ha of irrigated pasture production on adjoining hinterland
- irrigation of horticultural land, approximately 600 ha of irrigated horticulture, predominantly citrus and stone fruit produced mainly at Mypolonga and Woodlane, the region also produces vegetable crops
- drinking water for a population of approximately 22,000
- irrigation drainage water to wetlands, of which only 10% of the original wetland areas remain (69 wetlands – 590 ha) and are all considered to be of high conservation value
- there are 22.2 GL for Environmental Land Management Allocation (ELMA) for which a component is available for portion of the development site. This water is specifically for the management of salinity and is allocated to particular sites. The allocations are not transferable.

5.3 BOATING

Tourism and recreation represents one of the most popular uses of the River Murray contributing to a large part of the local economy, as well as the $150 million to the South Australian economy (RMUU 2006).

5.3.1 Recreational boating

One of the most common activities on the River Murray is recreational boating and house-boating (both private and commercial hire boats), with the majority of visitors being couples or families on short-stays. Recreational boating activities typically include powered boating activities including jet skis and speed boats, but also include canoeing and kayaking and other small motorised boats (refer Photo 5.2). Mannum is also considered one of the best water skiing locations along the River Murray.

Commercial houseboat hire is the most common boating activity on the River Murray adjacent to the site, as Mannum is considered the houseboat capital of Australia. The area is home to a fleet of over 50 commercial houseboats of varying sizes moored on the River and at the marinas in the Mannum area along the River Murray. There are several other hire companies further south and north of Mannum, also along the River Murray.

Several cruises operate along the River Murray (refer Photos 5.3 and 5.4) and pass through the Mannum area. The most popular of these are the paddle steamer cruises, such as the Murray River Princess, as Mannum is widely recognised as the birthplace of the Murray paddle steamer.

The Mannum slipway is located on the eastern side of the river just north of the Mannum ferry and is situated approximately 2.5km upstream from the entrance to the proposed development site (refer Photo 5.5).

Photo 5.2 – Mannum waterfront

Photo 5.3 – Murray Princess river cruiser moored at Mannum

Photo 5.4 – Local tourist boat

Photo 5.5 – Existing slipway at Mannum

The Mary Ann reserve (named after the first paddle steamer in the area) on the River Murray at Mannum has the main recreational public boat ramp for the area, where visitors can also hire a variety of equipment for water-based recreational activities. There are also several other boat ramps maintained by various accommodation facilities including the Mannum Caravan Park.

5.3.2 Houseboats

(A) Houseboat numbers

Houseboat numbers were investigated as part of the Preliminary Environmental Assessment prepared for Mid Murray council in 2003. At that time the number of houseboats registered on the River had increased by in excess of 40% over the preceding five years, and was in excess of the report *Ecological Impact of Houseboats on the River Murray in South Australia 2001*[1] (Houseboat Study) recommended maximum number (refer Table 5.4

Table 5.4 – Registered houseboats 1997 to 2002

Year	Number of Registered Houseboats
1997	608[(2)]
May 2000	742[(2)]
Sept 2002	Recreation: 582)) 857[(3)] Commercial: 275)

The Houseboat Study identified improvements in environmental management of the River Murray as follows:

- developing additional mooring sites
- permanent mooring posts at allocated mooring sites
- allocating one boat per mooring
- limiting the number of houseboats to a maximum of 800 (one per linear mile of the River in South Australia).

In 2005 the State Government began work on a River Murray Marina Strategy and Guidelines to:

- identify current trends and future demand for marinas
- to understand the factors that contribute to the success or otherwise of marinas and associated facilities.

This study is currently in progress

[1] Murray Darling Association Funded by the National Heritage Trust and Murray-Darling 2001 program (Commonwealth and State Governments and River Murray Water Catchment Board).
[2] Houseboat Study, derived from TransportSA.
[3] Transport SA, Boating Registrations – includes recreational and commercial registrations, however some boats may be registered under both categories.

(B) **Moorings – number and distribution**

The Houseboat Study identified the location of marinas along the River. Through further enquiry, this list was supplemented as shown in Table 5.5.

Table 5.5 – Houseboat marinas – distribution and facilities

Name of Marina (Location)	Total Houseboats Moorings	Potential Number of Moorings [1]	No. of Permanent Occupancy	Facilities Offered by Marina
Riverglen Marina (Murray Bridge)	90	0	30	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Kiosk; Public Toilets; Public Showers; Monitored Security; Each Mooring has: Electricity; Telephone; Water Pumps
Long Island Marina (Murray Bridge)	85	0	0	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Slipway; Public Toilets; Monitored Security; Each Mooring has: Electricity; Telephone; Water Pumps.
Kia Marina (near Mannum)	80	100	7	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Slipway; Kiosk; Each Mooring has: Electricity.
Greenings Landing (near Mannum)	40	0	0	Slipway; Waste Water Pumps; Public Toilets; Each Mooring has: Electricity; Telephone; Water Pumps.
Caurnamont Moorings	12	0	0	Refueling Bay; Waste Water Pumps; Slipway; Kiosk; Each Mooring has: Electricity.
Koala Marina (Morgan)	45	30	1	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Slipway; Kiosk; Ski Boat Storage. Each Mooring has: Electricity.
Waikerie River Front	7	2	0	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Each Mooring has: Electricity
Kingston on the Murray Marina	3	2	0	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Each Mooring has: Electricity
Lock 5 Paringa Marina	7	2	0	Refueling Bay; Waste Water Pumps; Filtered Water Pumps; Each Mooring has: Electricity
Jane Eliza Landing (Renmark)	24	0	6	Refueling Bay; Waste Water Pumps; Slipway; Each Mooring has: Electricity; Water pumps.
Total	**393**	**136**	**44**	

[1] Not approved, but based on proposals by operators

Although small mooring sites, around five in number, are not included in the Houseboat Study's inventory of moorings, the data available shows there is a considerable difference in the number of moorings compared to houseboats on the River, i.e. around 50% shortfall.

Whilst the majority of the moorings are located between Murray Bridge and Caurnamont, i.e. 307 or 78%, the Mannum Waters locality is:

- within convenient travel distance from metropolitan Adelaide
- the locality of highest demand along the River.

The houseboat supply information suggests an additional 400 moorings are required along the River to achieve the Houseboat Study's recommended outcome of one mooring per houseboat.

5.3.3 Recreational and commercial fishing

Fishing is a common recreational activity for holiday makers on the River Murray and is estimated to be worth over $400 million per year (RMUU 2006).

There are several regulations which apply to the River Murray across all states and in addition there are specific endangered species which are protected in South Australia. These include Catfish, Murray Cod (which has a closed season between September 1 and December 31), Murray River Crayfish, River Blackfish, Silver Perch, Trout Cod and Yabbies with eggs attached. There is also a ban on fishing within 150 metres of all locks and weirs on the River Murray and recreational fishers are not allowed to trade or sell their catch.

Photo 5.6 – Fishing off the bank at Mannum

The Murray cod is the largest fish found within the River Murray, but most will fish in the Murray for the Callop as it is the considered the best for eating. There are also several smaller fishing-related businesses which operate in the Murraylands area, such as Murray Aquaculture who are registered with the Exporting the Murraylands Project.

An annual fishing competition at Mannum, the “Mannum Big River Fishing Competition” hosted by the Mannum Rowing Club at Mannum Reserve attracts a growing number of visitors.

5.3.4 General recreation

In addition to the most popular recreational activities associated with boating, the region is associated with other recreational activities such as camping, bush walking, swimming, picnicking and trail bike riding.

There are several camping spots alongside the River Murray as well as the large council run Caravan Park that is popular during the holiday seasons. Camping is permissible in the 30 metre strip of crown land alongside of the River with permission from land/lease holders however, uncontrolled camping commonly occurs.

Swimming in the River Murray is another activity which is popular among tourists and locals camping alongside the River banks.

Photo 5.7 – Children swimming at Mannum with hire boats in the background

5.4 EXISTING SHIPWRECKS

There are two shipwreck locations identified near the development site, the Mary Ann and the Saddler. These shipwrecks are shown on Figure 5.3.

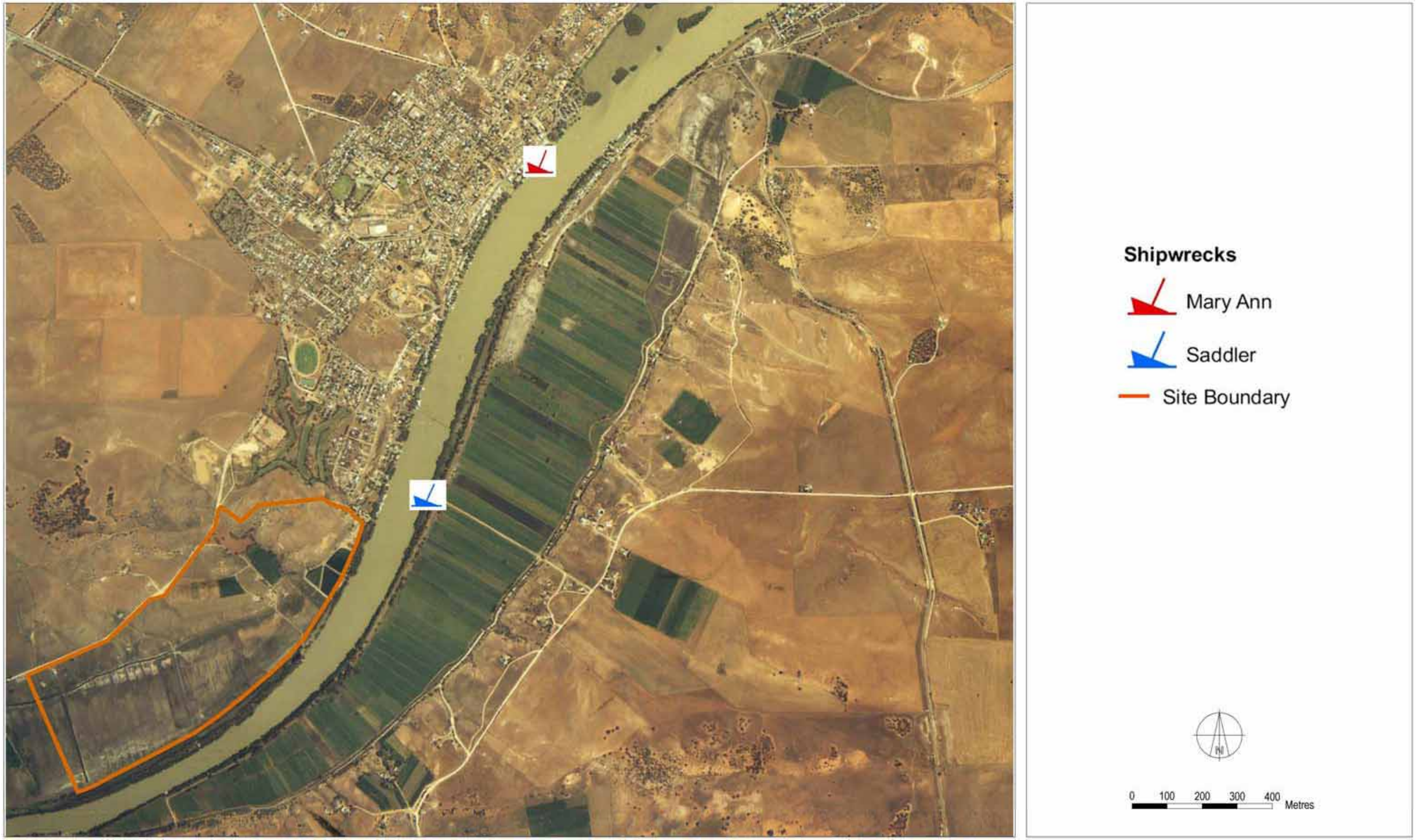


Figure 5.3 – Location of shipwrecks at Mannum

The Mary Ann was built in 1852 in the Mount Lofty Ranges and was left at its current location near the old ferry crossing at Mannum in 1863. The ship was a 20 tonne wooden paddle steamer 16.8 metres in length and was one of the original paddle steamers on the River Murray. The Mary Ann was used for animal transport on the River Murray. It is considered a protected item.

The other shipwreck is of the barge, "Saddler" which was built at the port Echuca in April 1877. It is now situated in Mannum on the opposite side of the River Murray to the town, where it was left in the year 1961. It is uncertain how the barge was wrecked and it is not considered a protected item. In its original form it was 21.5 metres in length and 45 tonnes in weight and is made of wood.

6 Existing physical environment

6.1 INTRODUCTION

Physical aspects related to the River Murray at Mannum are discussed in Chapter 5. These were dealt with in a separate chapter given the importance of the river system. Water quality, flows and levels are set out in Section 5.2 and information is indicated pertaining to base line data. This chapter looks more specifically at the physical environment within the boundaries of the proposed development site.

6.2 CLIMATE

The Murray Valley in South Australia is part of a much larger climatic region characterised by mild wet winters and long, hot, dry summers. Mannum possesses a very favourable living and tourism climate which is similar to that of Adelaide but with less rain days.

Advice from the Bureau of Meteorology (BoM) indicated that the records for Murray Bridge in relation to temperature, wind and relative humidity and Wellington in relation to evaporation could be considered appropriate for Mannum.

6.2.1 Rainfall

Table 6.1 shows the mean monthly rainfall for Mannum over the last 30 years**.**

Table 6.1 – 30 year monthly rainfall mean

Month	Average Rainfall (mm)
January	16.2
February	13.9
March	14.3
April	21.7
May	25.9
June	35.7
July	28.3
August	34.3
September	31.6
October	33.5
November	23.8
December	24.9
Total	**303.9**

Rainfall data was taken from a 130 year record at the Mannum Council Depot BoM station. The mean annual rainfall of approximately 304 mm for Mannum over the last 30 years compares with 562 mm at Adelaide. It falls mostly in the winter months from May to October. February is the driest month with a mean rainfall of 13.9 mm. This is slightly drier than Adelaide, with a January mean of 19.9 mm.

The wettest month is June with a mean rainfall of 35.7 mm, although there is a fairly even rainfall between May and October. Adelaide by comparison has a much less evenly distributed rainfall with the wettest month being June and mean monthly rainfall of 83.1 mm. The peak rainfall months in Adelaide are June, July an August all with mean monthly rainfall approximately 70 mm. Mannum has a mean of approximately 79 rainy days per year compared to 122 for Adelaide.

6.2.2 Temperature

As one progresses inland from the coast, temperature ranges increase reflecting more the conditions prevailing in the hot Australian interior. Mean annual temperature at Murray Bridge is 16.1^{o}C at 9.00 am and 23^{o}C at 3.00 pm. This can be compared with Adelaide 16.4^{o}C and 20.9^{o}C at 9.00 am and 3.00 pm respectively.

Table 6.2 shows the temperature data for Murray Bridge.

Table 6.2 – Mean daily temperatures (^{o}C)

Month	Maximum	Minimum
January	28.8	14.5
February	29.2	14.6
March	26.5	12.8
April	23.4	10.3
May	19.5	7.9
June	16.7	6.0
July	16.2	5.4
August	17.4	5.9
September	19.6	7.2
October	22.5	9.0
November	25.3	11.3
December	22.7	13.2

Daily mean maxima are 28.8^{o}C for January and 16.2^{o}C for July. Compared with 28.8^{o}C and 15.3^{o}C for Adelaide (BoM).

Daily mean minima are 14.5^{o}C for January and 5.4^{o}C for July. Compared with 16.8^{o}C and 7.4^{o}C for Adelaide (BoM).

6.2.3 Relative humidity

The area has relative humidity recordings very similar to those experienced in Adelaide, and which are inversely related to the temperature cycle.

The highest levels of humidity in Murray Bridge occur during the early morning hours, reaching 85% at 9.00 am in June and 59% at the same time in December. These values compare with 73% and 53% respectively for Adelaide.

The minimum levels of humidity in Murray Bridge occur during the afternoon, reaching 60% at 3.00 pm in June and 37% at the same time in January. These values compare with 61% and 37% respectively for Adelaide.

The annual mean of 9.00 am readings is 76% while the average for 3.00 pm readings is 50%. These values compare with 63% and 48% respectively for Adelaide.

Table 6.3 shows the relative humidity data for Murray Bridge.

Table 6.3 – Mean relative humidity (%)

Month	9am	3pm
January	61	37
February	66	38
March	69	41
April	72	46
May	81	54
June	85	60
July	84	58
August	77	53
September	69	48
October	61	43
November	61	38
December	59	38

6.2.4 Winds

Throughout the year winds are quite variable although they are generally more southerly in summer and more northerly in winter (BoM).

Winds in summer are mostly from the south-east, south and south-west although up to 14% of readings were from the north. Winds in winter are mostly from the south-west, west, north-west and north with few winds from the south through to the north-east sector.

The highest number of stronger winds (i.e. >30 km/hr) are recorded from the south-west and west, although occasional high wind speeds from the north have also been recorded

6.2.5 Evaporation

The average monthly evaporation was obtained from the Wellington Pumping Station over a period of thirty years from 1969 to 1998 (BoM). Based on this assessment the average annual net evaporation is approximately 1472.6 mm (with no pan correction). Pan correction at Mannum is assessed conservatively at 0.75 and the annual net evaporation from the water bodies at the proposed development as 1104.5 mm

Table 6.4 – 30 year monthly evaporation mean

Month	Average evaporation (mm)
January	207.7
February	175.1
March	145.7
April	96.0
May	65.1
June	48.0
July	55.8
August	74.4
September	99.0
October	136.4
November	171.0
December	198.4
Total	**1472.6**

6.3 GEOLOGY

The property lies on the riverine tract of the River Murray, the latter having cut its way down into the Murray Group limestone which forms the regional unconfined aquifer. With the rise of the Flandrian Sea the eroded valley started to infill with alluvial clays, silts and coarse sands (Firman, 1966). These units belong to the Monoman Formation which is overlain by the Coonambidgal Formation dominated by clays and silts with some light grey sands. To the west of the riverine tract limestones of the Murray Group outcrop on the rising ground.

Two geotechnical investigations were undertaken on the site in 2003 and 2006. Selective boreholes were drilled, three in the initial investigation in 2003 and eight in 2006. Details of the investigations are contained in Appendix D.

The Geological Map of the Mannum Region indicates that the floodplain area of the proposed development is likely to be underlain by Blanchetown Clay and (up to approximately 60 m) undifferentiated alluvial sediments comprising loose sand, silt and soft clay.

The initial bore holes drilled at the site generally yielded soils comprised of grey to black, high plasticity clay of firm to stiff consistency (although friable in places) overlying grey, high plasticity clay of firm to stiff consistency to the extent of the depth range investigated (about 3 m). The upper grey to black soil was also observed to have some organic matter and salt crystals present. In one of the holes drilled adjacent to the levee bank, the sub surface materials comprised an interbedded sequence of clay, sand and silt typical of recently deposited alluvial sediments found in the River Murray valley.

Subsequent bore holes generally supported the initial investigations. Groundwater observations in the boreholes suggest that groundwater is likely to be encountered below a depth of 1.0 m (AHD -1.6 m) to 1.5 m (AHD -2.1 m).

A schematic NW/SE geological cross section is given on Figure 6.1.

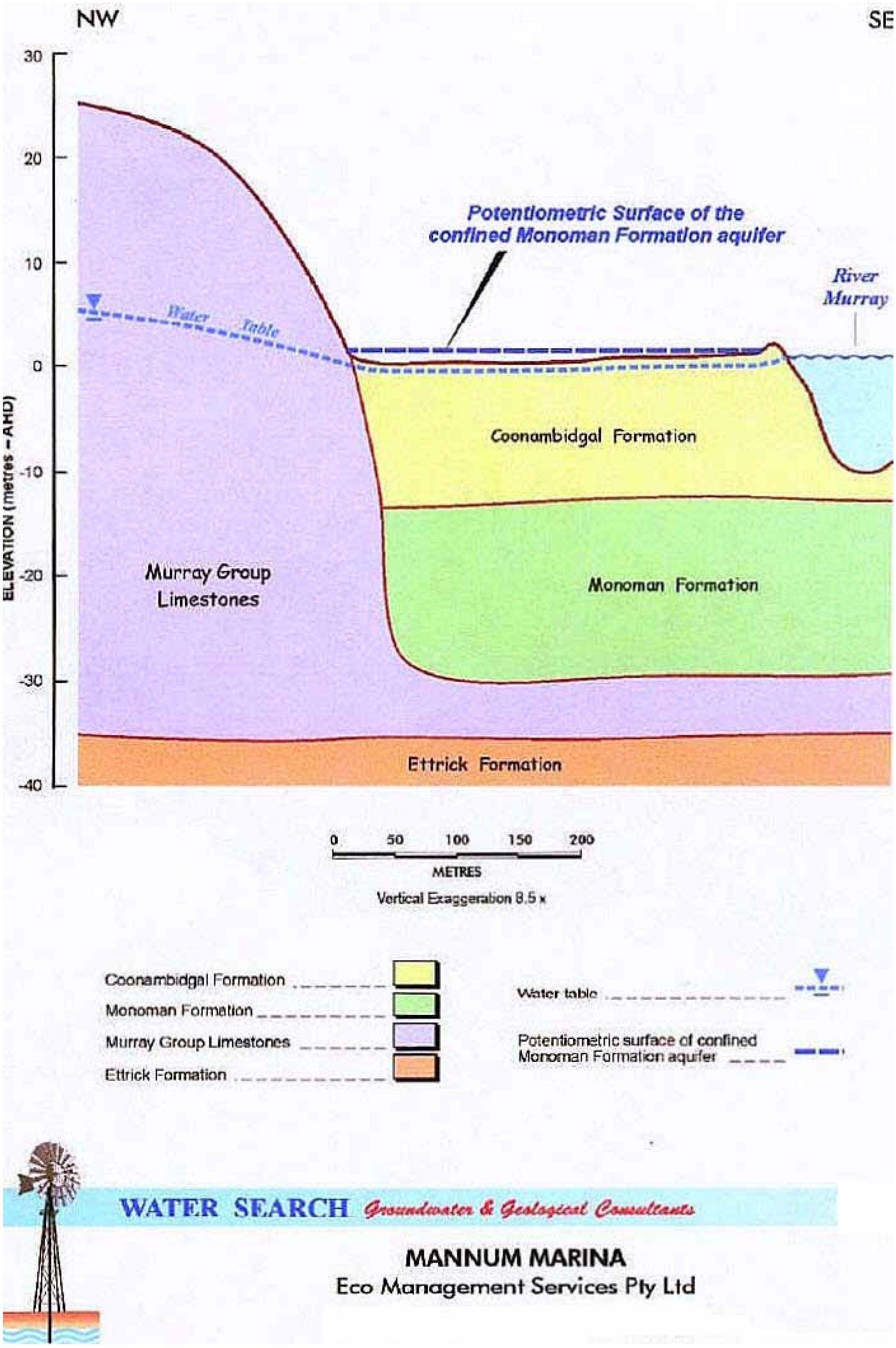


Figure 6.1 – Geological cross-section

6.4 HYDROGEOLOGY

6.4.1 Unconfined aquifers

Under the higher ground, the water table is contained within the Murray Group limestones with a south-easterly slope.

Groundwater flow is to the south-east towards the flats. The water table passes into the Coonambidgal Formation under the riverine flats and is in hydraulic contact with the River Murray.

Groundwater salinities in the upgradient limestone aquifer are high, ranging from 8,000 mg/L to over 20,000 mg/L. Under the flats, salinities are significantly lower due to past leaching of excess irrigation water down to the water table and subsurface inflow from the River Murray. Typical salinities under similar irrigated riverine tracts range from 2000 to 4000 mg/L.

Here the water table is essentially flat but with a westerly slope adjacent to the river in all situations other than at low river water levels. A simplified hydrogeological section of the current flow regime is shown on Figure 6.2.

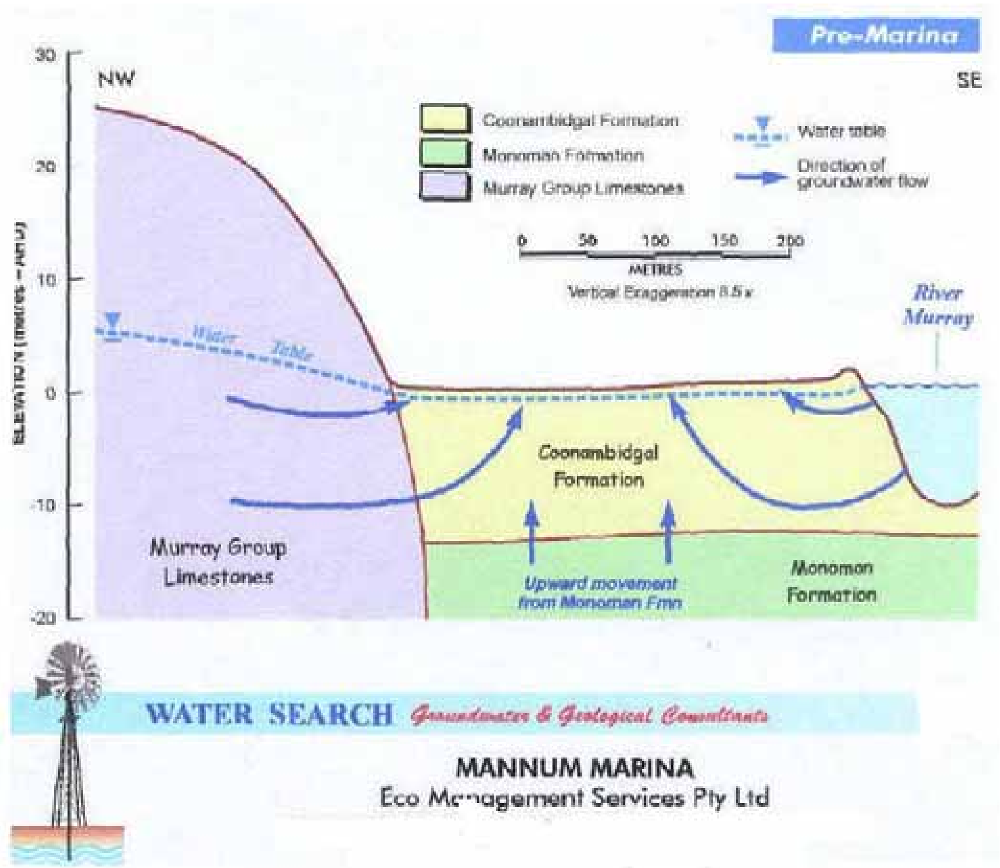


Figure 6.2 – Unconfined groundwater flow regime

6.4.2 Confined aquifer

The sands of the Monoman Formation contain confined groundwater with a pressure surface above that of the water table. This means that there is upward leakage from this aquifer, as shown in Figure 6.2. Its potentiometric surface (pressure surface) will also be sloping towards the River Murray.

Groundwater salinity in this aquifer is normally greater than 10,000 mg/L which has potential impacts on saline groundwater flow to the River Murray under low river flow conditions.

6.4.3 Groundwater flow

Ground elevations immediately to the west of the levee bank adjacent to the River Murray are typically of the order of one metre Australian height datum (AHD). While most of the river flats lie below 0 AHD, at the lowest point they have a surface level of approximately -0.65 m (AHD).

The cut-off trench at the toe of the break in slope has a base ranging from -1 to -1.2 m (AHD). This trench controls the elevation here whilst the river controls the elevation adjacent to its bank.

Drainage channels which traverse the river flats in the north-south direction (i.e between the cut off channel below the high ground and the old delivery channel adjacent to the levee) have bottom levels up to -1.5 m. At the present time no water was observed within these channels. The cut-off channel below the high ground and the larger return channel at the south western end of the site currently contain water. These channels have connection to the neighbouring properties. Current water level in these channels is approximately -1.65 m (AHD) and has a salinity of 10,300 mg/L (DWLBC). Neither the level of water nor the degree of salinity within these channels can be taken as representative of the existing groundwater as they have been subject to long periods of exposure to evaporation and have received run-off water from neighbouring properties.

Figure 6.2 shows the current shallow groundwater flow conditions for a typical river elevation of 0.75 m (AHD). Groundwater flow rates are very low because of the low hydraulic gradients and the low hydraulic conductivity of the Coonambidgal Formation, which is typically less than 0.1 m^3/day/m^2. Groundwater seepage into the cut-off trench is returned to the river downstream.

6.5 GEOTECHNICAL CONDITIONS

Two field investigations of subsurface geotechnical conditions have been undertaken. The principal purposes of these investigations were to determine:

- the physical properties of the soils and subsurface to enable decisions to be made about the ‘excavatability’ of the materials
- the potential use of excavated material as fill in the development
- the depth to groundwater.

Three boreholes were drilled in the preliminary investigations. An additional eight boreholes and ten electric friction cone (EFC) soundings were made in the second set of investigations. The boreholes ranged in depth from 3 to 4.5 metres.

Physical tests included nine Atterberg Limit (strength) tests and nine particle size distribution analyses.

6.5.1 Geotechnical results

In addition to physical examination, materials were sampled and analysed for some chemical parameters. A summary of the chemical test results from three boreholes drilled in the investigation undertaken in December 2003, including electrical conductivity, pH and total dissolved solids (TDS) is shown in Table 6.5.

Table 6.5 – Summary of chemical test results from boreholes drilled in Dec. 2003

Borehole	Sample depth (m)	Perceived water depth (m AHD)	Electrical conductivity (µS/cm)	pH	TDS
BH1	0.5 to 1.0	- 2.55	10,000	4.7	9500
BH1	1.5 to 2.0		7,400	4.6	6600
BH2	0.35 to 0.6	Approx. -0.8	2,200	7.7	1700
BH3	0.3 to 0.7		4,000	8.0	2100
BH3	1.5 to 2.0	- 3.2	3,100	8.4	1700

The locations of the boreholes are shown in Figure 6.3.

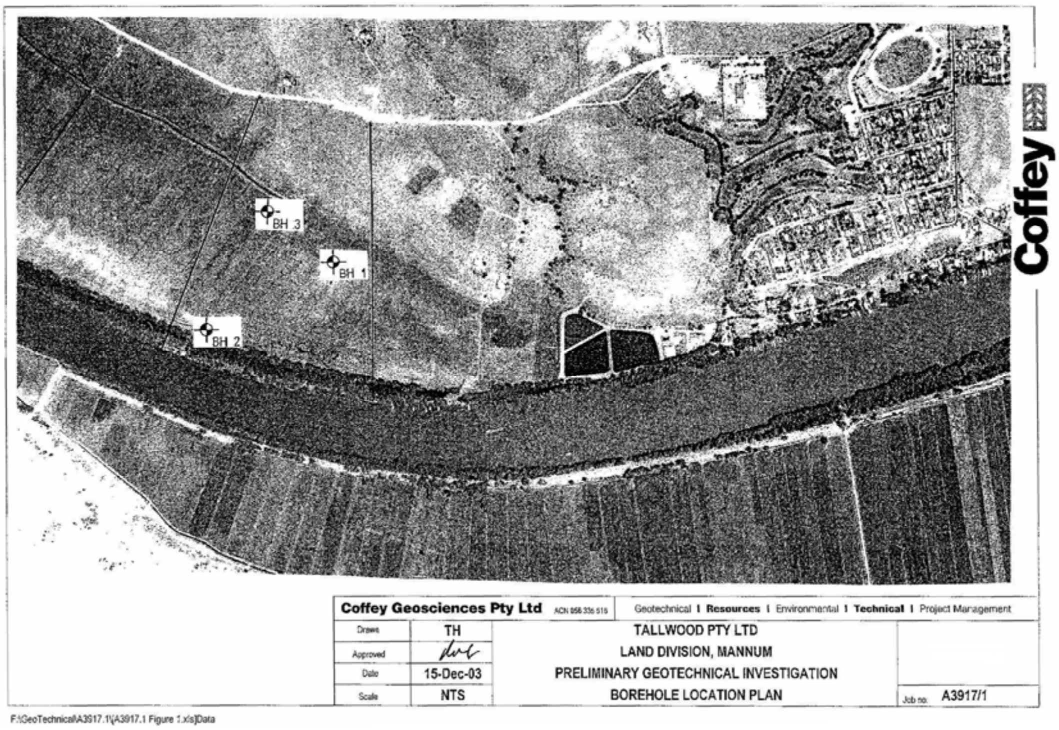


Figure 6.3 – Borehole location of 2003 investigation

Eight selected samples from the second set of investigations undertaken in 2006 were analysed for the Victorian Environment Protection Authority (Vic EPA) screen of potential contaminants. The locations of the boreholes for the 2006 investigation are shown in Figure 6.4

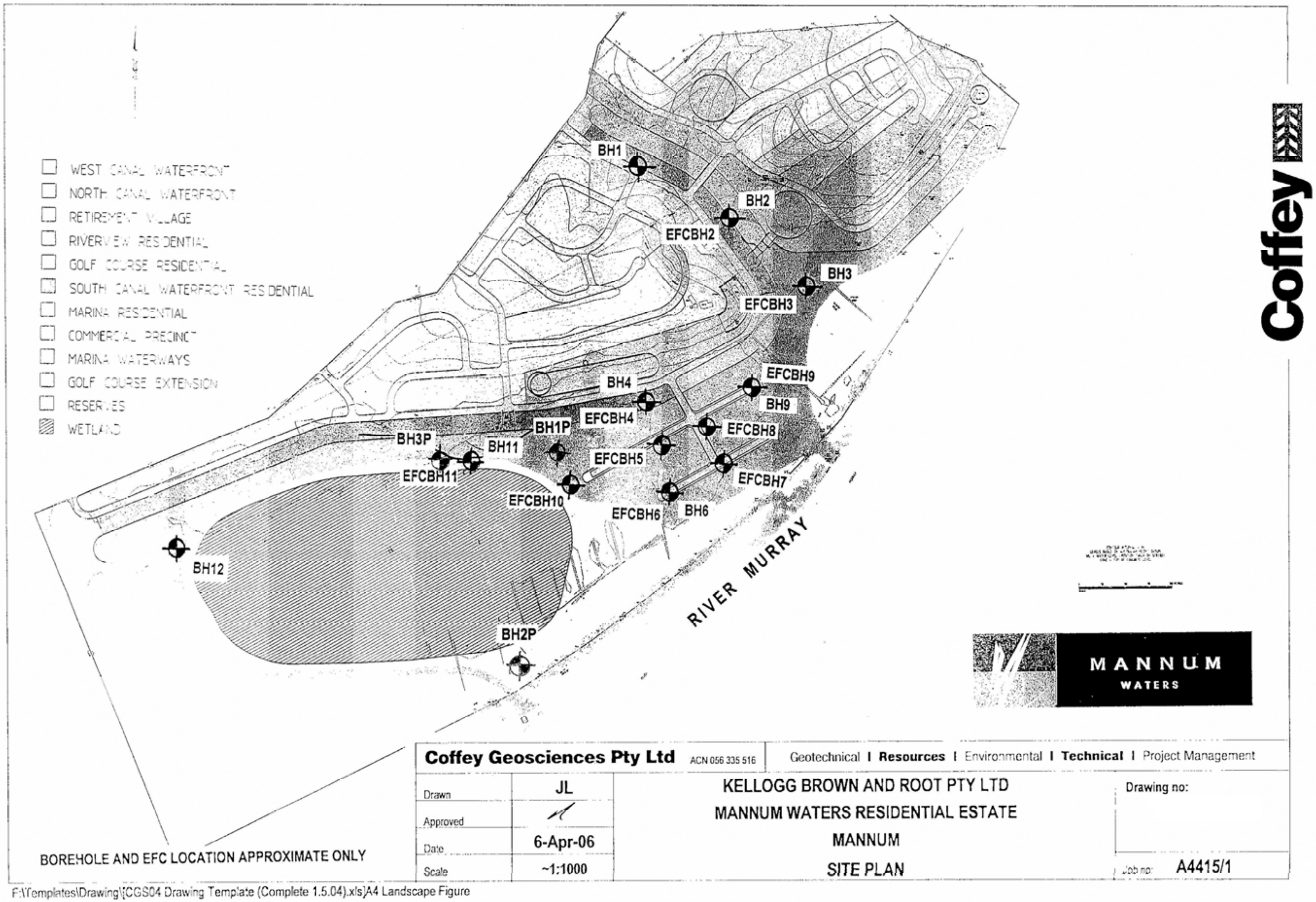


Figure 6.4 – Borehole location of 2006 investigation

Items analysed included polynuclear aromatic hydrocarbons (PAH); total recoverable hydrocarbons C6–C36 (TRH); benzene, toluene, ethylbenzene, xylene (BTEX); organochlorine pesticides (OCP); chlorinated hydrocarbons; cyanide; polychlorinated Biphenyls (PCB); phenol; cresols; and a suite of heavy metals including arsenic, cadmium, chromium, copper, lead, zinc, mercury, antimony, beryllium, cobalt, molybdenum, nickel, selenium and tin. The analytical methods employed were based on Vic EPA and US EPA standard methods.

Ten additional samples from the second set of investigations were assessed for their acid sulphate producing potential based on the POCAS test.

6.5.2 Geophysical results

The surface soils typically overlie high plasticity, grey to dark grey clay. The consistency of the clay ranged from very stiff to hard near the surface, to soft to firm at depth (generally below a depth of 1.0 m to 1.5 m) based on the pocket penetrometer results. The clay appeared to become sandier and moister with depth. In borehole BH12, clayey sand and sand were encountered underlying the clay.

The geotechnical laboratory testing indicated that the clay soils above about 1.5 m depth were more highly plastic (with liquid limits typically in the range of 90% to 100%) than the clay between 1.5 m and 2.5 m depth (liquid limits typically less than 60%).

The above subsurface profile was generally supported by the EFC soundings. The EFC soundings indicate that the clay extends to depths of about 2.0 m or more, and up to a depth of at least 6.0 m based on EFC BH5 to EFC BH10. The clay was of variable consistency above a depth of about 2.0 m, ranging between very soft to very stiff consistency. Below a depth of about 2.0 m the clay generally had a soft to firm consistency, although it was very soft or stiff in places. Underlying the clay, very loose to loose clayey sand and sand were indicated by EFC BH2 to EFC BH4 and EFC BH11.

In the flood plain valley the grey clay was not observed in boreholes BH1 and BH2. The soil profile comprised orange brown, wind blown sand to depths of about 0.7 m to 1.2 m, overlying calcrete and calcareous gravel in BH1 and loose yellow brown and pale grey sand in both boreholes to the limit of investigation.

6.5.3 Groundwater level observations

Groundwater observations in the boreholes are shown on the respective logs and summarised in Table 6.6. It should be noted that the short-term groundwater level recorded may not represent the piezometric surface. Based on these observations, groundwater is likely to be encountered below a depth of about 1.0 m (AHD -1.6 m to AHD -2.1 m) in the low lying flood plain sections.

The investigations showed that subsurface conditions were generally in agreement with the regional geological map (Geological Map of the Mannum Region at 1:50,000). In boreholes BH1 and BH3, dark grey to black, high plasticity clay of firm to stiff consistency was encountered to depths of 1.2 m and 0.8 m respectively. These clays were friable in places. There was some organic matter and salt crystals present. These soils were underlain by grey, high plasticity clay of firm to stiff consistency to the full depth investigated

Table 6.6 – Summary of geotechnical tests from the second set of investigations

Sample ID Depth interval (m)	Liquid limit (%)	Plasticity index (%)	Linear shrinkage (%)	% Passing 0.075mm sieve	% Passing 2.36mm sieve	Field moisture content (%)	Estimated CBR (%)	Perceived water depth (m AHD)
BH2 0.5 m to 1.25	NO	NP	0	5.5	100	1.3	14	
BH2 1.6 m to 2.0	31	16	4.5	26	100	23.5	10	0.5
BH3 0.3 m to 0.8	93	65	23.0	97	100	45.3	1.5	-2.8
BH4 0.4 m to 0.9	106	70	24.0	99	100	50.0	1.0	>2.5
BH6 2.0 m to 2.3	49	32	15.0	89	100	21.8	4.0	>3
BH9 1.1 m to 1.5	91	62	22.5	99	100	46.1	1.5	
BH9 2.0 m to 2.5	62	43	16.0	95	100	31.2	3.0	>3
BH11 1.0 m to 1.5	85	65	20.0	96	100	48.0	1.5	>1.8
BH12 1.5 m to 2.0	30	18	5.5	31	90	17.5	12	-2.0

NO = Not Obtainable

NP = Non Plastic

.

While groundwater levels were noted in each bore where wet soil occurred, it should be remembered that the level fluctuates with the level of water in the River Murray, and short-term measurements may not be representative of average annual groundwater levels. The measurements show that groundwater is likely to be encountered below a depth of 1.42 m (AHD 2.0 m) in the lower lying sections of the flood plain.

The implications of the geotechnical investigations for construction are discussed in Sections 11.2 and 12.2.

6.5.4 Laboratory test results

(A) Reference criteria (soil)

The guidelines concerning contamination of soils for residential sites are generally considered applicable to the assessment of the exposure risks to residents at the site.

For residential sites, the *Health Investigation Levels – A* (listed in Column A of Table 5-A in the NEPM guidelines) have been adopted as the investigation or acceptance criteria for the respective contaminants of concern.

For off-site disposal of excavated soil, reference has been made to the Southern Waste Depot License requirements for waste fill (WF), intermediate landfill cover (ILC) and low level contaminated waste (LLCW).

(B) Soil analysis results

Seven near-surface soil samples and one deeper natural soil sample from seven borehole locations (BH1, BH3, BH4, BH6, BH9, BH11 and BH12) were analysed to assess the concentration of compounds included in the Vic EPA screen. Copies of the laboratory test results sheets together with results of the laboratory QA/QC testing are contained in Appendix D.

The results of the laboratory testing indicated that the concentrations of PAH compounds, TRH compounds, BTEX compounds, OCP compounds, chlorinated hydrocarbons, cyanide, PCB compounds, phenol, cresol and selected heavy metals in all samples tested were generally below laboratory detection limits or the adopted site criteria (NEHF exposure setting A and WF criteria).

6.5.5 Acid sulphate soils

The results of the POCAS testing are presented in Appendix D and summarised in Table 6.7. No acid sulphate soils have been detected.

Table 6.7 – Summary acid sulphate test results

Sample and depth interval (m)	Material description	Acid trail: Total sulfidic acidity (mol H+/tonne)	Sulphur trail: % oxidisable sulphur	Acid sulphate soil*
BH3/2 1 m to 1.5	Clay, grey, pale grey	< 2	< 0.01	No
BH4/3 1.4 m to 2	Clay, pale grey, pale yellow brown	< 2	< 0.01	No
BH6/2 0.75 m to 1 m	Clay, dark grey, yellow brown	< 2	< 0.01	No
BH6/3 1.25 m to 1.5	Clay, dark grey, yellow brown	< 2	< 0.01	No
BH6/4 2.2 m to 2.5	Clay, pale grey, orange	< 2	< 0.01	No
BH9/2 0.8 m to 1.1	Clay, dark grey	< 2	< 0.01	No
BH9/3 1.8 m to 2.0	Clay, pale grey, orange	< 2	0.03	No
BH11/2 0.3 m to 0.6	Clay, dark grey, dark grey brown	< 2	0.02	No
BH11/3 1.5 m to 1.9	Clay, pale grey, yellow brown	< 2	<0.01	No
BH12/2 0.8 m to 1.1	Clay, pale grey, grey	< 2	< 0.01	No

**Determined from Appendix 3: Criteria for Acid Sulphate Soils from Vic EPA Information Bulletin (Publication 655, August 1999). Medium to heavy clay and silty clay is classified as acid sulphate soil if % Oxidisable Sulphur > 0.1 and/or Total Sulfidic Acidity > 62*

6.6 EXISTING INFRASTRUCTURE

This section provides a brief outline of existing infrastructure at the site.

6.6.1 Roads and tracks

The development site is currently served by Belvedere Road which connects to Mannum via the main Adelaide-Mannum Road and to Murray Bridge via the Mannum-Murray Bridge Road. Belvedere Road is unsealed (refer Photo 6.1).

Photo 6.1 – Looking along Belvedere Road to the existing entrance to Reschke's land

Two access tracks enter the site from Belvedere Road. One serves the property currently owned by Mr and Mrs B&K Reschke. This provides access to the Reschke's home and also to the river front where there is an existing boat ramp and a mooring area for private vessels. It also provides access to other unmade tracks through the property. One of these runs south parallel to the levee bank providing access to the dairy flat drainage system.

The second access from Belvedere Road, located further south, is an undeveloped track and traverses the site to the river where an unused boat shed is located.

6.6.2 Buildings

There is only one substantial building within the development area. This is the Reschke's home (refer Photo 6.2). An old dairy building and silo are located near Belvedere Road in the south of the development. Apart from this, a number of sheds are scattered over the site and a small building is located on the SA Water site.

The Reschke's home is a substantial building. It will be retained within the proposed residential areas together with the sheds immediately associated with the home. No other existing buildings will be retained in the ultimate development.

Photo 6.2 – Reschke's home

6.6.3 Stormwater

Apart from the culvert structure (refer Photo 6.3) connecting the main creek beneath Belvedere Road, no other stormwater infrastructure exists on the site.

Drainage follows natural gullies and creeks to the dairy flats. There is no natural drainage outlet from the development area to the river due to the presence of the levee.

Photo 6.3 – Culvert under Belvedere Road

6.6.4 Wastewater

The proposal includes the development of the current SA Water wastewater treatment site for Mannum (refer Photos 6.4 and 6.5).

Photo 6.4 – Looking from the site towards the treatment lagoons

Photo 6.5 – Looking from the existing township towards the treatment lagoons

Wastewater arrives at the treatment plant (refer Photo 6.6) through a pumping main from the township sewerage system on River Lane.

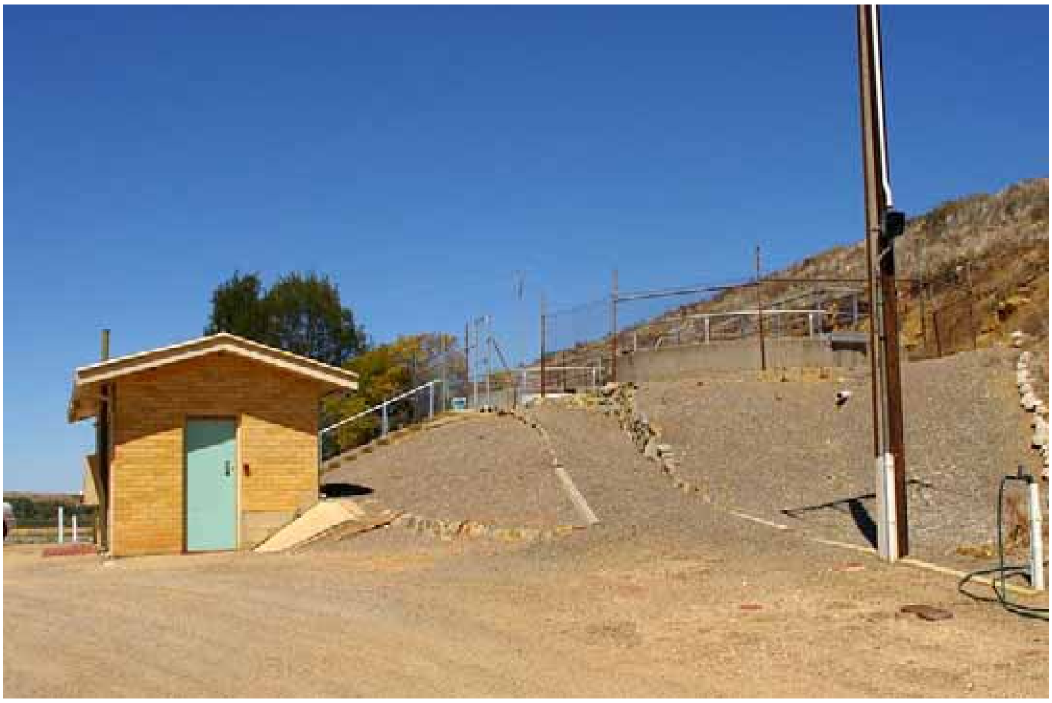


Photo 6.6 – The existing wastewater treatment tanks and building

Photo 6.7 – The existing wastewater lagoons overflow structure

The treated wastewater is stored within three lagoons for final treatment and used as reclaimed water on the Mannum Golf Course. The existing lagoons occupy an area of approximately 4 hectares. An overflow structure (refer Photo 6.7) permits flow from the lagoons to the river in emergencies. Sludge drying beds are also present (refer photo 6.8).

Photo 6.8 – The existing sludge drying beds

Photo 6.9 – The existing combined reclaimed water and river water pumping system

Photo 6.10 – The existing pumping suction pipe

An existing pumping station (refer Photo 6.9) which extracts water from the river (refer Photo 6.10) and also the storage lagoons delivers water for irrigation of the Mannum Golf Course. River water is used for irrigating the greens as it contains fewer nutrients and does not encourage excessive growth. The reclaimed water is used on the general fairways.

Surplus reclaimed water is distributed to an area of land owned by the Mannum Golf Club. This avoids overflow from the lagoons to the river.

The whole of the area occupied by the lagoons and sludge drying beds lies below the 1956 flood level recorded at Mannum.

The only other wastewater facility within the development site is the septic tank system which serves the Reschke home.

6.6.5 Water supply

There is no mains water supply to the development site. A water licence is owned by Mr. Reschke for 170 megalitres/annum and will be made available for purchase by the proponent when the project proceeds.

6.6.6 Irrigation systems

Private irrigation systems have operated on the high ground and within the gully of the main creek (refer Photo 6.11). The systems are no longer in use and will be decommissioned as the development proceeds.

Photo 6.11 – Existing irrigation area (not currently used) within the creek

Extensive drainage channels traverse the site. These were established as part of the flood irrigation schemes along the lower River Murray and discussed in Section 3.1.2.

6.6.7 Electricity supply and public lighting

An electric overhead supply traverses the site via easements providing power to the SA Water site, the Reschke land, the disused dairy and neighbouring property to the south. Under the development the overhead supply will be replaced with an underground service which will maintain supply to the adjacent properties as required.

6.6.8 Telecommunications

There is an existing telecommunications service to the Reschke's home only.

6.6.9 Gas

There are no gas services to the site

6.6.10 Embankments and levees

Constructed embankments surround the SA Water wastewater lagoons. They will not form part of the new development.

A levee bank which isolates the dairy flats from the River is constructed along the length of the site from the SA Water lagoons to the southern boundary and beyond.

6.6.11 General

Figure 6.5 shows locations of the existing structures and features on the development site.

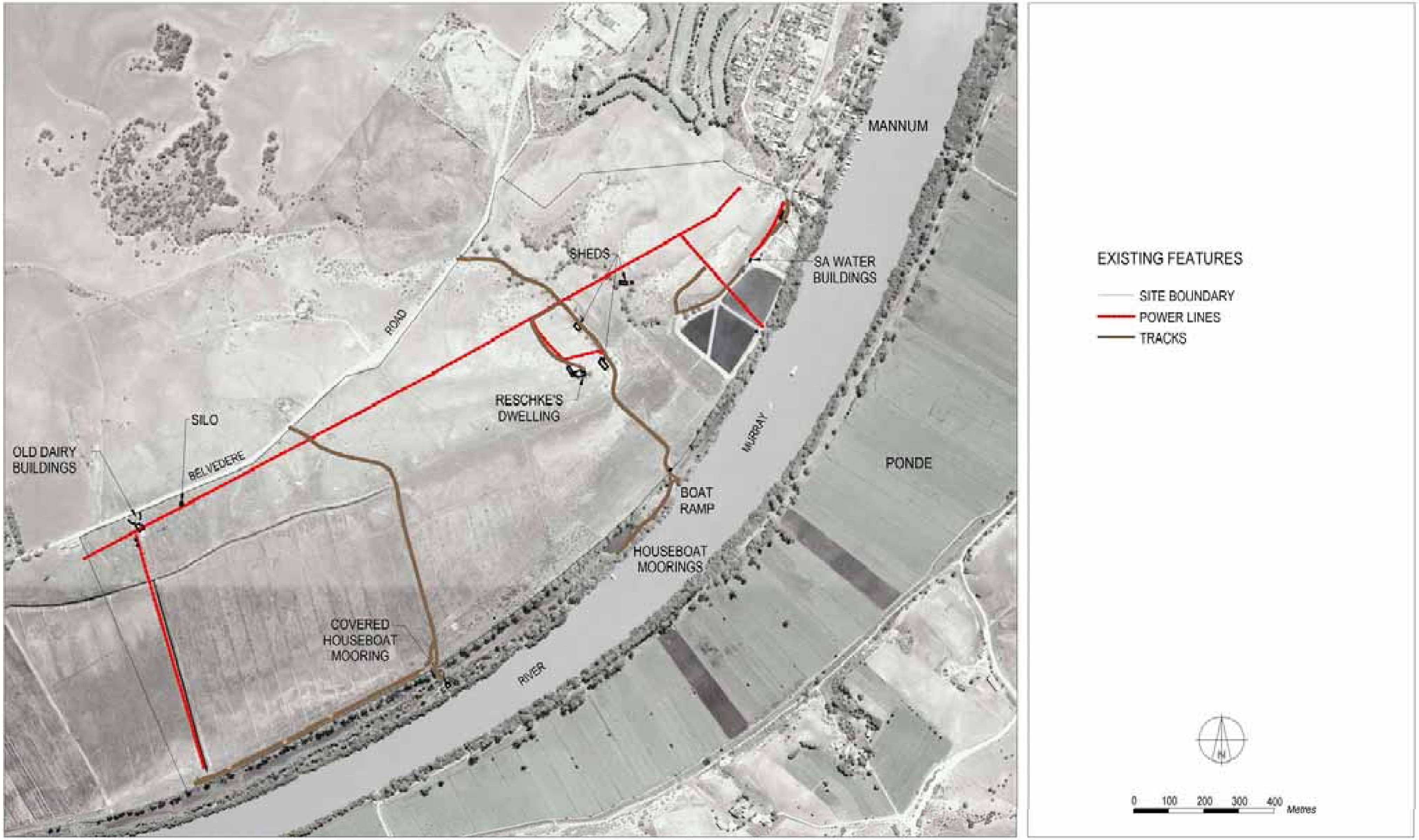


Figure 6.5 – Existing features

7 Existing biological environment

7.1 INTRODUCTION

The existing biological environment of the proposed Mannum Waters development is a mixture of remnant riparian vegetation and areas heavily influenced by anthropogenic forces.

Fauna, flora and potential habitat areas were assessed to determine potential environmental impacts.

This section provides a summary of detailed flora and fauna assessments and potential legislative implications.

7.2 REGIONAL LANDSCAPE FLORA CONTEXT

The landscape of the riverine environment between Mannum and Wellington has been described by Laut et al. (1977) as flood plain incised into calcrete plains with intensive pastures and swamps being the primary land use.

In summary, the study area is divided into:

- riparian/wetland zone (Baseby Riverine Wetland) – between the levee bank and the river. This zone is assessed as having a moderate to high conservation status because of its high habitat diversity and its location in an area with few wetlands
- the retired Baseby Irrigation Area, formerly the flood plain/swamp zone – former reed beds associated with lignum (*M. florulenta*) and patches of river red gum (*E. camaldulensis*)
- cliff face zone and highland zone - formerly shrubland dominated by Myoporum, Acacia and Senna, and includes the remnant Black Box Woodland in the gully.

As described in the following sections, the swamplands, cliff face and highland are highly modified. The riverine wetland, which is approximately 7.2 ha, while impacted to some degree, retains much of its natural attributes, and has been variously described in a number of reports. In the Wetlands Atlas (Jensen *et al*. 1996), it is described as a stranded remnant wetland: a linear wetland that runs between the irrigation levee bank and the river. It is along the whole length of the irrigation area, consisting of ‘three linear depressions, located between an irrigation embankment and the river. Tall River Red Gums stand over areas of open water and small clusters of reeds’ (Jensen *et al*. 1996). It was classified by Jensen *et al* (1996) as having moderate to high conservation value as it has high habitat diversity and is located in an area where few wetlands remain. It is listed in the National Directory of Important Wetlands, as it is a remnant of the Lower Murray swamps.

The riverine wetland was also included in Thompson's Murray Wetland Survey (1986), the Regional Wetland Strategy for Murray Bridge (1999), Hyde's Biodiversity Study (2000) and the 2001 Biodiversity Plan for the Murray-Darling Basin. None of these other studies have considered the Baseby Wetland specifically, except to recognise the importance of linear riverine wetland areas as part of the remaining wetlands in the Lower Murray Swamp region.

The Australian Nature Conservation Agency (1996) listed the lower Murray swamps from Mannum to Wellington as important wetlands under physical, hydrological and biological criteria of significance. All of the Lower Murray Swamps from Mannum to Wellington have also been listed by Environment Australia (2001) as an important wetland area. The wetlands are not continuous but composed of isolated remnant wetlands along the river. Human impact has caused a significant loss of wetlands along the River Murray with less than 10% of the original wetlands remaining. Areas that remain are generally degraded due to changed water regime, invasion by weeds and grazing by stock. As there is such a low proportion of the original wetlands in this region, any remaining should be regarded as a valuable asset and given high priority for conservation and rehabilitation (Jensen et al., 1996; Wetland Care Australia, 1999).

The Mannum Swamps and Reedy Creek are two larger wetland areas located nearest to the Baseby riverine wetland, refer figure 7.1. Both are listed in the National Directory of Important Wetlands (Environment Australia, 2001) as part of the Lower Murray Swamps and have also been classified by Jensen *et al.* (1996) as having high conservation value, and were briefly described as follows.

7.2.1 Mannum Swamps (north)

The Mannum swamp stretches upstream from Mannum for approximately 7km and covers an area of 197.8 hectares (Jensen *et al.,* 1996). This wetland contains regenerating river red gums, lignum, sedges, bulrush and an abundance of aquatic plants. There are also several large patches of reeds throughout and willows are abundant at the south-western end. The wetland supports a moderate number and diversity of waterbirds and aquatic invertebrates. Many birds have been observed roosting in the area and it once provided a breeding site for black swans. It has been classified as having high conservation value due to the diversity of flora and fauna it contains (Jensen *et al,* 1996).

7.2.2 Reedy Creek (south)

The Reedy Creek swamp area lies downstream of the riverine wetlands. It consists of a permanent wetland, which covers approximately 98.6 hectares and a larger, ephemeral swamp area. Both have been classified as having high conservation value as they contain communities of remnant vegetation that are rare in the area and provide a range of habitat types which support a high diversity of fauna (Hyde, 2000; Jensen *et al.*, 1996; Thompson, 1986). The area has been disturbed by human activity and as a result some parts have suffered significant degradation (Hyde, 2000; Jensen *et al.,* 1996).

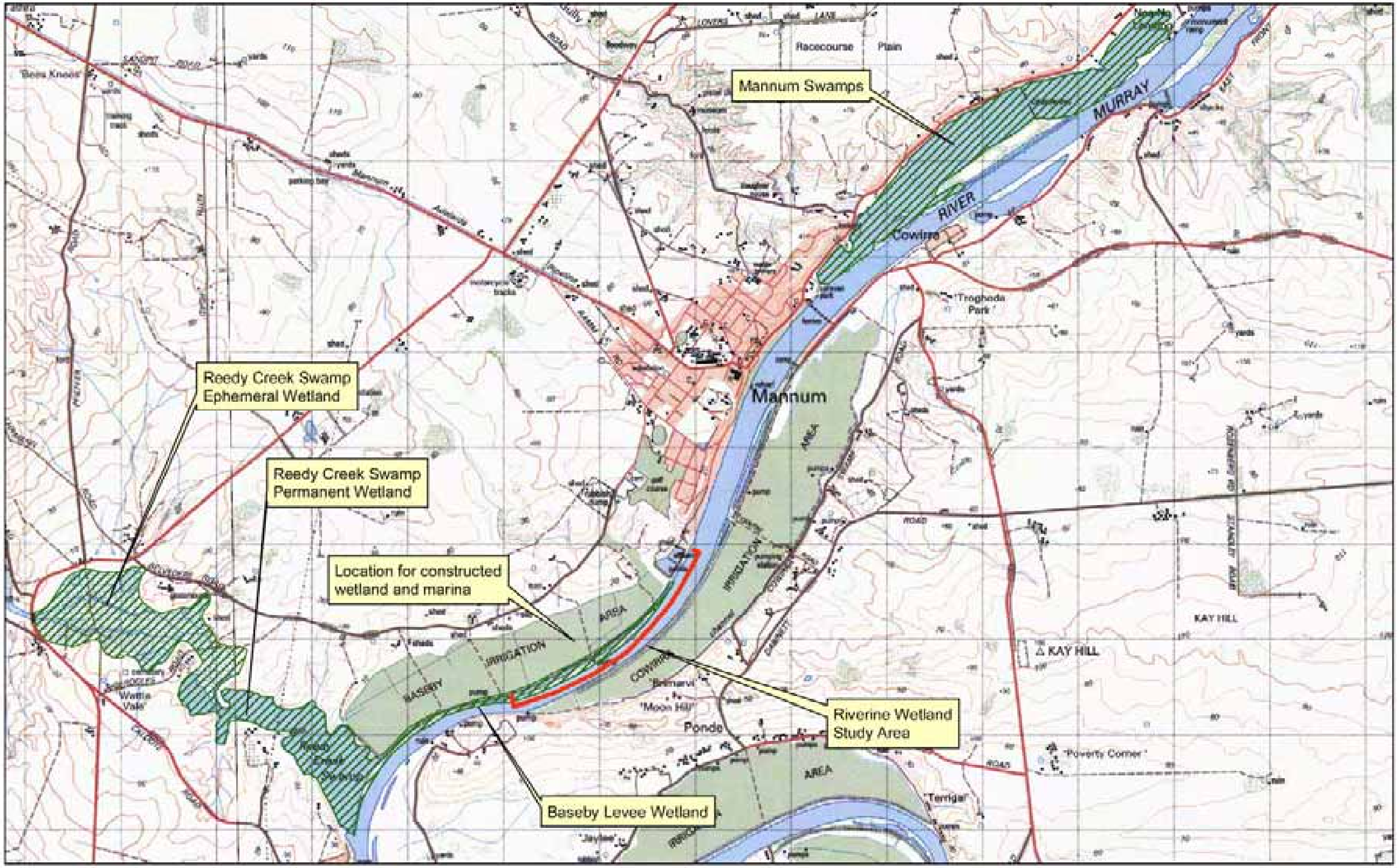


Figure 7.1 - Study area location

While studies tend to focus on such larger wetland units, smaller areas such as the Baseby Riverine Wetland are still valuable to the functioning of the river ecosystem. They assist bank stability, affect resistance to flow and stream morphology and filter nutrients from water entering the river. They provide habitat for wildlife, especially small fish, frogs and macroinvertebrates. The presence of native vegetation helps to maintain indigenous populations and reduces the likelihood of invasion by exotic species. Linear, riverine wetlands are also likely to be important as corridors, which facilitate movement of fauna along the river and between other wetland areas (Wetland Care Australia, 1999).

7.3 FLORISTIC COMMUNITIES/HABITAT AVAILABILITY

7.3.1 Methodology

A preliminary survey was conducted by Eco Management Services Pty Ltd (EMS) in 2003 (see Eco Management Services and Planning Advisory Services 2003) to determine any important features at the proposed marina development, determine whether the development would affect any sensitive areas and that it could afford appropriate levels of protection to the natural environment. This was never intended to be a quantitative survey of the area. It included a delineation of habitat areas, an initial walk over survey of the vegetation.

In the 2003 study, the Riverine wetlands were identified as a distinct habitat area. A further detailed survey of the important riverine wetlands was undertaken by EMS in 2005 as part of the preparation of a Wetland Management Plan (EMS 2005). This included a further delineation of floristic communities within the riverine wetland and major features, the use of transects through the riverine wetland and the identification of all species discovered. In many places the density of vegetation eg boxthorn/lignum, reed beds, prevented the use of random quadrats. Within the wetland area, four communities were identified, being, ephemeral wetlands, riparian woodland/shrublands, River Murray frontage/levee bank and inland levee bank.

A fauna survey of the site was also carried out along with a vegetation survey. Initial reconnaissance was completed and potential habitat areas established. The fauna survey was carried out during February, which provides an indication of species diversity during the hotter summer months.

Opportunistic observations of bird species and active searches for reptiles and mammals were made during a seven hour survey of the area. Observations were then compared to data collected from the South Australian Museums Fauna databases and previous reports. Pitfall trapping and Elliot trapping were not undertaken. It was considered that they were likely to yield very low catch rates. Trapping, however, will be undertaken as part of the development of the proposed baseline fauna and flora surveys, refer Section 12.3.1.

During the EMS February 2005 survey photopoints were established, with GPS coordinates taken for future reference as part of ongoing monitoring.

In this section the results of the 2003 and 2005 investigations are combined. This has been supplemented with other information particularly the biodiversity study of Hyde

(2000), who undertook a biodiversity study for an approximately five kilometre wide strip of land on either side of the River Murray from Mannum to Wellington.

Two additional field surveys were undertaken in December 2005 and February 2006. These assessments supplemented existing records of flora and fauna collected around Mannum and the surrounding region (in some cases, up to 60 km away) provided by the State Department for Environment and Heritage (SA DEH) and South Australian Museum (SAM).

Vegetation was sampled from quadrats established within each of the vegetation communities. Sites were similar in area, approximately 100m diameter (where possible), to those used for vegetation surveys by the Biological Survey and Research Section of the SA Department for Environment and Heritage (e.g. Brandle 1998). Voucher specimens were not collected in the surveys as all species were positively identified in the field.

Further, a Protected Matters search was also undertaken to discern all Matters of National Environmental Significance under the Commonwealth EPBC Act 1999 that may be affected by the proposed development.

7.3.2 Communities

The general vegetation communities are:

- Flood plain/swamp zone (Samphire, chenopod, nitre bush shrublands and Boxthorn (+/-Lignum) tall shrublands on the retired Baseby Irrigation area).
- Cliff face and highland zone
- Baseby riverine wetland and riparian/levee vegetation (refer Photos 7.1, 7.2 and 7.3).

Photo 7.1 - Samphire on former irrigation areas

Photo 7.2 - View from highland zone towards gully with scattered River Box

Photo 7.3 - View of Baseby riverine wetland

The locations of the vegetation communities are shown in Figure 7.2.

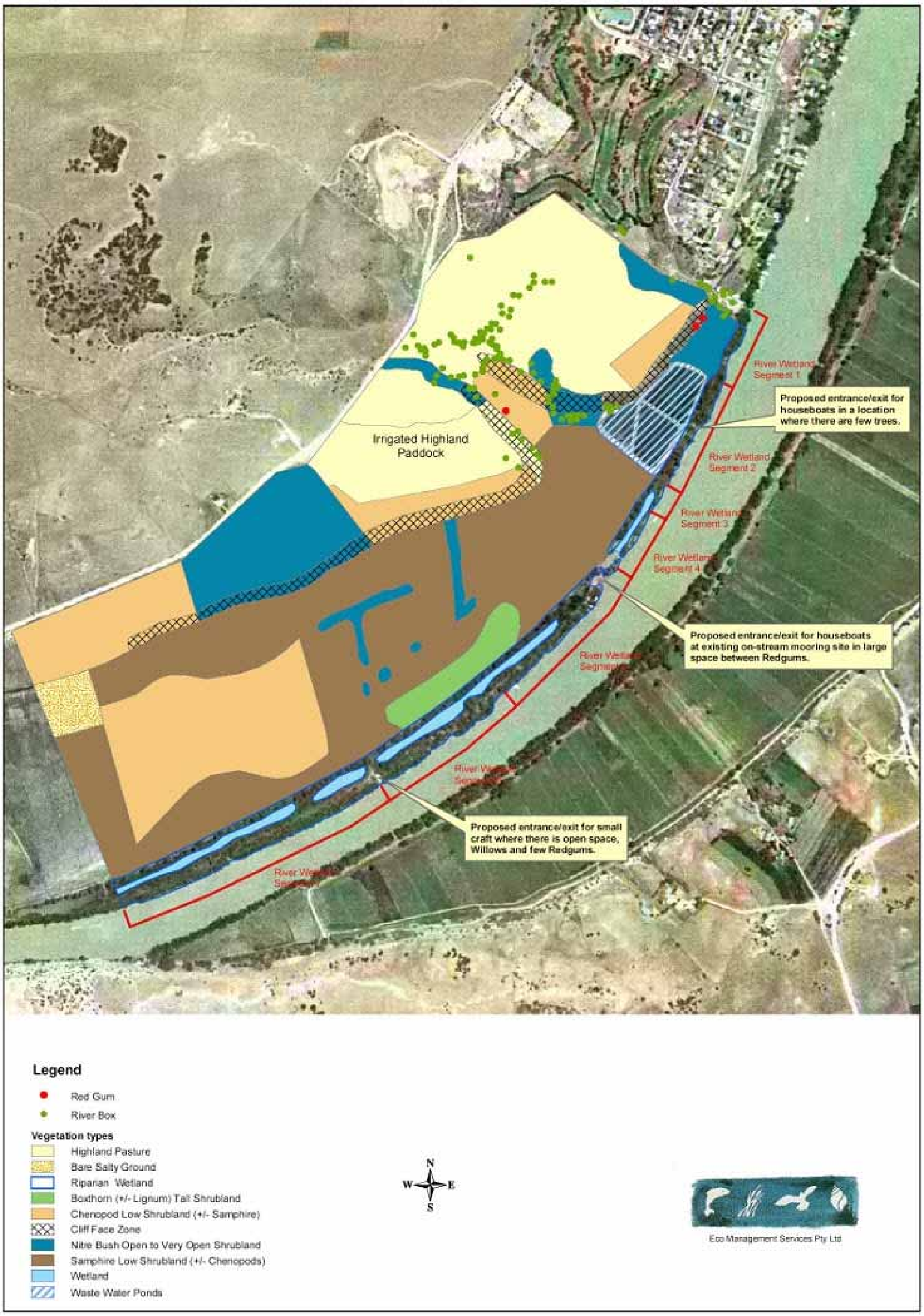


Figure 7.2 - Vegetation associations

In describing the floristic communities, their location extent and condition a description is also provided of the habitat available for fauna.

The communities and their habitat characteristics are described in the following sections.

7.4 FLOOD PLAIN/SWAMP, CLIFF FACE AND HIGHLAND ZONES

Hyde (2000) reconstructed the pre-European vegetation associations for this zone based on a compilation of all previously known vegetation surveys undertaken. He plotted patches of significant native vegetation, both terrestrial and aquatic (wetlands) and provided a detailed list of plant species for each vegetation association to guide revegetation projects.

He describes the flood plain/swamp zone as former reed beds associated with lignum (*Muehlenbeckia florulenta*) and patches of river red gum (*Eucalyptus camaldulensis*). He noted that river red gums often formed an overstorey in the reed beds, along the water's edge and in seasonally inundated areas

The cliff zone and the highland zone above the development site were recorded as former shrubland dominated by *Myoporum*, *Acacia* and *Senna*.

Little of the original terrestrial native vegetation remains at the development site today except for:

- a small shrubby patch along the cliff face zone facing the SA Water sewage treatment works
- occasional mature river box trees (Eucalyptus largiflorens) scattered around the lower edges of the gully west of the existing sewage treatment plant.

The floodplain was extensively modified for dairying. With the retirement of this area, it has not reverted to freshwater swamp zone species but rather species adapted to high soil salinities including samphires and chenopods (refer Photo 7.4 for aerial view).

Photo 7.4 - Aerial view of former irrigation areas and gully in the distance

Similarly, the highland zones have been recolonised by species adapted to higher soil salinities, including the nitre bush (*Nitraria billardierei*) and chenopods.

Sheep still heavily graze much of the development site and existing vegetation is limited to species that are thorny or unpalatable. In the few locations where sheep are excluded, species' numbers are often higher.

The elevated terrain primarily associated with the SA Water Sewage Treatment Ponds contains different plant species to those found in the lower relief floodplain areas. These areas have been heavily grazed in the past and subsequently species diversity is low.

Approximately 60 mature River Box (*Eucalyptus largiflorens*) are located in this zone. The understorey species are mixture of saltbush species (*Atriplex* sp, *Einadia* sp, *Enchylaena* sp) over an anthropogenic groundcover of introduced species.

The species of the plant associations in the floodplain and cliff face zones are summarised in Table 7.1

Table 7.1 - Plant Species for the Flood plain and Cliff face Communities

Species	Common Name	Conservation Status			Boxthorn Shrubland	Samphire Areas	Chenopod Shrubland	Nitre bush Shrubland	SA Water Cliff Face
		AUS	SA	MU					
Acacia oswaldii	Umbrella Wattle								
Asperula gemella	Twin-leaf Bedstraw								
Atriplex nummularia ssp. nummularia	Old-man Saltbush								
Atriplex semibaccata	Berry Saltbush								✓
Atriplex suberecta	Lagoon Saltbush								
**Avena barbata*	Bearded Oat								
Azolla filiculoides	Pacific Azolla								
**Berula erecta*	Water Parsnip								
**Brassica tournefortii*	Wild Turnip								
Centella cordifolia	Native Centella			U					
Chenopodium nitrariaceum	Nitre goosefoot			??					
**Cirsium vulgare*	Spear Thistle								
**Critesion marinum*	Sea Barley-grass								
**Critesion murinum*	Barley-grass					✓	✓	✓	
**Cynodon dactylon*	Couch								
**Cyperus eragrostis*	Drain Flat-sedge								
Cyperus gymnocaulos	Spiny Flat-sedge								
Danthonia sp.	Wallaby-grass								
Disphyma crassifolium ssp. clavellatum	Round-leaf Pigface				✓				
Distichlis distichophylla	Emu-grass			U					
Einadia nutans	Climbing Saltbush								✓
Enchylaena tomentosa var. tomentosa	Ruby Saltbush								✓

Species	Common Name	Conservation Status			Boxthorn Shrubland	Samphire Areas	Chenopod Shrubland	Nitre bush Shrubland	SA Water Cliff Face
		AUS	SA	MU					
Eremophila divaricata ssp. divaricata	Spreading Emubush			U					
Eucalyptus camaldulensis var. camaldulensis	River Red Gum				✔				
Eucalyptus largiflorens	River Box								✔
**Euphorbia terracina*	False Caper								
**Galenia secunda*	Galenia								
**Gynandriris setifolia*	Thread Iris								
Gyrostemon australasicus	Buckbush Wheel-fruit								
Halosarcia pergranulata	Black-seed Samphire								
**Heliotropium curassavicum*	Smooth Heliotrope								
Hydrocotyle verticillata	Shield Pennywort								
Juncus usitatus	Common Rush								
**Lepidium africanum*	Common Peppercress				✔				
Lycium australe	Australian Boxthorn								
**Lycium ferocissimum*	African Boxthorn				✔				
Lycopus australis	Australian Gipsywort			R					
Maireana brevifolia	Short-leaf Bluebush						✔		✔
Maireana erioclada	Rosy Bluebush								
Maireana trichoptera	Hairy-fruit Bluebush								
**Marrubium vulgare*	Horehound								
**Mesembryanthemum crystallinum*	Common Iceplant				✔				
**Mesembryanthemum nodiflorum*	Slender Iceplant								
Muehlenbeckia florulenta	Lignum								
Myoporum insulare	Common Boobialla			U					
Myoporum platycarpum	False Sandalwood								
**Nicotiana glauca*	Tree Tobacco								
Nitraria billardierei	Nitre-bush								✔
**Paspalum distichum*	Water Couch								
**Pennisetum clandestinum*	Kikuyu								
Persicaria decipiens	Slender Knotweed								
Phragmites australis	Common Reed								
**Phyla canescens*	Lippia								

Species	Common Name	Conservation Status			Boxthorn Shrubland	Samphire Areas	Chenopod Shrubland	Nitre bush Shrubland	SA Water Cliff Face
		AUS	SA	MU					
Pittosporum phylliraeoides var. microcarpa	Native Apricot				□	□	□	□	□
Rhagodia spinescens	Spiny Saltbush				□	□	□	□	□
Rumex bidens	Mud Dock				□	□	□	□	□
**Salix babylonica*	Weeping Willow				□	□	□	□	□
**Salix x rubens*	White Crack Willow				□	□	□	□	□
Salsola kali	Buckbush				□	□	□	□	□
Sarcocornia quinqueflora	Beaded Samphire				□	□	□	□	□
**Schinus areira*	Pepper-tree				□	□	□	□	□
Schoenoplectus validus	River Club-rush				□	□	□	□	□
Sclerolaena tricuspis	Three-spine Bindyi			U	□	□	□	□	□
Senecio lautus	Variable Groundsel				□	□	□	□	□
Stipa sp.	Spear-grass				□	□	□	□	□
Suaeda australis	Austral Seablite				□	□	□	□	□
**Suaeda baccifera*	Seablite				□	□	□	□	□
Triglochin procerum	Water-ribbons				□	□	□	□	□
Typha domingensis	Narrow-leaf Bulrush				□	□	□	□	□
Urtica incisa	Scrub Nettle			U	□	□	□	□	□
**Urtica urens*	Small Nettle				□	□	□	□	□
Vittadinia dissecta var. hirta	Dissected New Holland Daisy				□	□	□	□	□
Zygophyllum aurantiacum	Twinleaf				□	□	□	□	□
					□	□	□	□	□

Plant Names and Conservation Status ratings are according to Lang and Kraehenbuehl (Feb, 2002).

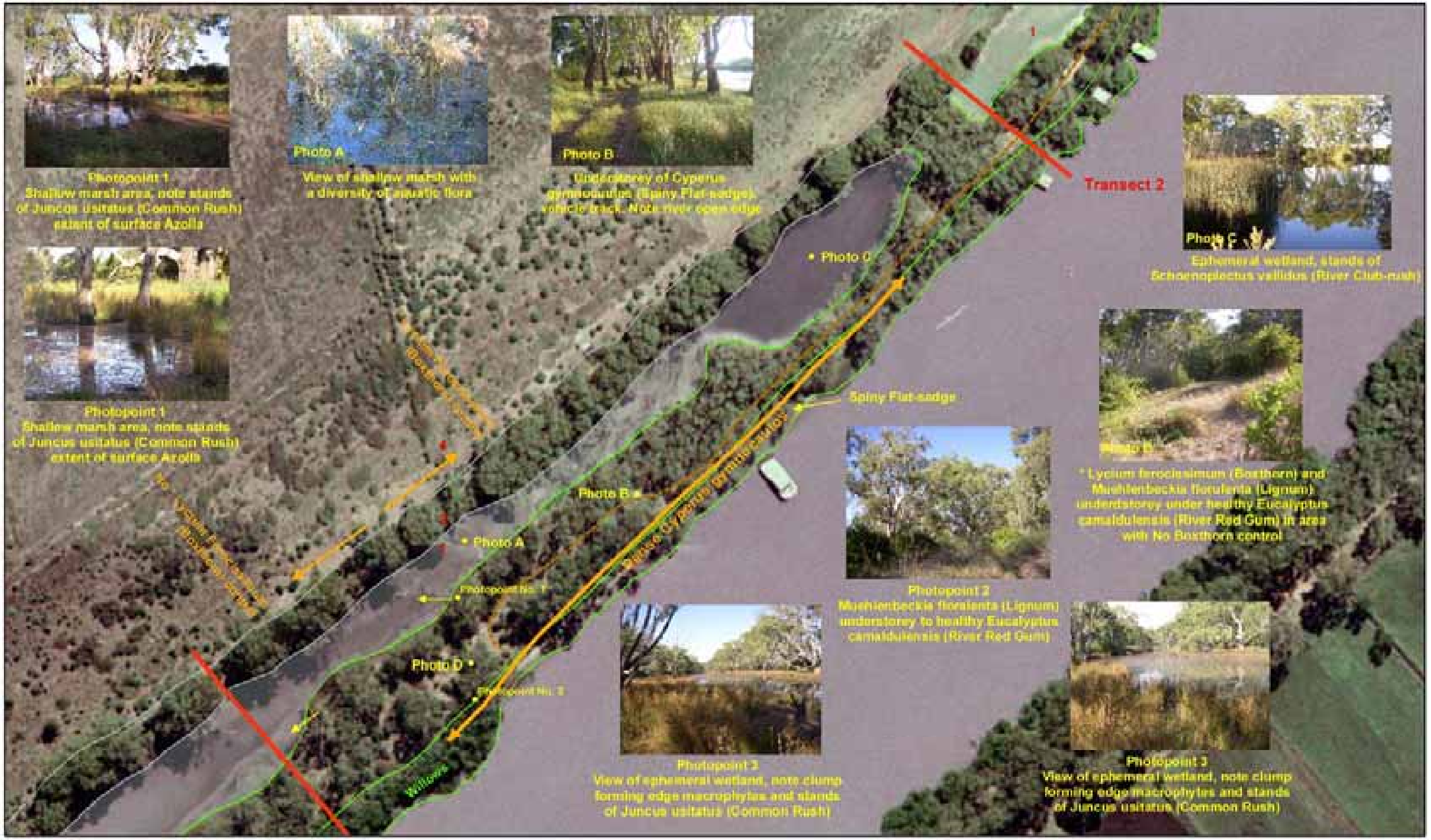
- indicates a non-native or weed species,

U=Uncommon

R=Rare

Figure 7.3 - Riverine wetland area (1)

Figure 7.4 - Riverine wetland area (2)



Legend

Photo Numbers

Vehicle track

Management Units

1 Ephemeral Wetlands

2 Riparian Woodlands and Shrublands

3 River Murray Frontage

4 Northern Inland Levee Bank

4 Southern Inland Levee Bank

0 12.5 25 50 75 100 Meters

Figure 7.5 - Riverine wetland area (3)

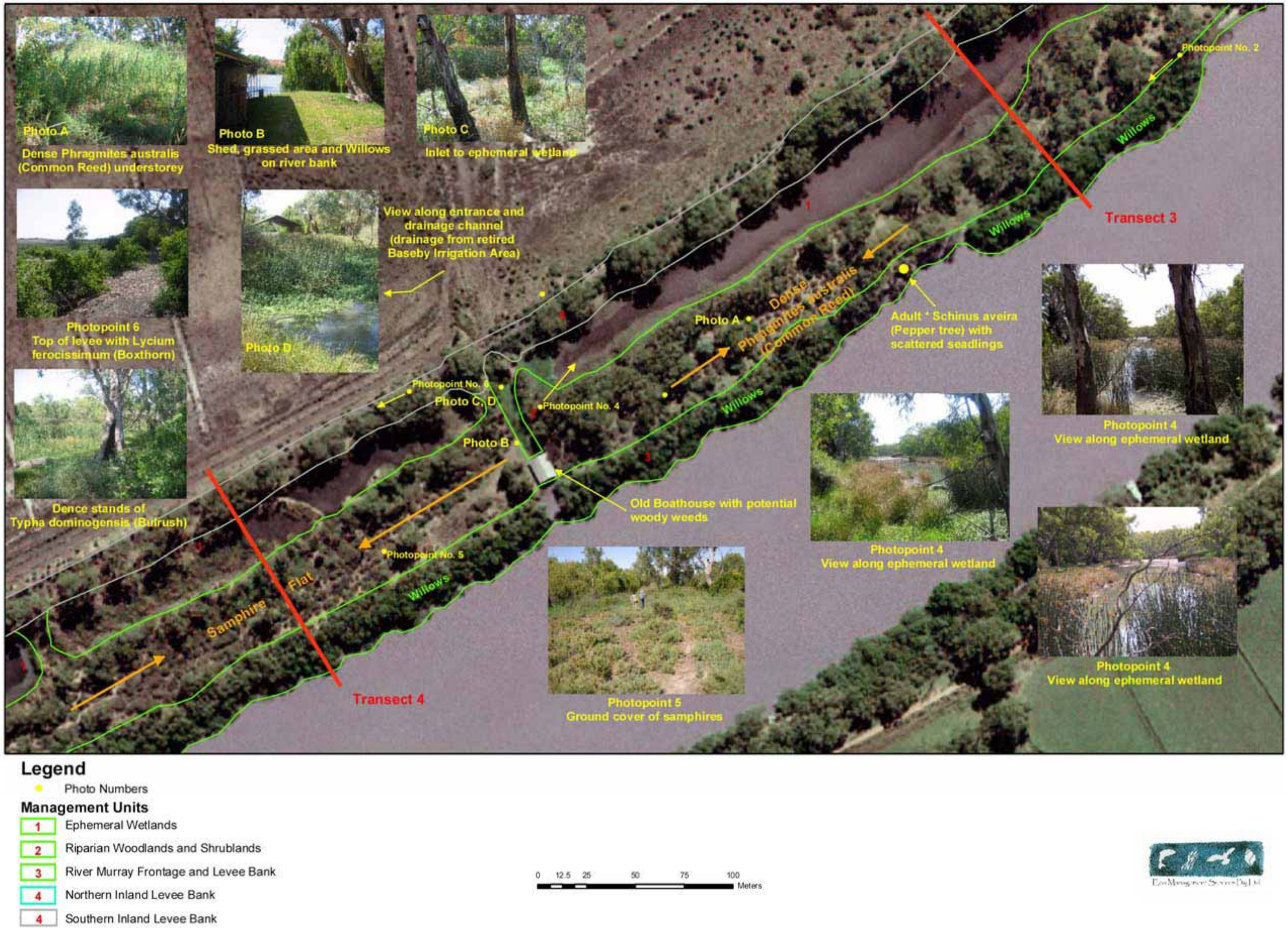


Figure 7.6 - Riverine wetland area (4)

Legend

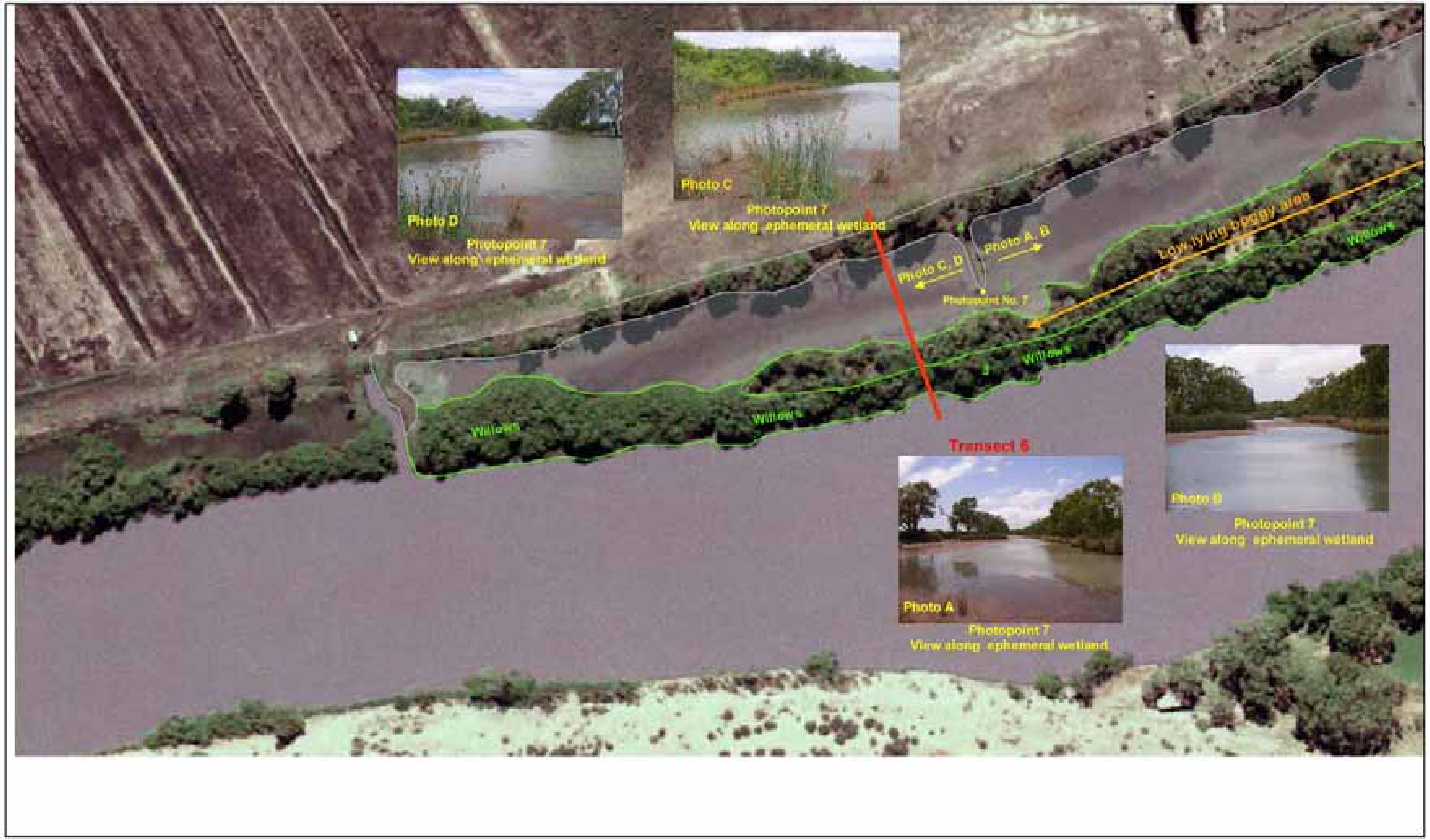
- Photo Numbers

Management Units

- 1 Ephemeral Wetlands
- 2 Riparian Woodlands and Shrublands
- 3 River Murray Frontage
- 4 Northern Inland Levee Bank
- 4 Southern Inland Levee Bank

0 12.5 25 50 75 100 Meters

Figure 7.7 - Riverine wetland area (5)



Legend

Photo Numbers

Management Units

1 Ephemeral Wetlands

2 Riparian Woodlands and Shrublands

3 River Murray Frontage

4 Northern Inland Levee Bank

4 Southern Inland Levee Bank

0 12.5 25 50 75 100 Meters

Figure 7.8 - Riverine wetland area (6)

7.5 FLORA AND HABITATS IN THE BASEBY LINEAR WETLAND

7.5.1 Definition of Habitats and Management Units

The Baseby Linear Wetland has been divided into four basic habitat zones. Because of the need to protect these zones they are also defined as management units, as follows:

- Ephemeral Wetland – Management Unit 1
- Riparian Woodlands and Shrubland – Management Unit 2
- River Murray Frontage – Management Unit 3
- Inland Levee bank – Management Unit 4

These are defined on Figures 7.3 – 7.8. The emphasis at this stage is generally to describe the area, its habitat diversity, vegetation associations, current management issues and those associated with the proposed development. The flora species recorded are included in Table 7.2. A long term management focus will be the protection of the area, to the extent of largely preventing public access, with minimal physical disturbance to the area.

7.5.2 Ephemeral Wetlands (Management Unit 1)

(A) Description

As indicated on Figures 7.3 – 7.8, the wetlands extend along the whole length of the study area. Only one small section, indicated on Figure 7.4, is permanent water. Wetland Care Australia's (1999) classification of wetlands identifies the Baseby wetland as a stranded linear River Murray wetland. It is constrained by the higher ground associated with riparian woodlands and shrubs zone (MU 2) and the Levee (MU 4). The wetlands are inundated in the spring-early summer period in response to the seasonal water level variations in the river and occasional flood flows. At the time of the recent (Feb 2005) survey all of the wetland area held water, except for one small basin near the car park area and boat mooring area. This was to be expected and the wetland would be in the process of gradual drying due to evaporation.

This zone provides a diversity of habitats, through a combination of:

- varying depths for different ponds, from a few centimetres when full up to approximately 1 metre
- varying sizes of ponds
- open water areas and emergent macrophyte beds
- a range of aquatic vegetation, including emergent, submerged and floating species
- areas of shade and more exposed areas.

The characteristics along the southern portion of the wetland, south of the boat mooring area, are illustrated in Photos (PP 1), 7.5, 7.6and 7.7 (refer Figure 7.5), which give views of the very shallow marshy areas. Photo 7.8 (PP 3), Photos 7.9 and 7.10 (both PP 4) give views of shallow and wider areas with open water visible (refer Figure 7.8).

Photo 7.5 - Shallow marsh area in ephemeral wetland with a diversity of aquatic vegetation

Photo 7.6 - Shallow marsh, note stands of *Juncus usitatus* (common rush) and *Azolla* on water surface

Photo 7.7 - Shallow marsh area with complete cover of *Azolla* on water surface

Photo 7.8 - View of ephemeral wetland (Photopoint 3)

Photo 7.9 - View along narrow ephemeral wetland area (Photopoint 4)

Photo 7.10 - General wetland view

Table 7.2 - Baseby Wetland: Plant Species List

		Conservation status				Management units			
Scientific name	**Common name**	**AUS**	**SA**	**MU**	**Weed status**	**1**	**2**	**3**	**4**
Asperula gemella	Twin-leaf Bedstraw					+	+		
**Aster subulatus*	Aster-weed					+	+		
**Atriplex prostrata*	Creeping Saltbush					+	+		
Atriplex semibaccata	Berry Saltbush						+	+	+
Azolla sp.	Azolla					+			
**Bromus diandrus*	Great Brome						+	+	
Calystegia sepium	Large Bindweed			U		+			
**Casuarina cunninghamiana*	River Oak				Env		+		
**Cirsium vulgare*	Spear Thistle						+		
**Conyza albida*	Tall Fleabane						+		
Crassula helmsii	Swamp Crassula					+			
**Critesion* sp.	Barley-grass						+		
**Cynodon dactylon*	Couch				Env		+	+	
**Cyperus eragrostis*	Drain Flat-sedge				Env	+			
Cyperus gymnocaulos	Spiny Flat-sedge					+	+	+	
Distichlis distichophylla	Emu-grass			U			+		
Einadia nutans	Climbing Saltbush						+	+	+
Eleocharis acuta	Common Spike-rush					+			
Enchylaena tomentosa	Ruby Saltbush						+	+	+
Eucalyptus camaldulensis	River Red Gum					+	+	+	+
Eucalyptus largiflorens	River Box								
**Eucalyptus* spp.	Western Australian Eucalypts				Env		+		
**Euphorbia terracina*	False Caper				SA		+		
**Galenia secunda*	Galenia						+		
Gratiola peruviana	Austral Brooklime			R		+			
Halosarcia pergranulata	Black-seed Samphire						+	+	
**Heliotropium curassavicum*	Smooth Heliotrope						+		
**Heliotropium europaeum*	Common Heliotrope						+		
Hydrocotyle verticillate	Shield Pennywort					+			
**Juncus articulatus*	Jointed Rush					+			
Juncus usitatus	Common Rush					+			
**Lactuca serriola*	Prickly Lettuce						+	+	
Lilaeopsis polyantha	Australian Lilaeopsis			U		+			
Lobelia alata	Angled Lobelia			R		+			

		Conservation status				Management units			
Scientific name	**Common name**	**AUS**	**SA**	**MU**	**Weed status**	**1**	**2**	**3**	**4**
**Ludwigia peploides*	Water Primrose					+			
**Lycium ferocissimum*	African Boxthorn				SA		+	+	+
Lycopus australis	Australian Gipsywort			R		+			
Lythrum sp.	Loosestrife					+			
Maireana brevifolia	Short-leaf Bluebush						+		+
**Mesembryanthemum crystallinum*	Common Iceplant								+
Mimulus repens	Creeping Monkey-flower					+			
Muehlenbeckia florulenta	Lignum					+	+	+	+
Myoporum florulenta	Lignum								
Myoporum insular	Common boobialla			U					
Myoporum parvifolium	Creeping boobialla								
Myriophyllum sp.	Milfoil					+			
**Nicotiana glauca*	Tree Tobacco				Env				+
Nitraria billardierei	Nitre-bush								+
**Paspalum distichum*	Water Couch				Env	+	+		
**Pennisetum clandestinum*	Kikuyu				Env	+		+	
Persicaria decipiens	Slender Knotweed					+			
Phragmites australis	Common Reed					+	+	+	
**Phyla canescens*	Lippia				Env	+	+		
**Polygonum aviculare*	Wireweed						+		
Ranunculus sp.	Buttercup					+			
**Reichardia tingitana*	False Sowthistle						+		
Rhagodia spinescens	Spiny Saltbush						+		+
**Rorippa nasturtium-aquaticum*	Watercress					+			
**Salix babylonica*	Weeping Willow				Env			+	
**Schinus areira*	Pepper-tree				Env		+	+	
Schoenoplectus validus	River Club-rush					+		+	
Senecio lautus	Variable Groundsel						+		
**Sonchus oleraceus*	Common Sow-thistle						+		
Stemodia florulenta	Bluerod						+	+	
Suaeda australis	Austral Seablite						+		
Triglochin procerum	Water-ribbons					+			
Triglochin striatum	Streaked Arrowgrass					+			

		Conservation status				Management units			
Scientific name	Common name	AUS	SA	MU	Weed status	1	2	3	4
Typha domingensis	Narrow-leaf Bulrush				Env	+			
					Native	24	15	10	8
					Introduced	9	21	7	3
					Total	33	36	17	11

TABLE 7.2 NOTES

Table 7.2 is not an exhaustive plant list for the wetland. Species with a low density or abundance may not have been recorded. This particularly applies to introduced plants.

SCIENTIFIC NAMES, COMMON NAMES and CONSERVATION STATUS follow Lang & Kraehenbuehl (2002) using Florlist v2.0d and data file flz0205, * = Introduced plant species

Australia – Conservation Status under *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)

South Australia – Conservation Status under *National Parks and Wildlife Act 1972* (SA)

Murray botanical region – advisory Conservation Status follows Lang & Kraehenbuehl (2002)

Conservation Status codes - in order of significance

X = Extinct, E = Endangered, V = Vulnerable, R = Rare, U = Uncommon, (blank) = Common

WEED STATUS

Proclaimed pest plant for South Australia under *Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986 (SA)*

Environmental Pest Plant or potential Environmental Pest Plant, as assessed by Green Environmental Consultants

Native plant OR introduced plant not considered to be an Environmental Pest Plant

MANAGEMENT UNITS

1 1 = Ephemeral Wetlands, 2 = Riparian Woodlands and Shrublands, 3 = River Murray Frontage and Levee Bank, 4 = Inland Levee Bank

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DATE of SURVEY 1 February 2005 SURVEYOR Paul Green

Photos 7.11 (PP 7) and 7.12 give views of a much wider wetland area (approx 50 metres) with large open water areas (refer Figures 7.7 and 7.8). Photo 7.13 gives a view of a dry wetland basin near the boat mooring area (refer Figure 7.4). With the development of the mooring and car park, this basin has been cut off from the river and is now likely only inundated during higher flow events. There is little aquatic vegetation, which may be due to the more infrequent inundation and/or the effects of grazing. Sheep were present when the site was examined in February 2005.

Photo 7.11 - View along wide wetland area (Photopoint 7)

Photo 7.12 - View of wide wetland area, with extensive *Azolla*

Photo 7.13 - Dry wetland pond near boat mooring area

Photo 7.14 - View of permanent wetland area, looking north from the boat mooring area. Note extent of *Schoenoplectus vallidus*

Photo 7.15 - View of permanent wetland area and Aboriginal canoe tree

Photo 7.16 - Northern end of permanent water area

Photo 7.17 - Weedy growth and willows at location of proposed northern inlet culvert to the marina basin

Photos 7.14 (PP 8) and 7.15 give views of the deep permanent water wetland, accessible to boats, immediately north of the boat mooring area (refer Figure 7.4). Photo 7.15 also shows the Aboriginal canoe tree.

Photo 7.16 gives a view of the northern end of the permanent water pond. Photo 7.17 (PP 10) gives a view of the most northerly extent of the study area, where the wetland zone, only approximately 250 metres in length, is now very narrow and consists of a mixture of weeds, emergent macrophytes (*Typha*, *Schoenoplectus*) and some Lignum thickets.

The ephemeral wetlands had the highest native flora species diversity (~24). Very few of the aquatics are large emergent macrophytes. Most are floating or submerged or small emergent macrophytes (eg Photo A on Figure 7.5). Many of these colonise exposed mud or very shallow water and are at their most abundant in the shaded shallow areas indicated on Figure 7.5.

Taller emergent aquatic macrophytes are found in the deeper water areas. The main species are *Juncus usitatus* (Common Rush), *Phragmites australis* (Common Reed), *Schoenoplectus validus* (River Club-rush) and *Typha domingenis* (Narrow-leaf Bulrush). Many wetland areas elsewhere are dominated by one or two emergent species such as *Typha or Phragmites.* This is not the case along this wetland zone, where a feature is the diversity of species in different areas. Of particular note is the limited occurrence of *Typha domingenis* (Narrow-leaf Bulrush), a species which has the potential to dominate. *Schoenoplectus validus* (River Club-rush) was a dominant species within many of the wetland pond areas (e.g. refer Photo 7.11 and Photo 7.14).

The value of the smaller aquatic macrophytes of the ephemeral areas is further illustrated by Table 7.1. Of the 6 species listed in the table as having a Conservation Status, 5 were recorded from the wetlands and of these 4 are smaller aquatic macrophytes.

Within this zone there are a relatively low number of introduced species (~9), however at least 4 of these species are threats to the integrity of the ephemeral wetlands. **Cyperus eragrostis* (Drain Flat-sedge) has the potential to colonise shallow boggy area and exclude other species. **Paspalum distichum* (Water Couch) and **Pennisetum clandestinum* (Kikuyu) have the potential to form dense monospecific mats in damp areas (as shown on Photo 7.11), so excluding of choking other species. **Phyla canescens* (Lippia) can form dense beds, which prevent natural regeneration of native species, if a wetland is left dry for too long. In all 4 cases maintaining the natural patterns of water level variation will plays a critical role in the control of the spread and threat posed by these introduced species.

(B) Red Gum Health Assessment

Tucker's (2004) tree health assessment scale was applied to selected sites throughout the wetland. The mature trees at most sites scored a rating of 5 with a low number scoring 4. In addition to healthy individuals, the population of *Eucalyptus camaldulensis* (River Red Gum) is healthy. There are groves of regenerating seedlings and saplings within the Management Unit providing the next generation of trees (as illustrated in Photo 7.18). The healthy nature of both individuals and the population is in part due to the ephemeral nature of the wetland.

Photo 7.18 - View of shallow marsh, with a diverse aquatic flora (note shade)

7.5.3 Riparian Woodlands and Shrublands (Management Unit 2)

(A) **Description**

The riparian woodlands and shrublands occupy higher ground between the ephemeral wetlands and the River Murray frontage. It is a zone which extends along the full length of the southern section of the wetland, as indicated on Figures 7.3 – 7.8.

It is covered by a *Eucalyptus camaldulensis* (River Red Gum) woodland for its whole length, as illustrated in Photo 7.19 (PP 2). Photo 7.19 also gives a view of an area dominated by *Muehlenbeckia florulenta* (Lignum) and **Lycium ferocissimum* (Boxthorn) beneath the *Eucalyptus camaldulensis* (River Red Gum) trees. The health of the trees making up this woodland is discussed below.

Photo 7.19 - Healthy (Photopoint 2) Red Gums

The understorey has several intergrading themes. The dominant theme is a shrubland of *Muehlenbeckia florulenta* (Lignum) +/- **Lycium ferocissimum* (Boxthorn) and is found over the whole length of the zone (refer Photo19). **Lycium ferocissimum* (Boxthorn) is actively controlled along a small section as indicated in Figures 7.3 – 7.8. It is not currently controlled over the rest of the site and has reached such densities that it is co-dominant with *Muehlenbeckia florulenta* (Lignum) in places.

The ground layer of this theme is dominated by *Cyperus gymnocaulos* (Spiny Flat-sedge) at the zone's northern extent (Refer Photos 20 and 21 and Figure 7.5). Here and elsewhere introduced grasses and herbs are common. There is evidence of past cattle grazing throughout this shrubland. Natural regeneration and regrowth has begun to occur since the cessation of grazing.

Photo 7.20 - Track along river, note open waterfront

Photo 7.21 - Understorey of *Cyperus gymnocaulos* (Spiny Flat-sedge)

A secondary theme to the understorey occurs where *Phragmites australis* (Common Reed) has begun to regenerate. The principal location of this natural regeneration is shown on Figure 7.6 and illustrated in Photo 7.22.

Photo 7.22 - Understorey of *Phragmites australis* (common reed)

A third theme in the understorey was located towards the southern end of the zone just south of the boat shed (refer Figures 7.6). Here the dominance of the *Muehlenbeckia florulenta* (Lignum) shrubland has declined and for a distance of approximately 200 metres the ground is covered in a mix of samphire species, gradually declining south. The dominant one is *Halosarcia pergranulata* (Black-seed Samphire) as illustrated in Photo 7.23 (PP 5).

This samphire area suggests a saline soil and/or groundwater. This area is immediately adjacent the discharge point for the previously active Baseby Irrigation area. This would have had an elevated salinity because of the interception of the shallow saline groundwater in the drainage system. With the retirement of the irrigation area there would be no dilution of this groundwater with runoff from the former flood irrigation of the bays. This saline outflow may result in a localised effect in the zone favouring the samphires.

Photo 7.23 - Groundcover of samphire, south of boat shed (Photopoint 5)

Overall this zone has a moderate diversity of native species (~15), which is not unexpected because of the dominance of species such as *Muehlenbeckia florulenta* (Lignum), *Phragmites australis* (Common Reed) and *Cyperus gymnocaulos* (Spiny Flat-sedge), which are dense in areas. Many of the other native species are capable of providing a dense native cover as part of any vegetation program after weed control. One of these is *Distichlis distichophylla* (Emu-grass), which is the only species from this zone with a Conservation Status. A revegetation program could act to enhance its population.

This zone has a high diversity of introduced species (~20). Most of these are grassy and herbaceous weeds which have spread throughout the zone. One of these is **Phyla canescens* (Lippia), which can form dense beds such as those found at places along the northern end of the zone. These dense beds prevent natural regeneration of native species.

Two of the introduced species are proclaimed pest plants; **Euphorbia terracina* (False Caper) and **Lycium ferocissimum* (Boxthorn). Of these, the latter species is the priority introduced species to control. If **Lycium ferocissimum* (Boxthorn) is controlled then *Muehlenbeckia florulenta* (Lignum) is the preferred revegetation species.

Several species are potential environmental woody weeds. A previous owner planted some amenity trees at the old boathouse (refer Figure 7.6). The species involved were **Casuarina cunninghamiana* (River Oak) and several unidentified Western Australian Eucalypts. They should be controlled (removed) before they spread. There are also scattered **Schinus areira* (Pepper-tree) seedlings adjacent to an adult tree marked on

Figure 7.5. Both the adult tree and seedlings should be removed before they spread further.

(B) Red Gum Health Assessment

Tucker's (2004) tree health assessment scale was applied to selected sites throughout the zone. The trees shown on Photo 7.19 (PP 2) and most other sites scored a rating of 5 with a low number scoring 4. These were Turner's healthiest ratings.

The samphire flat was mostly devoid of trees. Some dead trees were present in this area. Some regenerating seedlings were observed on the margins of the samphire flat. It is not clear if this area was naturally devoid of trees or whether they were originally present but had died as a result of the salinisation.

7.5.4 River Murray Frontage (Management Unit 3)

The zone defined as River Frontage is marked on Figures 7.3 – 7.8.

A dominant feature along the river front is the occurrence of **Salix babylonica* (Willow) woodland for most of its length. The distribution of this species is indicated on Figures 7.3 – 7.8. At the northern end of this zone there are more *Eucalyptus camaldulensis* (River Red Gum) trees and fewer **Salix babylonica* (Willow). Willows are a major environmental issue along the River Murray. Their dominance presents a major management issue for the Baseby Linear Wetland area.

Although the zone is defined on Figures 7.3 – 7.8, the actual boundary between it and the riparian woodland and shrubland zone is fuzzy. One such area is an extensive boggy area indicated on Figure 7.7. This is a low-lying area, only centimetres above river level in places and would be more frequently inundated. Being relatively flat, it would also drain more slowly, refer Photo 7.24. The height of the riparian woodland and shrubland zone varies along its length, which influences the width of the defined river front zone as well as probably being a factor in the understorey themes described above. The understorey along the river front is dominated by two themes. The first theme has a species composition similar to the understorey of the riparian woodland and shrubland zone, particularly where the boundary between them is fuzzy. Table 7.1 shows this similarity at the level of introduced grasses and herbs and chenopod shrubs.

The second theme occurs beneath the **Salix babylonica* (Willow) trees. It is dominated by aquatic macrophytes and wet area weeds (eg. **Paspalum distichum* Water Couch and **Pennisetum clandestinum* Kikuyu). It should be noted that Table 7.1 does not list all the aquatic macrophytes occurring in the understorey of Management Unit 2. Many of these are associated with the River Murray itself.

South of the boat mooring area, for a distance of approximately 400 metres, much of the river bank is open and has been use for boat mooring, camping, picnicking etc, refer Photo 7.20, 7.25 and 7.26. Photo 7.20 also shows the vehicular track, which runs the length of this section.

Photo 7.24 - View of low-lying, boggy area

Photo 7.25 - River front with little vegetation, south of boat mooring area

Photo 7.26 - View of river front south of boat mooring area, easily accessible, note stand of *Schoenoplectus vallidus*

(A) **Red Gum Health Assessment**

Tucker's (2004) tree health assessment scale was applied to selected sites throughout Management Unit 3. Most trees scored a rating of 5 with a lower number scoring 4. These were Tucker's healthiest ratings.

7.5.5 Inland Levee Bank (Management Unit 4)

(A) **Description**

The location of the levee is indicated on Figures 7.3 – 7.8. It can be divided into two parts, a shorter northern section and a much longer southern section. It is covered by a *Eucalyptus camaldulensis* (River Red Gum) woodland on its southern slope for its whole length.

The health of the individual trees making up this woodland is discussed below. South of the boat mooring area, the levee bank's understorey is dominated by a **Lycium ferocissimum* (Boxthorn) shrubland. The density of this species is well illustrated in Photo 7.27 (PP 6), refer Figure 7.6. This species is a proclaimed pest plant. It is the major environmental weed of the Baseby wetland. The levee is acting as a major source of seeds for the rest of the wetland complex. The only other species identified as a potential environmental weed for the levee bank is **Nicotiana glauca* (Tree Tobacco). A small population was recorded from the northern section. The levee has a low density of native chenopod shrubs. None have a Conservation Status. As a group they are capable of providing a dense native cover along the levee bank if **Lycium ferocissimum*

(Boxthorn) is controlled. The levee, adjacent to the wastewater treatment lagoons, is used as an access track, and so the top is devoid of any vegetation, refer Photo 7.28 (PP 9).

Photo 7.27 - Boxthorn on levee banks

Photo 7.28 - Levee bank, looking south from the wastewater treatment lagoons

(B) **Red Gum Health Assessment**

The trees of *Eucalyptus camaldulensis* (River Red Gum) at both Photopoints 6 and 9 score a rating of 5 on Tucker's (2004) tree health assessment scale. This is the healthiest rating.

7.6 FAUNA IN THE BASEBY WETLAND

7.6.1 Species Recorded

(A) **Avifauna**

In the 2002 survey a total of 27 bird species were in the wetlands and floodplain zones. In the 2005 survey a total of 34 species were recorded. Over both visits a total of 48 bird species were recorded in the two zones. Bird species recorded at the site are presented in Table 7.3. The observations are briefly described below in relation to their occurrence in the linear wetland and flood plain (retired irrigation flats) areas.

(i) **Linear wetland**

A total of 43 species observed during both survey periods. It supports a range of waterbirds (15 species recorded in total), woodland species (10 recorded) and several grassland and scrub birds (five species). A number of open country species such as Magpies and birds of prey were also observed.

In 2005 Galahs (*Cacatua roseicapilla*) were particularly common with many flying overhead and also perching in River Red Gums. Other woodland birds such as Adelaide Rosellas (*Platycercus elegans adelaidae*), Red-rumped Parrots (*Psephotus haematonotus*), Noisy Miners (*Manorina melanocephala*) and Red Wattlebirds (*Anthochaera carunculata*) were also abundant where Red Gums were present, and Superb Fairy-wrens (*Malurus cyaneus*) were common in areas dominated by lignum. The White-faced Heron (*Ardea novaehollandiae*) and Australian White Ibis (*Threskiornis molucca*) were the most frequently observed water birds. They were seen swimming and feeding on the river and river banks, and flying over the rest of the wetland area.

In 2002 the most common species in the wetland were the Australian Shelduck (*Tadorna tadornoides),* Little Corella (*Cacatua sanguinea*) and Welcome Swallow (*Hirundo neoxena*). Superb Fairy-wrens (*Malurus cyaneus*) were common in areas with Lignum and other shrub species, and Red-rumped Parrots (*Psephotus haematonotus*) were frequently observed perching in Red Gums and flying between the wetland and floodplain zones.

Several New Holland Honeyeaters (*Phylidonyris novaehollandiae*), White-plumed Honeyeaters (*Lichenostomus penicillatus*) and Willie Wagtails (*Rhipidura leucophrys*) were observed in lignum and reeds immediately upstream from the boat entry near the WWTP lagoons. Several birds were observed in the lagoons themselves, including a large flock of Australian Wood Ducks (*Chenonetta jubata*) and Pacific Black Ducks (*Anas superciliosa*). Three Australian Shelducks (*Tadorna tadornoides*), two Masked

Lapwings (*Vanellus miles*) and a Silver Gull (*Larus novaehollandiae*) were also observed at the lagoons. These species were recorded nowhere else in the wetland.

The high number and different species composition of birds in the area around the lagoons is likely to be somewhat attributable to the proximity of human activity. The lagoons themselves provide an area for resting or feeding. In addition, this part of the study site is closest to the nearby town of Mannum.

(ii) **Floodplain**

Far fewer species were observed on the floodplain than in the riparian zone during both surveys, with 12 recorded in 2002, 11 in 2005 and a total of 18 during both surveys (refer Table 7.3). Most birds recorded were observed flying over the floodplain.

The only significant habitat is the boxthorn shrubland, which provides shelter and lookout positions for scrub species such as Superb Fairy-wrens (*Malurus cyaneus*) and Zebra Finches (*Taeniopygia guttata*) and perching opportunities for Red-rumped Parrots (*Psephotus haematonotus*). White-plumed Honeyeaters (*Lichenostomus penicillatus*) and Willie Wagtails (*Rhipidura leucophrys*) were also seen in Boxthorns near the wetland zone. None of these species, however, appear to be reliant on the boxthorn habitat; all were observed in the riparian zone and commonly flew between the two adjacent areas.

The Boxthorn shrubs also provide a resting place for large flocks of Common Starlings (*Sturnus vulgaris*), which are non-native, common, and known to displace native species from nest hollows. In 2002 the House Sparrow (*Passer domesticus*) and Eurasian Blackbird (*Turdus merula*), two other non-native species, were observed on the floodplain but not in the wetland. The floodplain, and particularly the introduced Boxthorn plants, support a number of birds from these widespread, non-native species, but do not seem to provide valuable habitat for native birds of the area.

Table 7.3 - Fauna Observed at Baseby Wetland

(NB. None of these species are listed as protected under the EPBC or NPW Acts)

Species		**Wetland**		**Floodplain**	
Common name	**Scientific name**	**2002**	**2005**	**2002**	**2005**
Birds					
Australian Pelican	*Pelecanus conspicillatus*	x	x		
Australian White Ibis	*Threskiornis molucca*	x	x	x	
Yellow-billed Spoonbill	*Platalea flavipes*	x			
White-faced Heron	*Ardea novaehollandiae*		x		
Darter	*Anhinga melanogaster*		x		
Great Cormorant	*Phalacrocorax carbo*		x		
Little Pied Cormorant	*Phalacrocorax melanoleucos*		x		
Silver Gull	*Larus novaehollandiae*		x[1]		
Masked Lapwing	*Vanellus miles*		x[1]		
Australian Wood Duck	*Chenonetta jubata*		x		
Chestnut Teal	*Anas castanea*			x	
Grey Teal	*Anas gracilis*		x		
Pacific Black Duck	*Anas superciliosa*		x		
Australian Shelduck	*Tadorna tadornoides*	x	x[1]		
Eurasian Coot	*Fulica atra*	x	x		

Species		Wetland		Floodplain	
Common name	**Scientific name**	**2002**	**2005**	**2002**	**2005**
Purple Swamp Hen	*Porphyrio porphyrio*		x		
Whistling Kite	*Haliaster sphenurus*	x			
Little Corella	*Cacatua sanguinea*	x			
Galah	*Cacatua roseicapilla*		x	x	
Adelaide Rosella	*Platycercus elegans adelaidae*		x		x
Musk Lorikeet	*Glossopsitta concinna*		x		
Red-rumped Parrot	*Psephotus haematonotus*	x	x	x	x
Noisy Miner	*Manorina melanocephala*		x		
Red Wattlebird	*Anthochaera carunculata*		x		
Singing Honeyeater	*Lichenostomus virescens*		x		
White-plumed Honeyeater	*Lichenostomus penicillatus*		x		x
New Holland Honeyeater	*Phylidonyris novaehollandiae*		x		
Peaceful Dove	*Geopelia placida*	x			
*Rock Dove	*Columba livia*	x			
Crested Pigeon	*Ocyphaps lophote*	x	x		x
Laughing Kookaburra	*Dacelo novaeguineae*	x	x		
Sacred Kingfisher	*Todiramphus sanctus*	x			
Grey Shrike-thrush	*Colluricincla harmonica*	x	x		
Australian Reed Warbler	*Acrocephalus stentoreus*	x			
Little Grassbird	*Megalurus gramineus*	x			
Superb Fairy-wren	*Malurus cyaneus*	x	x	x	x
Willie Wagtail	*Rhipidura leucophrys*	x	x	x	x
Tree Martin	*Hirundo nigricans*		x		
Welcome Swallow	*Hirundo neoxena*	x			
White-fronted Chat	*Epthianura albifrons*			x	
Zebra Finch	*Taeniopygia guttata*			x	
*House Sparrow	*Passer domesticus*			x	
*Common Starling	*Sturnus vulgaris*		x	x	x
*Eurasian Blackbird	*Turdus merula*			x	
Australian Raven	*Corvus coronoides*		x		x
Little Raven	*Corvus mellori*		x		x
Australian Magpie	*Gymnorhina tibicen*		x	x	x
Australian Magpie-lark	*Grallina cyanoleuca*		x		x
Mammals					
Western Grey Kangaroo	*Macropus fuliginosus*	x	-	x	-
*Fox	*Vulpes vulpes*	x	-	x	-
*European Rabbit	*Oryctolagus cuniculus*	x	-	x	-
Reptiles					
Marbled Gecko	*Christinus marmoratus*	x	-		-
Amphibians					
Brown Toadlet	*Pseudophryne bibrioni*	x	-		-

[1] Observed at wastewater treatment lagoons only

* Non-native species

The surveys undertaken in 2002 and 2005 revealed a high diversity and abundance of bird species using the wetland. Further, the species recorded on each visit varied, so the total number of species observed was significantly higher than for each survey individually. This difference could be due to seasonal differences in occurrence and behaviour, coincidental differences in survey conditions such as the time of day or temperature in which certain areas were surveyed. With additional surveys of the area, the total number of species observed in the wetland could be expected to increase.

Hyde's biodiversity study (2000) lists a range of species recorded in the general study area and links the presence of each species with vegetation associations it usually occupies. For comparison, the vegetation associations used by Hyde were assigned to either the wetland or floodplain zone based on the zone's floristic communities. Associations used by Hyde, but not present in the study area were disregarded. In this form the information provides an indication of the zones in which various fauna species are likely to be found based on the type of vegetation present in each zone. The species compiled by Hyde (2000) are included in Appendix G.

Appendix G lists 137 species using wetland areas, compared to 53 species recorded for the section of the Baseby Linear wetland surveyed (Refer Table 7.3). When comparing Hyde's results with the results from the Baseby wetland surveys, some points should be noted:

- Time: Hyde's list is a product of years of research, while the surveys undertaken for this project were carried out in one day only. The chance of encountering certain species in a shorter period of time is obviously lower. If further surveys were carried out in different seasons, a greater diversity of birds could be expected.
- Habitat degradation: Hyde collated fauna records dating as far back as the early 1900's. Since that time severe disturbance and degradation of habitats has occurred, this is likely to reduce animal and species numbers.
- Study area: Hyde's study covered large region encompassing wetlands of varying sizes and composition. While only vegetation associations present in the current study area were used for comparison, larger wetlands containing diverse vegetation are likely to be occupied by a greater diversity of species.

Given these factors, the number of species recorded in the Baseby wetland is a significant proportion of the birds on Hyde's list. The wetland habitat within the wetland is fairly diverse and provides valuable habitat for a range of birds in the region. There are tall trees, shrubs, groundcover, reed beds and open and sheltered areas of water providing a range of habitats for different bird species. In particular, Lignum appears to provide valuable habitat for wrens and other small scrub species, and River Red Gums provide sites for feeding, perching and roosting, especially for typical woodland birds. Water birds are well supported; with the ephemeral water bodies providing resting and feeding sites, with the vegetation offers shelter and protection.

(B) Mammals, Reptiles and Amphibia

As indicated above, the focus in the field survey has been on describing the habitat and floral diversity in the study area. Apart from the avifauna, no surveys have been undertaken for other faunal groups. Based on the habitats described a fauna survey for mammals, reptiles and amphibians (and additional bird surveys) will be designed and undertaken to provide baseline data for future monitoring. This work will be undertaken during 2007.

It is appropriate, however, to briefly summarise the information of Hyde (2000) and the observations made during the 2002 and 2005 surveys of the study area.

No mammals were recorded in the wetland in the 2002 survey, although the direction of tracks found across the floodplain indicate the wetland is used by the Western Grey Kangaroo. Evidence of fox and rabbit activity was also observed, and two foxes were spotted during the 2005 bird and vegetation surveys. The lack of mammal occurrence is unsurprising given the small number that exists along the Murray River. Hyde (2000) reported only five extant mammal species that have been recorded in wetlands between Mannum and Wellington since the early 1900's. The low numbers reflect the status of mammals in wetlands generally and surveys of other wetlands have revealed similar results (see for example Jensen, A. et al. (1999); Wetland Care Australia (1999)). It is also likely that the presence of foxes and rabbits in the wetland decreases its value as habitat for native mammals of the area.

The only amphibian species found was the common and widespread Brown Toadlet (*Pseudophryne bibrionii*), which occurred in large numbers as indicated by their calls along the entire length of the zone. The common Marbled Gecko (*Christinus marmoratus*) was also found quite frequently under the bark of mature River Red Gums (*Eucalyptus camaldulensis*), although no skink species were recorded in the wetland. The wetland does not appear to support a diversity of amphibian or reptile species, which may be due to the presence of foxes and rabbits. It does, however, provide habitat for high numbers of more common species in the area.

The cracking soils of the floodplain have the potential to provide habitat for reptiles and small mammals. While evidence was found of previous attempts by reptiles and rabbits to develop cracks and holes into burrows, the lack of food plants, adequate cover and the presence of foxes appear to severely limit the opportunity for individuals to establish populations in this zone. Old fox tracks were found throughout the zone, indicating that foxes hunt in it extensively. Three abandoned rabbit warrens were located, with one showing modification by foxes (again, abandoned). Foxes appear to effectively exclude sleepy lizards from this zone, with ten bleached lizard carcasses found during the 2002 survey, all partly eaten and all with one or more bleached fox scats within a few centimetres of each carcase.

Tracks of the Western Grey Kangaroo were located at numerous places across the zone, all indicating a direction of travel back and forth between the landward cliff slope and the wetlands. However, no evidence of permanent occupation of the zone was found.

(C) Macroinvertebrates

Aquatic macrofauna were surveyed in this zone during February 2006. Baited nets were submerged for 20 min and the animals collected. Specimens were preserved and stored in 70% ethanol. Smaller macrofauna associated with reeds were targeted by dragging a dipnet through the aquatic vegetation. Fauna were preserved in 70% ethanol. Dipnets were also utilised to target snag areas along the river bank.

Freshwater shrimp and yabbies were commonly found. Minimal diversity (two species) and abundance (three individuals) of smaller aquatic macroinvertebrate fauna were collected. No juvenile fish species were seen in the snag areas investigated, however this may relate to seasonal differences and spawning times.

7.7 CONSERVATION STATUS OF FLORA AND FAUNA

7.7.1 Environment Protection and Biodiversity Conservation Act, 1999

A Protected Matters Search was completed to provide guidance on matters protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and to determine whether there are any relevant matters at or adjacent to the site. The results of this search are summarised in Table 7.4.

Table 7.4 - Summary of database search for the development site (7 August 2006)

Matters of national environmental significance	Present in area at or adjacent to site
World Heritage properties	None
National Heritage places	None
Wetlands of international significance	None
Commonwealth lands	None
Commonwealth Heritage places	None
Places on the Register of the National Estate	None
Critical habitats	None
Commonwealth Reserves	None
State and Territory Reserves	None
Other Commonwealth Reserves	None
Regional Forest Agreements	None

The majority of all birds, mammals and frogs identified in the broader region as matters of national significance are unlikely to occur at the development site.

No birds recorded at the site are protected under the Japan Australia Migratory Birds Agreement (JAMBA) or the China Australia Migratory Birds Agreement (CAMBA).

Species listed under the *National Parks and Wildlife Act 1972* (South Australia; NP&W Act) recorded in the Mannum region are summarised in Appendix G. Overall, 21 plant species are listed as either vulnerable or endangered under the NP&W Act. None of these species were identified in the development area.

A search conducted of the South Australian Museum and Department of Environment (SA) fauna indicated that several species of State significance occur at the site or have occurred at the site in the past. Table 7.5 provides a species summary.

Table 7.5 - Matters of national significance search results

Species	Common name	NP&W Act Status	Likelihood of occurrence
Reptiles			
Morelia spilota variegata	Variegated Carpet Python	Vulnerable	Likelihood of occurrence - low
Birds			
Biziura lobata	Musk duck	Rare	Likely & recorded. Wetlands including River represent good habitat .
Botaurus poiciloptilus	Australasian bittern	Vulnerable	Unlikely
Cinclosoma castanotus	Chestnut quail-thrush	Rare	Unlikely. This is a ground dwelling species with a preference for old growth mallee. It is also susceptible to introduced predators
Cisticola exilis	Golden-headed cisticola	Rare	Unlikely
Entomyzon cyanotis	Blue-face honeyeater	Rare	Likely. Habitat present. Maybe a vagrant or occasional visitor
Falcunculus frontatus	Crested shrike-tit	Vulnerable	Unlikely. Would be confined to river red gum woodland
Leipoa ocellata	Malleefowl	Vulnerable	Unlikely. potential habitat is degraded
Plectorhyncha lanceolata	Striped honeyeater	Rare	Possible. Prefers dry scrub and woodland areas as well as saltbush
Podiceps cristatus	Great-crested Grebe	Rare	Unlikely, although habitat is present

It is possible that some bird species of State significance may occur on the site, particularly in the Riverine Wetland.

A number of species were found having a conservation status for the Murray Mallee Botanical region according to Lang & Kraehenbuehl (2002). These are recorded in Table 7.6.

Table 7.6 - Plants identified on site with a state conservation rating

Species	Common name	Conservation status (SA)
Centella cordifolia	Native centella	Uncertain
Distichlis distichophylla	Emu grass	Uncommon
Eremophila divaricata ssp. divaricata	Spreading emubush	Uncommon
Lycopus australis	Australian gipsywort	Rare
Myoporum insulare	Common boobialla	Uncommon
Sclerolaena tricuspis	Three-spine bindyi	Uncommon
Urtica incisa	Scrub nettle	Uncommon

The native centella (*Centella cordifolia*) is a low growing, locally abundant species occurring along water edges in all the nearby irrigation areas including the Cowirria. It is classified as uncertain from a state conservation perspective. Further investigation into this species and its distribution is required. Investigations throughout the immediate area show that the species is abundant.

The levee bank area contains Emu grass (*Distichlis distichophylla*). It is found in similar locations from Mannum to Wellington. It is generally classified as uncommon.

Isolated plants of emubush (*Eremophila divaricata* ssp. *divaricata*) occur along the elevated area above the SA Water sewage treatment ponds and are unlikely to be threatened by the project.

Australian gipsywort (*Lycopus australis*) is a river-edge growing species that has been found scattered along most irrigation areas from Mannum to Wellington. It is common along riverbanks that have been disturbed.This species was not noted at the time of the survey.

Several mature tall shrubs of the common boobialla (*Myoporum insulare*) occur along the river edge at the northern end of the sewage treatment ponds. It is locally abundant and present across the river in the Cowirra Irrigation Area. It is also located further up river on several private allotments.

Three-spine bindyi (*Sclerolaena tricuspis*) occurs scattered in the samphire zone. This very thorny low plant is a coloniser of disturbed saline soils. It is often present when heavy grazing has taken place as it is largely unpalatable to sheep.

Scrub nettle (*Urtica incisa*) is locally abundant and is known to occur along the river edge of several irrigation areas between Mannum and Wellington.

Each of the plant species described above occurs in moderate numbers throughout the development site and surrounding region. Removal of plants from the development site is unlikely to impact on regional populations. Revegetation with local species will be undertaken as part of landscape works, as discussed in Section 2.9.

7.8 PEST PLANTS AND ANIMALS AND INTRODUCED SPECIES

Landuse within the area has ranged from cropping to irrigated pasture. As a result the understorey throughout the site is largely anthropogenic and non-native. Weed species are prevalent throughout the entire site. Of particular importance is the presence of Box thorn (*Lycium ferocissimum*) and Horehound (*Marrubium vulgare*) both species are proclaimed plants in South Australia and require weed control.

Other weed species present include:

- *Euphorbia terracina* (False caper)
- *Galenia secunda* (Galenia)
- *Mesembryanthemum crystallinum* (Common iceplant)
- *Phyla canescens* (Lippia)

Several pest animal species are present at the site. Rabbits, cats, foxes and house mice are prolific throughout the area.

8 Existing social environment

This chapter summarises the existing social environment on both local and regional scales. It sets the scene for following chapters in which potential impacts, both adverse and beneficial, of the proposed development are described.

8.1 ABORIGINAL HISTORY AND CULTURE

TimeMap Pty Ltd, Heritage Consultants, have discussed the aboriginal anthropology and history within the Mannum area in their report "Cultural Heritage Assessment of a Pr0posed Marina, Mannum, SA, March 2005. The report can be viewed in Appendix H.

Further comments can also be found in Vivien Wood's report "An Aboriginal Heritage Study of the proposed Mannum Marina, Lower Murray, South Australia October 2002. This report can also be viewed in Appendix H.

Evidence from the north of Mannum recognises intensive occupation of the River Murray environs by aboriginal people for at least 6,000 years. Today Mannum is recognized as principally lying in Peramangk country. The area has not been claimed under Native title nor is it under an Indigenous Land Use Agreement. Aboriginal heritage is discussed in more detail within a separate chapter (refer Chapter 10).

8.2 SHORT EUROPEAN HISTORY OF MANNUM

Located 84 km east of Adelaide and 13 metres above sea level, Mannum is an attractive town on the banks of the River Murray. It came into existence with the advent of the paddle steamer transport industry in the 1850s.

The first European who had an involvement in the area was Captain Charles Sturt who, being assigned to solve the great mystery of why so many rivers flowed westward from the Great Dividing Range, rowed a whaleboat down the Murrumbidgee in late 1829 and reached the junction with the River Murray on 14 January 1830. He continued down Australia's largest river passing Mannum in early February 1830 (a plaque beside the river in Mannum records the event) and reaching Lake Alexandrina, at the mouth of the river, on 9 February 1830.

The River Murray was seen as an opportunity for transportation and for providing access to the agricultural produce of the western areas of New South Wales and Queensland. However it was not until the formal establishment of Goolwa as the port at the mouth of the river that this became a reality.

There was a debate as to whether Victor Harbor or Port Elliot would be the ocean port. It was eventually decided that Port Elliot was the best location, probably based on its proximity to Goolwa and the belief that a canal could be constructed between the two locations. In 1851 it was agreed to build a railway between Port Elliot and Goolwa which was eventually completed in 1854.

By 1840 the land along the River Murray around Mannum had been surveyed and, although the river was not being used commercially at the time, some people started to lease and purchase the land. The most prominent was the explorer Edward John Eyre who took up land near the town in 1841.

By 1853 paddle steamers were operating on the Murray. The first two steamers were the 'Mary Ann' captained by William Richard Randell and the 'Lady Augusta' captained by Francis Cadell. William Randell, the founding father of Mannum, had built the first flour mill at Gumeracha. Believing that there was money to be made by paddle steamers on the River Murray, he built a boat at Gumeracha and transported it by bullock dray to a landing which is about three km north of present-day Mannum. The steamer which was 55 feet long was named 'Mary Ann' after Randell's mother. It was given a trial run on the Murray on 19 February 1853. Shortly afterwards Randell made a successful trip as far as Echuca and Moama, and subsequently he travelled up the River Murray as far as Menindie.

By the 1860s up to 20,000 bales of wool were being brought down the river each season. The steamers were used to move huge barges which were laden with wool. Some went to Goolwa and on to Port Elliot. Others were unloaded at Mannum and overlanded to Adelaide by bullock teams. The town was surveyed in 1868.

In the 1870s David and John Shearer established a blacksmith business in the town and the company evolved into Horwood Bagshaw, a successful engineering and farm machinery company. Major changes occurred to these industries in the 1990s and they have ceased to be a major influence in the town.

By the 1870s and 1880s many Germans had moved into the area. Agriculture and irrigated pasture along the river banks were becoming the mainstay of the town's economy.

The lower lying areas of the town and the main street suffered a significant impact from the 1956 flood.

Mannum now retains its place as a local service centre and vacation destination with a significant number of dwellings on both sides of the river being available as holiday homes. It is located within a region which has agriculture and the processing of agricultural products as the major activity and employment focus. In recent times the town has been recognised as a retirement destination because of its pleasant aspect and supporting services such as the district hospital.

8.3 CURRENT LAND USE IN THE VICINITY OF THE PROPOSED DEVELOPMENT

The land under consideration for the Mannum Waters development comprises an area of approximately 172 ha immediately south of Mannum.

Current uses of this land include:

- SA Water sewage treatment plant, lagoons, associated buildings and infrastructure, with vehicular access via River Lane
- abandoned irrigated river flats (flood irrigated pasture and irrigation system) formerly used for grazing

- existing irrigated pasture (fitted sprinklers) of around 3 ha (this system is not currently in use)
- existing marina for five houseboats and houseboat shed
- a brick dwelling and outbuildings (centrally located in the proposed development area) in an elevated position overlooking the river
- rural buildings (packing shed and hay/implement shed)
- private access tracks connecting Belvedere Road to the river
- mature vegetation of river red gums and willows along the river bank. The vegetation includes three scarred trees of Aboriginal cultural significance.

There are two distinct landforms delineated by the extent of the river flood plain. The low areas comprise the flood plain itself and river bank which extends into an east/west gully which rises from the river bank to Belvedere Road by five metres and effectively dissects the high ground into two land units.

The major adjoining land uses are:

- north-east – urban residential development
- north – Mannum golf course greens
- west – dryland farming
- south – former irrigated river flats, now grazing
- east – River Murray river bank (native vegetation and wetland) and river channel.

8.4 RECREATION AND TOURISM

Because Mannum is a “River Town” a great part of its recreational activity both for the resident and the visitor centres on the River Murray. The opportunity to moor and launch various craft and its proximity to Adelaide makes Mannum an ideal location for river based recreation such as skiing, fishing and houseboat related activities. The close proximity of Adelaide reinforces the opportunity for visitors to include river based recreation in day or weekend trips.

In addition to the river the town has two major ovals. One is at the showgrounds and the community oval is adjacent to joint use facilities involving the swimming pool, secondary school and community centre.

The Town has active sporting club activities centred on baseball, basketball, bowling, cricket, motorcycle, pistol and shooting, football, golf, little athletics, netball, riding, rowing, squash and tennis. The new development will provide a new influx of population that will support the existing town’s sporting club activities.

8.5 DEMOGRAPHY

8.5.1 Population

The 2001 Census has four Collector Districts that cover the town of Mannum. The population of Mannum was 2160 persons at the 2001 Census. The population base for the town has shown marked fluctuations over the last twenty years with a significant decline in numbers within the 1986–1996 period as a result of the loss of local industry and jobs, particularly in the farming implement industry. In more recent times (1996–2001) there has been an increase in population which, when taken in the historical context, is at a significantly high level.

Whilst Mannum has shown a decline in population, the Mid Murray Council district as a whole has indicated marked growth over the full twenty year period ranging from 7.1 per cent up to 21.7 per cent which, by comparison with South Australia as a whole, indicates much higher levels of population growth. The causes of this growth can be set against expansion in the wholesale trade, transport and storage and communication services sectors, and retirement population.

Whilst the population of the overall Murraylands region has shown a lower level of growth than the Mid Murray Council area (particularly in 1991–1996) this is largely due to the eastern segment of that region (Karoonda-East Murray, Coorong and Southern Mallee) experiencing a population decline. Importantly, the local government areas in the western segment, notably Murray Bridge and Mid Murray, have shown growth of 1.2 per cent per annum and 3 per cent per annum respectively over the twenty year period 1981–2001.

Table 8.1 – Population in various regions of South Australia

Area	1981	1986	1991	1996	2001
Mannum	1,984	2,056	2,025	1,966	2,160
Mid Murray Council	5,260	5,631	6,037	7,348	8,448
Murraylands region	29,811	30,958	33,017	32,825	34,064
South Australia	1,285,037	1,345,896	1,400,627	1,427,936	1,467,261

Table 8.2 shows the same data as Table 8.1 but emphasises the changes in population in each region.

Table 8.2 – Changes in population in each region

Area	Percentage Change			
	1981–1986	1986–1991	1991–1996	1996–2001
Mannum	3.6	-1.5	-1.4	9.8
Mid Murray Council	7.1	7.2	21.7	13.0
Murraylands region	3.8	6.7	-0.6	3.6
South Australia	4.7	4.1	1.9	2.7

One of the primary reasons for growth in the region, particularly in the town of Mannum, is the influx of persons retiring to the area. The overall ageing of the South Australian population and the opportunity to settle in a township with existing health, community and commercial services, within an hour's travel of metropolitan Adelaide is an attractive proposition.

The age structure of the population at the 2001 Census indicated that the median age of the Mannum population was 49 compared with South Australia as a whole at 37 years of age. Data in Figure 8.1 indicate that the proportion of persons aged 65 years and over is 26 per cent in Mannum compared with the overall South Australian proportion of 14 per cent. The significantly higher level of retirement age residents in Mannum is similar to the 'sea change' area of Victor Harbor where 30.5 per cent of the population was 65 years and older in 2001.

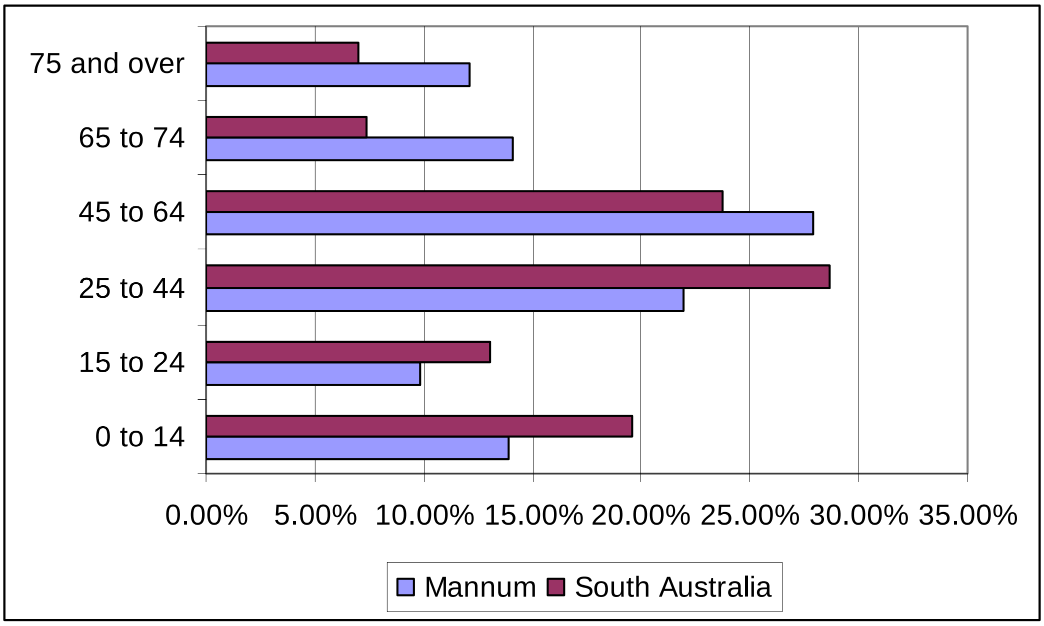

Figure 8.1 – Age structure of the population in Mannum compared with South Australia

The skew of the population towards the higher-aged residents is not balanced by an increased proportion of younger persons. The data in Figure 8.1 also indicate that only 14 per cent of the population in Mannum is in the 0 to 14 year age group, compared with the South Australian figure of nearly 20 per cent.

8.5.2 Ethnicity

The town of Mannum and the Council area of Mid Murray have a similar profile in regard to country of origin. The majority of the population is born in Australia (82 per cent) with the next major category being from United Kingdom and the Republic of Ireland (7.4 per cent). This ethnicity profile is significantly different to that of South Australia as a whole, where people born in Australia are represented less at 75 per cent and there is a greater influence from UK, Ireland and other European countries. This is illustrated in Figures 8.2 and 8.3.

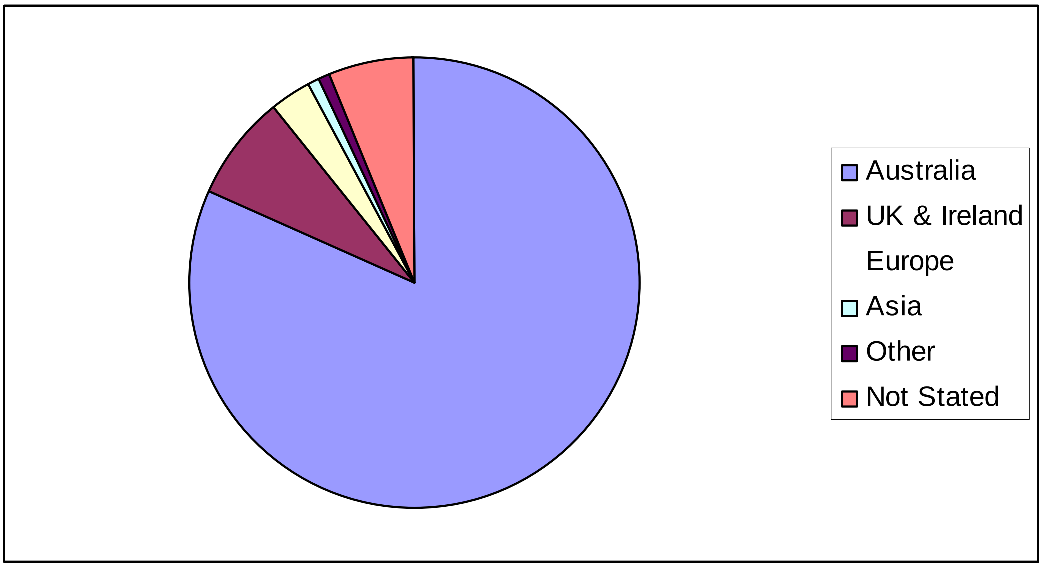

Figure 8.2 – Country of birth for residents of Mannum

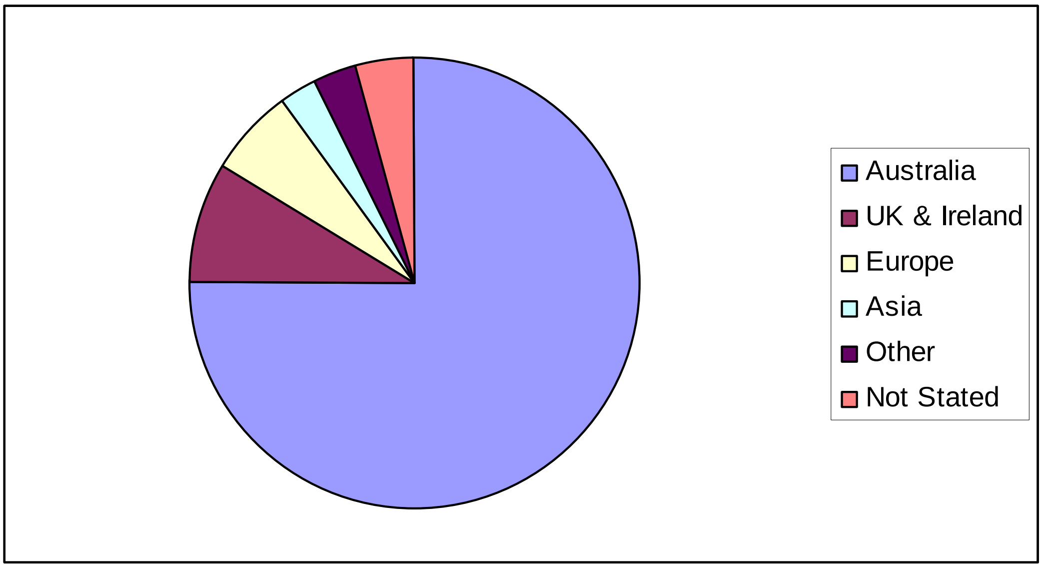

Figure 8.3 – Country of birth for residents of South Australia

8.5.3 Family and household structure

Significant proportions of the households in Mannum are occupied by couples without children or dependents, or are single occupancy, and therefore do not contain children. This reinforces the data shown on Figure 8.3 (age structure of population in Mannum) which shows a disproportionate representation of people of retirement age, and a deficit in younger people. Analysis of the data indicates that the predominant household type in Mannum is the single occupancy household. Indeed households that have children comprise only 27 per cent of the population, as opposed to the figure for South Australia which is 42 per cent. All the data reinforce the fact that Mannum has become a retirement destination.

Table 8.3 indicates that there is a higher proportion of one parent families in the Mid Murray Council area than that shown for the whole of South Australia. This situation at the Council level is an indication of housing opportunities and affordability in some settlements providing higher possibilities for one parent families to improve their economic position.

8.5.4 Changes in household dynamics

Table 8.3 indicates that, for the Mid Murray Council area as a whole, the proportion of one parent families has increased markedly over the period 1991–2001 with a 17.6 per cent increase in the 1996–2001 period. The two parent family has shown an opposite trend.

Table 8.3 – Percentage change in household dynamics between 1996 and 2001

Household type	Change (%)
One parent	17.6
Couple only	2.6
Two parent	-6.1
Other	8.4

8.5.5 Population mobility

Population mobility is a measure of both the stability of the resident population, and of the movement of people into and out of the Mannum area.

The population of Mannum has been relatively stable over the ten year period between the census in 1996 and that in 2001. Close to 60 per cent of the population has remained at the same address for at least five years.

The majority of the people who were at a different address moved from other areas of South Australia, with the second largest movement being within the Mid Murray and Mannum areas. The movement of people from elsewhere in South Australia has shown a decline in the period 1996–2001, while in the same period the number moving within the Mid Murray and Mannum areas has shown a marked increase.

The factors contributing to these changes include the movement of retirees from rural areas into local towns such as Mannum, and a decline in employment opportunities associated with agriculture. Table 8.4 shows the data on which this analysis is based.

Table 8.4 – Population mobility

Address	1991 (%)	1996 (%)	2001 (%)	Change between 1996 and 2001 (%)
Same address five years ago	59.1	59.4	58.6	4.5
Different address five years ago in:				
Local area	7.8	9.4	10.9	23.3
Elsewhere in South Australia	24.7	23.8	19.8	-11.9
Interstate	3.5	3.1	3.7	24.5
Overseas	0.5	0.4	0.6	41.2

The percentage does not total 100% because approximately 4% of returns did not state a previous address

8.6 SOCIAL SERVICES

8.6.1 Health services

Mannum health services are focused on the Mannum District Hospital which serves the town of Mannum and a hinterland that extends to Murray Bridge, midway to Palmer and north-east to Walkers Flat. This is a catchment of approximately 5000 to 6000 people.

Photo 8.1 – Mannum Community Hospital

General practitioner services are co-located with the hospital with six consulting rooms, four full-time doctors and one part-time with the hospital having a teaching function and therefore able to utilise the services of students. The hospital participates with TAFE (Renmark, Barossa, Onkaparinga, Murray Bridge and Mount Barker) for Certificate III Aged Care placements for Nursing Pathway students and Enrolled Nurse students.

The hospital has a strong policy of succession planning and in comparison with many regional areas is well resourced and capable of handling the expansion in the town of Mannum and its region.

The hospital is a public hospital run by its own Board of Directors responsible to the Hills Mallee Southern Region.

Services provided by the Mannum District Hospital are as follows:

- acute adult and paediatric medical inpatient services
- 24 hour emergency care with retrieval to Adelaide if necessary
- outpatient services
- diabetes clinic

- asthma clinic
- hypertension clinic
- community midwife
- Domiciliary Care
- Day Centre
- residential aged care
- respite and palliative care.

There has been a recent increase in the level of Home and Community Care (HACC) funding which has gone towards further increases in services to better meet the needs of the frail elderly and those with disabilities.

The population of Mannum has a significant proportion of elderly people and therefore the hospital and associated medical services are geared towards the care of the elderly. In particular there are:

- eight aged care beds funded by the Commonwealth Government in conjunction with Hills Mallee Southern Aged Care Facility
- six State Government-funded nursing home beds
- Aminya Village Hostel adjacent to the Mannum District Hospital with 31 beds.

The site of the hospital is capable of expansion and the hospital Board has discussed plans for growth. Discussion with a hospital representative indicated that the expansion of the population catchment brought about by Mannum Waters, at the projected rate and composition of population, will be able to be met by the hospital and its associated medical services.

8.6.2 Education services

Mannum is currently served by the Community College, a Reception to Year 12 school.

A review of educational services in Mannum was completed in July 2000. The review recommended the amalgamation on one campus, of the kindergarten, primary school and high school to form a community school providing care and education services to all members of the community, regardless of age.

The school currently has 400 enrolments from a catchment that extends to Murray Bridge in the south and midway to Cambrai/Sedan in the north. Cambrai also has an area school. These areas are served by school buses. While the school population suffered a decline in numbers from late 1990 to early 2002, this trend has been reversed in recent times.

The Community College shares a number of facilities with the community with joint facilities comprising the school ovals, leisure centre and library. School buildings are used for community meetings and the University of the Third Age. The latter opportunity is significant in a community with a growing elderly population. The school campus has room for growth in keeping with any increase in enrolment levels.

Photo 8.2 – Community College

A number of students in Mannum travel by bus to attend private schools at Murray Bridge and Birdwood.

The demographic profile for Mannum indicates that there has been a decline in two parent families and a significant increase in one parent families. Notwithstanding these trends, the age structure of Mannum is such that the area is likely to continue to be a retirement centre and it is therefore not likely that there will be any major increases in the numbers of children and associated pressure on the resources of the Community College.

It is considered that the Community College is quite capable of absorbing any increase in student population that may occur as a result of the growth of Mannum Waters over its development time line.

Continuing education and training for the town's younger residents is likely to be absorbed by TAFE facilities at Murray Bridge and Mount Barker, or tertiary education facilities within the Adelaide metropolitan area.

8.6.3 Emergency services

Police services in Mannum are currently covered within the Hills Murray Local Service Area (HMLSA) with major stations at Mount Barker and Murray Bridge. The HMLSA covers an area from the eastern Mount Lofty Ranges to the Southern Murray Mallee and Meningie regions, an area of 17,202 km².

The local service area concept was first established in 1999. There are fourteen local service areas (LSAs) in the State, enabling the integration of core strategies and improved policing in defined geographical areas. Local service areas aim to achieve safer local communities and work together on broader community safety outcomes for issues extending beyond particular LSA boundaries. The LSA is a local police force dealing with public order, crime prevention, road safety, emergency response and criminal justice. Centrally located Crime Service and Operations Support Service resources provide specialist assistance when required.

Mannum has a police station which operates during normal business hours from Monday to Thursday but with extended times on Friday and Saturday nights to cater for possible disturbance from hotel patrons. A patrol car operates from Mannum with backup resources from Murray Bridge and Mount Barker if required.

The major policing concerns for Mannum are vacant holiday home properties and the possibility of larceny and vandalism because owners are absent for a large part of the year, traffic control and accidents, control of local events and public order issues as a result of hotel and celebration activities. In addition, because of the seasonal nature of the town as a holiday destination, the population can vary markedly.

Whilst the expansion of Mannum Waters will increase the town's population with possibly more housing vacant for part of the year, the growth of the development will be gradual and not likely to require any significant extension of police services

8.6.4 Fire services

Mannum falls within CFS Region 3 (Murraylands and Riverland). This is a diverse region covering 54,000 km2.

Photo 8.3 – Mannum CFS

Along with the range of fire risks associated with rural towns, a variety of vegetation and open cropping areas the Annual Report 2003-04 notes:

"Tourism within the area continues to flourish, with an annual increase in houseboats and the potential for associated problems. The number of vehicles passing through and visiting the Region contributes towards the overall number of highly traumatic incidents." (CFS Annual Report, 2003/04)

Region 3 has 7 Groups, 55 Brigades and 1726 volunteers. Mannum has a brigade and there are other fire stations at Cambrai, Bow Hill, Purnong, Sedan and Walkers Flat as well as back up from Murray Bridge. In the case of a significant wild fire the adjacent Region 1 (Mount Lofty Ranges) to the west can also offer support.

Table 8.5 indicates the incidents in the Region over the period 2002 to 2004 and it is noted that the highest category of call-out relate to vehicles and rural fires and issues. Variation year to year will be high but there is no major trend from these data as to a significant overall increase in workload.

Table 8.5 – CFS Region 3 Total Incidents 2002/03 to 2003/04

Total Incidents	2002/03	2003/04	% Variance
Fixed alarm (no cause)	75	109	+31
HAZMAT incidents	16	29	+45
Miscellaneous incidents	57	50	-12
Other incidences/attendance	91	39	-57
Rural incidents	251	253	+1
Special service incidents	105	68	-35
Structure incidents	42	53	+21
Vehicle related incidents	256	260	+1.5
Total incidents	**893**	**861**	**-4**

The Country Fire Service (CFS) has three main concerns in regard to the development of Mannum Waters all of which have been addressed in the design of the proposal:

- The provision of a reticulated water supply: The overall development, including residential and marina areas, will comply with the standards for water pressure and location of fire plugs to ensure the required provision of water in the case of emergencies. These standards will be agreed with the CFS and SA Water.
- The provision of a buffer to agricultural areas and any surrounding land that is the subject of a fire risk: The development has grazing land and no significant stands of trees or scrub on its northern and western sides. The southern and eastern sides are flanked by the River Murray and the town of Mannum including the golf course. The topography to the north is generally flat with some undulation around a valley. The subject land has a gentle slope which is south facing. The CFS has indicated that the lack of significant stands of vegetation and the nature of surrounding grasslands minimises the potential fire impact. Belvedere Road directly abuts the subject land on the northern side forming a break, and some buffering with this road in the final design will reinforce the buffer on this side. The majority of the western face of the land is taken up with the proposed wetlands to be established on the river flood plain.
- Road access to properties and marina areas: The site will be divided to provide access for vehicles to all allotments, including lightweight trucks used for refuse collection

or services such as those required in an emergency. The marina areas and all boats will be located in areas that are accessible for provisioning, servicing and emergency.

8.6.5 Transport services

Mannum is served by Murray Bridge Passenger Services (MBPS), which provides bus transport and has its depot at Murray Bridge. The other major service (between Adelaide, Birdwood and Mannum) closed in 2004 because of the lack of patronage.

Transport services to Mannum are limited. The MBPS operates two daily services between Mannum and Murray Bridge. This service leaves Mannum at 8 a.m. and returns at 4 p.m. There are four connecting services per day from Murray Bridge to Adelaide. During school holidays the timetable changes and the return journey from Adelaide to Murray Bridge is later in the day. This requires passengers to take a later bus from Murray Bridge to Mannum.

The service is mainly used by school age children and pensioners. A full adult fare to Adelaide is currently $23.20 (March 2006) with pensioners and children being charged half price. The cost and frequency of the service to Adelaide is not conducive to regular use and would limit its use to those on essential business or without alternative modes of transport. The shorter trip to Murray Bridge, whilst only twice a day, creates the opportunity for shopping and visiting medical and other services in the larger regional centre.

It is not considered that the proposed Mannum Waters development would put significant additional pressure on the existing service and it may indeed reinforce public transport operations by adding to growth in Mannum. Given the demise of the Adelaide–Birdwood–Mannum service, it is important that there be some significant reinforcement in the town of Mannum to ensure a population threshold is reached with regard to a achieving a more regular and lower cost service.

8.6.6 Telecommunications

(A) Mobile telephone service

Mannum is served by a mobile telephone base station on the eastern side of the River Murray directly opposite the town. Mobile telephone reception for the existing town is good and this standard also extends to the proposed Mannum Waters' development site.

Mobile telephone coverage for CDMA adequately covers the whole area proposed for the Mannum Waters development including the Marina and the residential lands. It is understood that as from 6 October 2006 Telstra has released "Next G" mobile network which equals the overall coverage in this map and in some areas betters the performance. (The Next G is the next generation network mobile network which enables high speed wireless broadband internet to mobile phones and laptops across Australia.)

(B) Broadband internet service

Broadband internet access has only been available in Mannum since early in 2006. The Murraylands and Riverland Regional Development Boards are negotiating with carriers to enable a solution for ADSL (high-speed broadband) availability in their regions. Tenders for this service have now closed.

9 Existing economic environment

Several studies are reported in the literature that describe the existing economic environment of the Murray Darling Basin, both in South Australia and upstream of the border.

These studies point to the overwhelming economic influence of the River Murray itself. This influence is both direct (e.g. extraction of water for ‘consumptive use’) or indirect (e.g. amenity and environmental value).

This chapter outlines the economic environment of Mannum and the region particularly in terms of its relationship to the River Murray.

9.1 RIVER MURRAY INFLUENCES

Figure 9.1 is a summary of how the total economic value of a resource (in this case, the River Murray) is viewed (Figure adapted from Young (1992) and reproduced in ACF (2004)).

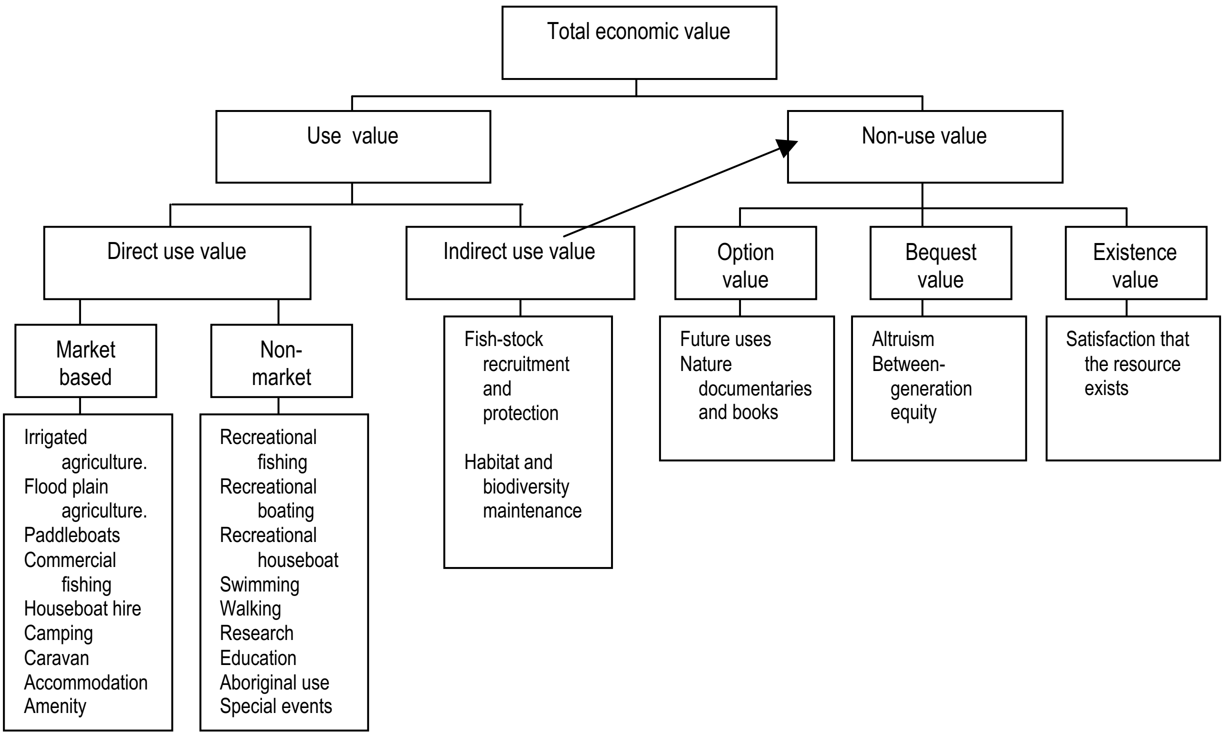

Figure 9.1 – Summary of ‘total economic value’

9.2 REGIONAL ECONOMY

The town of Mannum is located within the Murraylands Regional Area but is also influenced by the Adelaide Hills region to the west. As indicated in Section 9.1 there are significant economic advantages that are as a result of the River Murray and Mannum is an example of this in regard to its historical growth and the current major industries and employment generators.

Mannum's local economy is dependent on:

- Vacation growth: comprising the multiplier impact of absentee owners of holiday houses substantially increasing the town's population over weekends and school holiday periods.
- Tourism: the predominant visitor base to the Mannum area and region is from intrastate visitors, comprising:
  - longer-term and day tripper activity with a significant number of houseboat hirers
  - on-river holidays with Mannum's proximity to Adelaide and suitable mooring facilities encouraging this activity
  - services support, hospitality and accommodation.
- Manufacturing comprising:
  - farm machinery production
  - boat-building.
- Retailing: Located in a central place with threshold population from Mannum and its hinterland and influenced by vacation and day tripper trade
- Retirement: Mannum is a pleasant place to which to retire and this activity has a consequent multiplier impact on the supply of goods and services
- Medical and aged care services: comprising a well-established local hospital and associated aged care facilities.

Whilst Mannum has some government offices and services, the bulk of this type of activity is located in the regional centres of Murray Bridge and Mount Barker, or further away in Adelaide.

The regional economy of the Murraylands is dependent on agriculture, food processing, machinery manufacturing and emerging industries such as plastics-based manufacturing, hay exports, timber treatment and light metal manufacturing.

Agricultural activity is diversified ranging from broadacre cropping and extensive livestock production to intensive horticulture and intensive livestock production. According to the Murraylands Regional Development Board,

> Approximately 25% of South Australia's dairy production comes from an area along the Murray from Mannum to Meningie. Pig production in the area represents about 25% of total production in the State. The intensive poultry industry is of comparable importance...and 30% of the state's glasshouse industry (tomatoes, cucumbers and capsicums) is located in the Murraylands. (Murraylands Regional Development Board *Sixth Annual Report 1997/1998)*

The total agricultural production for the Murraylands in 2001–02 was $496.8 million and of this production the most important sectors were livestock (32%), field crops (19%) and horticulture (15%), with dairy and animal feed sharing another 25% between them.

Levels of employment indicate that the industries with the highest participation are:

- agriculture, forestry and fishing (28%)
- retail trade (13%)
- manufacturing (11%)
- health and community services (7%).

Manufacturing is closely tied to and dependent upon agriculture with the key employment focus being on the manufacture of grain storage, irrigation equipment and farm machinery.

Trends in the labour market show that in the late 1990s major gains were made in the areas of:

- wholesale trade (38.9% increase between 1996 and 2001)
- transport and storage (33.4% increase between 1996 and 2001)
- communication services (28.6% increase between 1996 and 2001)
- construction (25.7% increase between 1996 and 2001), largely brought about by housing growth in the Murray Bridge area and the new plant construction in the expanding food sector.

Conversely there have been significant declines in the areas of:

- electricity, gas and water supply (35.2% decrease between 1996 and 2001)
- manufacturing (10.3% decrease between 1996 and 2001).

The Murraylands region is a key regional contributor to the state's agri-food industries, and the region will contribute more than six per cent of the state's gross food revenue in the near future.

Importantly, the agri-food business will be reliant heavily on water to be sustainable and in particular, reliant on the continuing supply and the maintenance of the quality of the major source of that supply: the River Murray.

10 Aboriginal heritage

10.1 HERITAGE CONSULTANT REPORTS

Several indigenous heritage studies of the area were conducted in the company of representatives of the Mannum Aboriginal Community Association Incorporated (MACAI) during the course of the development of the proposal. The purpose of the studies was to identify and map any constraints on the development of Mannum Waters. Knowing the location and nature of the constraints, plans for Mannum Waters have been designed to avoid disturbance of sites with heritage significance.

The first study was undertaken by Vivienne Wood, Heritage Consultant, in October 2002. A second study was undertaken in March 2005 by TimeMap Pty Ltd, Heritage Consultants, and a follow up review by TimeMap Pty Ltd in May 2005. The reports prepared as part of these studies are contained at Appendix H.

10.2 ARCHAEOLOGICAL FINDINGS IN THE AREA

The Lower River Murray has been the focus of much archaeological and historical research. The large number and extent of sites recorded along the length of the river support the hypothesis that the region was one of the more densely settled areas of indigenous Australia. A study by Wood (1993)[1] involved an archaeological survey of the River Murray and areas adjacent to it between Mannum and the entrance to Lake Alexandrina. The study recorded a total of 213 sites that had not previously been documented, and confirmed the 98 previously documented sites. The sites included middens (shell mounds), scarred trees (culturally modified trees) campsites, burial sites, hearths and a rock shelter that had occupation deposits.

Previous sites recorded by Wood (1993) in the proposal site include:

- three middens – Baseby Middens 1 to 3 (refer Photos 10.1, 10.2 and 10.3), which are recorded on the State register, South Australian Aboriginal Heritage Act, 1988 as sites 6728-1060, 1061 and 1062
- two scarred trees – Baseby Scarred Trees 1 and 2, which are recorded on the State register as sites 6728-1056 and 1057
- a scarred tree which lies immediately outside the development area – Baseby Scarred Tree 3, which is recorded on the State register as site 6728-1058.

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[1] Wood V. 1993 Lower Murray Aboriginal Heritage Study: An Archeological survey of the Lower Murray River, between Mannum and Lake Alexandrina, South Australia. Unpublished report to Culture and Sites Services Section, Dept. State Aboriginal affairs and Murray Darling Basin Commission.

Photo 10.1 – Baseby Midden 1

Photo 10.2 – Baseby Midden 2

Photo 10.3 – Baseby Midden 3

Descriptions of the sites as they were recorded in 1993 may be found in Appendix H. The survey conducted in 2002 by Wood confirmed the previously recorded sites, but noted that Baseby Midden 3 had been disturbed by the construction of a shed.

A further site, Baseby Midden 4 (refer Photo 10.4), reported by Wood in 2002 had been destroyed as a result of earthmoving.

Other identified and reported sites[2], Baseby Midden 5 (refer Photo 10.5) and Baseby Midden 6, were located on site and considered appropriate for preservation. An area of cultural interest was also identified which encircled Baseby Middens 5 and 6.

A further small area of interest was identified by representatives of MACAI within the SA Water site adjacent to the cliff face.

While several dense concentrations of midden material and artefacts were identified, there also appears to be a general low-density scatter of midden material across much of the study area. Particularly sensitive locations include the colluvial slopes fringing the flood plain and the immediate cliff line. Archaeological materials were also found beyond the western limits of the previously identified Baseby Middens 1 to 3. The flood plain has only limited archaeological sensitivity, given that it would have been permanently or periodically inundated by water prior to the construction of the levees.

[2] Walshe & Bonnell, March 2005

Photo 10.4 – Baseby Midden 4

Photo 10.5 – Baseby Midden 5

Photo 10.6 – Baseby Scarred Tree

As a result of the reviews and consultation with MACAI representatives and heritage consultants, the following conclusions were determined:

- the land has not been placed under a Native Title Claim or under an Indigenous Land Use agreement
- none of the recorded indigenous sites in the proposed development are registered under the SA Aboriginal Heritage Act, but they are protected under that Act
- five Baseby Middens 1,2,3,5 and 6 were nominated for preservation while Baseby Midden 4 has previously been destroyed
- one additional site in the SA Water land has been nominated for preservation
- three culturally modified trees, Baseby Scarred Trees 1, 2 and 3 have been nominated for preservation.

The locations of sites identified for preservation are shown in Figure 10.1.

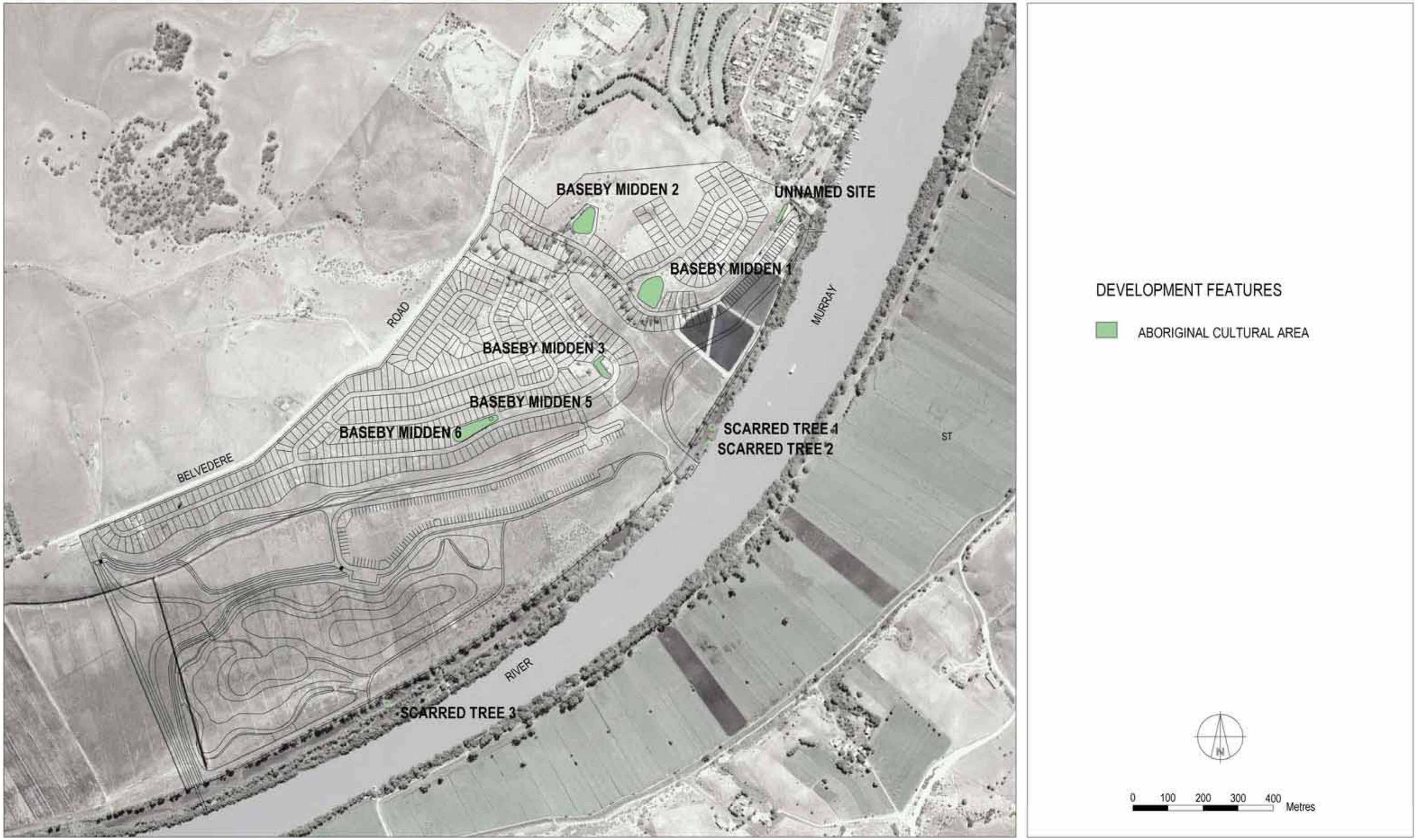


Figure 10.1 – Aboriginal cultural heritage sites for preservation

10.3 NATIVE TITLE

As previously indicated the land proposed for development was investigated by TimeMap Pty Ltd and it was concluded that the land is not subject to a Native Title claim.

In addition to the work undertaken by TimeMap Pty Ltd, the proponent sought advice from the Department for Environment & Heritage (River/South-East) at Berri concerning the locations where the main entrance and the inlet and outlet channels traversed Crown Land (Sections 856 and 857, Hd. Finniss) adjacent to the River Murray (refer Section 3.2, Fig 3.3). The proponent was advised that Native Title is deemed to have been extinguished over both Sections.

10.4 CONSULTATION

Considerable consultation has occurred between members of MACAI, heritage consultants TimeMap Pty Ltd and Tallwood's representatives. In particular, this included MACAI representatives Richard Hunter, elder, custodian and Chairman of MACAI, Cynthia Hutchison and Isobel Campbell.

All sites identified by the heritage consultants were inspected by Mr Hunter and others and the specific sites nominated for preservation. These were later surveyed in the presence of MACAI members and accurately located on the Development Plan (refer Figure 10.1).

At a further meeting with MACAI representatives, discussions were held to confirm the involvement of local Aboriginal people in the planning and design for the protection of the areas to be preserved. Talks were also held to discuss Aboriginal monitoring of the construction works, the opportunities for Aboriginal employment during the construction stages and on-going involvement in an interpretive centre and in developing interpretive material.

A very satisfactory working relationship has been established between Tallwood and MACAI and a successful outcome for the preservation of Aboriginal Cultural Heritage Items has been assured.

A letter of agreement has been received by the proponent from MACAI, confirming MACAI's support for the proposal's treatment of aboriginal heritage.

Currently, consultants are investigating commercial opportunities on behalf of the Federal Government for the Ngarrindjeri people along the lower Murray. Discussions were held with the proponent in regard to opportunities that may be available at Mannum Waters. Several points were raised which included:

- the possibility of an independent living area for Ngarrindjeri elders
- business opportunities, eg. tours etc.
- educational facilities linked with the interpretive centre
- investment opportunities.

The proponent indicated a readiness to pursue the possibilities with the Aboriginal communities and Federal Government should they consider it appropriate.

10.5 PROTOCOLS FOR DESIGN, CONSTRUCTION AND OPERATION

On-going protocols for consultation with MACAI were discussed and agreed by the proponent with MACAI. Furthermore, a set of mitigation measures were agreed with MACAI. These are and detailed as follows (refer also Appendix H):

10.5.1 Planning

Six midden sites for preservation have been shown in the site layout (refer Figure 10.1), two of which are included in a more general area of cultural interest. In addition three scarred trees have also been shown on the plan. All of these sites are protected through the layout and design of the proposal.

All sites have been included within larger open space areas to enable on-going protection. During the design and construction stages of the project, Tallwood will consult with MACAI representatives to ensure the most appropriate protection to the sites is undertaken.

It was agreed with MACAI to combine interpretative information for use with walking trails throughout the development with other trails being planned and established by Friends of Mannum Walking Trails Group (FMWTG). MACAI members are not in favour of localised on-site interpretative signs, believing it draws to much attention to the sites. MACAI prefers informative literature and flyers to be made available to environmentally aware walkers. To assist the development and sustainability of the Aboriginal Cultural Heritage it is proposed to include an Interpretative Centre within the commercial complex of the development.

10.5.2 Detailed Design

During the detailed design stage of the development, members of MACAI will provide consultancy services to confirm the boundaries of the preserved sites, provide additional information on appropriate protective measures, confirm the location of walking trails in conjunction with FMWTG and provide design assistance for the interpretive centre, literature and display.

10.5.3 Construction

During the construction period MACAI will be engaged for the following services:

- training of all machine operators in observation techniques for identifying items of Aboriginal Cultural importance
- provide a response within 24 hours to confirm objects identified by the construction work force
- provide daily on site monitoring by three monitors for areas of high interest viz. At the interface of the floodplain and higher ground and also adjacent to the areas identified on the development plan for preservation

- provide a scan on other areas (e.g. upper level roads) once roads have been pegged and prior to construction to enable retrieval of any surface artefacts or objects of interest
- report any archaeological finds to MACAI and at the discretion of MACAI involve the State Heritage Committee and Department of Aboriginal Affairs and Reconciliation (DAARE) heritage team
- cease work in the immediate vicinity until an effective process for site avoidance is instigated.

In addition on-site contractors will be encouraged to provide employment opportunities for local Aboriginal people who have the appropriate skills.

10.5.4 During operation

MACAI representatives will be invited to provide input to the management of the interpretive centre and assist others in tourist activities for the area.

10.6 INTERPRETIVE FACILITIES

An interpretive centre is planned for location in the Commercial Area. It is envisaged that it will serve both the interests of the Aboriginal community by providing information on items of preservation both on site and in the region and also environmental aspects of the existing and constructed wetlands.

MACAI representatives will be invited to play an active role in the preparation of exhibits and interpretive brochures and also in staffing the centre.

11 Potential impacts and mitigation measures

11.1 INTRODUCTION

At an early stage, key environmental issues were identified and the development designed to minimise impacts, including the protection of the high conservation status Baseby Linear Riverine Wetland, the need to protect water quality and minimise water abstraction from the river.

The design features of the wetland and the physical and management measures taken to minimise or eliminate potential environmental impacts are outlined in the following sections. Also outlined are some important environmental benefits in providing much needed facilities for houseboats

11.2 PHYSICAL ENVIRONMENT

11.2.1 Water Quality, Stormwater and Wastewater

(A) Water quality in the marina waterways and river

Water quality in the river will improve as a result of the development, principally due to:

- the provision of facilities for 156 (150 permanent and 6 casual) houseboats which provide for the safe disposal of grey water and sewage effluent. As described previously (refer Section 2.3), there are insufficient moorings and no pump out facilities for grey water along the River. This is currently a significant pollution source and facilities will be in place within the marina for houseboat pump out of all liquid waste. All occupiers of berths within the marina will be governed by a Marina Owner's Charter which will require boat owners and operators to abide by the requirements of the EPA
- the change in land use from grazing to a marina with overall reductions in pollutant loads, particularly with the removal of stock, which currently have direct access to the riverine wetland and river (refer Photos 11.1 and 11.2). As pointed out in Section 5.2.4, the retirement of this part of the Baseby Irrigation Area has resulted in a major reduction in pollutant loading (nutrients and faecal micro-organisms).
- previously the irrigation returns, when all of the area was used for dairying, would have impacted on the river and the linear riverine wetlands. The irrigation returns would have coincided with the seasonal inundation of the linear wetlands, bringing in nutrient rich water. This may have resulted in algal blooms. This is no longer an issue.

- the SA Water wastewater lagoons and overflow structures will be removed from the floodplain, reducing water pollution risk.

Photo 11.1 – Grazing within the existing riverine wetland

Photo 11.2 – Impacts of cattle grazing on foliage and bank destabilisation

Water quality in the marina and waterways is largely dictated by river water flowing into the marina and waterways. Without adequate safeguards and preventative measures it could be impacted by stormwater runoff from the development following storm events.

As discussed previously in Section 5.2.4, water quality in the river is described as moderate to good, with nutrients, algal blooms, faecal bacteria count, salinity and turbidity being generally within the ANZECC 2000 Water Guidelines - Recreational Contact. Water quality in the river deteriorates downstream of Mannum due to irrigation water returning to the river from dairy farmland, (refer Section 5.2.4).

All water flowing through the marina and waterways will be protected by a range of measures described below, and finally flow through a constructed wetland as an additional safeguard prior to discharge back to the river, refer (C) below.

To ensure protection of water quality within the waterways and river, the following measures will be implemented:

- houseboat facilities will be located off-stream. A purpose built marina with facilities that include vacuum sewage discharge, solid waste disposal bins and regulated refuelling stations will be established in the current floodplain zone
- collection and treatment of stormwater runoff, as described in more detail in (B) below
- sealed wastewater disposal system, refer (D) below
- bunding of fuel service supply (refer Sections 2.4.8 and 12.3.3)
- the development of a spill response plan as part of the overall EMMP for the project (refer Section 12.3)

In the short term, potential impacts from construction will be managed through a Construction Environmental Management Plan (CEMP) to be implemented by the construction contractor, refer section 12.2.

(B) **Stormwater**

The recommendations of the Stormwater Industry Association Ltd (Argue 2004) will be incorporated into both the preparation of the site and ongoing management. While the constructed wetland can be seen as the ‘end point’ of the management of water in the development, other features will address the sources of water entering the development (except for the water entering the marina from the river, over which the proponent has no control).

A large majority of the development will be situated on the land located above the Coonambidgal Formation. The soil in this location is classified as Murray Group limestone, which has a very low hydraulic conductivity. This may limit the ability to adopt some Water Sensitive Urban Design (WSUD) techniques such as leaky wells and soakage trenches.

(i) **Porous Surfaces**

Where stormwater flow paths cross porous surfaces, grass swales will be constructed to reduce flow rate. This will increase infiltration and promote recharge through the soil profile.

(ii) **Hard surfaces**

Within hard stand areas there are several WSUD techniques that may be adopted, some of which include permeable paving, subsurface storage tanks and leaky wells. Detailed design will determine the appropriate selection and location of the techniques to ensure that the development objectives are satisfied.

These techniques have limited usefulness at this site as the immediate return of clean stormwater to the river has also significant value. In those locations where the return of stormwater to the soils can assist in minimizing irrigation it will be an advantage to put into practice some of the techniques. This will be subject to final design.

(iii) **Gross pollutants**

A Gross Pollutant Trap (GPT) will be installed at each public open space stormwater collection system. The purpose of a GPT is to remove all hard refuse that may be mobilised by stormwater flows. A GPT also substantially reduces the passage of oils and greases. The GPT is designed to treat up to 90 per cent of the theoretical total annual flow. The GPT will be monitored during the defects liability period and after any rainfall events to ascertain the expected maintenance frequency.

(iv) **Retention ponds**

Stormwater run-off from roads and allotments will be diverted into gross pollutant traps located in open space areas in the development. The pollutant traps will be followed by localised retention ponds prior to discharge into the waterways. Planted swales will be used to direct stormwater into the retention ponds. The swales will also have an effect in reducing the level of contamination in the stormwater.

Roof run-off will be collected in rainwater tanks, required under the House Owners' Charter to be established on each allotment. Excess run-off from roofs will be discharged via the road drainage systems to the retention pond nearest to its collection point, and then discharged into the waterways.

All stormwater run-off passing through the piped systems will be treated for a one year annual Return Interval (ARI). The first flush of larger events will also be treated with larger flows passing through the treatment elements. The quality of the stormwater run-off generated by the site is expected to be consistent with that of an urban catchment. Typically the retention ponds could be expanded to remove approximately 80% of suspended solids, nitrogen and heavy metals. This has been discussed previously in Section 2.7.2, where an indicative concept design was presented in Figure 2.26.

(v) **Riparian vegetated buffers**

As discussed previously in Section 2.3.8, riparian buffer areas will be developed on all allotments to provide an additional water quality safeguard. The waterfront allotments have been planned with depths ranging from 40 to 70 metres. These will reinforce the plantings for erosion protection provided with the initial development by the proponent. There is a large literature on the effectiveness of vegetated riparian buffers in reducing pollutant export to watercourses and it is shown that grassed buffers of 5 m are sufficient. In this instance buffers even up to 15 metres depth from the river should be possible on all allotments.

(C) **Treatment wetland requirement**

As described in Section 2.3.9, all flows through the residential waterways and marina basin will pass through a large shallow wetland area developed on the anabranch channel. The preliminary design revealed that a wetland having a total water surface area of approximately six hectares would be required in order to achieve a ten-day residence time and to satisfy the water quality requirements. Of this six hectare wetland, approximately 4 ha would comprise the deep zone and the remaining 2 ha would incorporate the macrophyte zone.

The wetland size was based on an estimated peak flow rate of 2 m^3/s. This flow rate corresponds to a catchment area of approximately 69 ha and a one year ARI. A run-off coefficient of 0.6 was adopted over the entire catchment.

(D) **Wastewater**

The wastewater system proposed for the development has already been described in Section 2.7.3.

The following points identify how wastewater flows will be confined to the treatment system and the development protected from environmental harm:

- the existing wastewater treatment plant and lagoons will be removed from their current location in the floodplain and adjacent to the river
- the existing overflow from the lagoons to the river will be removed
- all residences, commercial buildings, public toilets and houseboat moorings will be connected to the sewer system
- houseboats will be required to have greywater storage or treatment (refer Section 2.3) as well as blackwater storage for connection to the sewer system
- vacuum sewers will serve the houseboats and the waterfront allotments where stable gravity sewer drains can not be assured. Final choices will be made in conjunction with SA Water
- sewer pumping stations will be equipped with emergency generators which will operate automatically during power failures
- sewer pumping stations will be equipped with stand-by pumps, alarm dialers and emergency storage (where necessary) for emergency purposes
- the wastewater treatment plant will be provided to the requirements of SA Water and subject to the separation distances required by the draft provisions of the EPA “Guidelines for Separation Distances”
- if required, reclaimed water will be stored beyond the required separation distance from the River Murray
- irrigation of the reclaimed water will be subject to an Irrigation Management Plan and discharged to the requirements of the Department of Health and EPA “South Australian Reclaimed Water Guidelines”.

11.2.2 Water balance

In order to ascertain the necessity for water imports from the River Murray, a water balance was created for the proposed marina and waterway area. Pre and post development scenarios were investigated in average rainfall conditions. Also, a 1 in 10 dry year rainfall condition was considered for post development.

Monthly rainfall data was taken from a 130 year record at the Mannum Council Depot Bureau of Meteorology (BoM) station (refer Section 6.2.1), from which cumulative rainfall deciles were extracted. Data in the first decile formed the basis of the 1 in 10 dry year rainfall, whilst monthly averages of the 1976-2005 data-set formed the 30 year average rainfall.

Measures of monthly pan evaporation were sourced from the BoM climate station at the Wellington Pumping Station (refer Section 6.2.5). A pan factor of 0.75 was applied to account for the evaporation difference between the marina and waterway area in comparison to the measured standard pan.

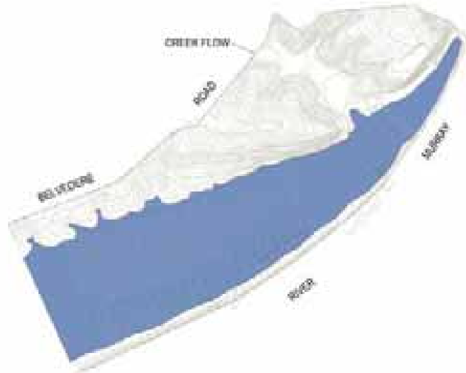
The pre development catchment consists of a 3,100 ha natural creek catchment, and a further 172.4 ha compromising the development area itself. The creek catchment is gently sloping with mostly open pasture cover and a defined creek line. A coefficient of runoff of 0.02 has been chosen based on published data for such catchments and the rainfall for the region. The development catchment areas and runoff coefficients are summarised in Figures 11.1, 11.2, 11.3 and 11.4).

It is assumed that all rainfall that falls on the wetland and water bodies will be collected, whilst no runoff will be collected from areas of revegetation. Half the runoff from embankments and roads, and 70% of runoff from more densely packed commercial areas has been included. Finally, runoff from allotments has been capped at 20% given the inclusion of household rainwater tanks and the relatively large allotment sizes.

The results of the water balance for pre and post development scenarios are shown in the Figures 11.1, 11.2, 11.3 and 11.4. In each case it has been assessed that sub-surface movement of water remains relatively unchanged and is therefore not included within the analysis

In the early days before the construction of the levees, the area would have fluctuated in level with the river. In those days, assuming there has been little change in the average surface level, annual evaporation would have been significant with an annual net loss from the river of approximately 302 ML. Currently, no water from the area or the existing creek catchment reaches the river as it is diverted to an area behind the river levee. In this situation the only water to be considered is the amount currently extracted from the river under licence viz. up to 170 ML/annum.

In the post development scenario, the water balance indicates a loss of 31 ML in the average year and 119 ML in the 1 in 10 dry years. However, it is intended that the detailed design will result in a draw from the river in an average year as close to zero as practical. This can be achieved in the final size (area of waterways, size of wetland and/or the extent of ephemeral versus more permanent water wetland areas and managing the wetting and drying cycles as well as the irrigation requirement for controlling salinity on the revegetated areas.



Item	Area ha	Run-off coeff. or water gain coeff.	Annual rainfall to river flats (ML)	Annual evaporation losses from river flats (ML)	Annual net gain/loss in river flats (ML)	Comments specific to item
River flats	86	1.00	261.53	759.89		Evaporation assumed at 80% due to annual surface variation
High ground	86.4	0.03	7.88			Gentle to steep slopes
Creek catchment (off-site)	3100	0.02	188.54			Gentle to medium slopes, pasture, defined creek
Total			457.95	759.89	-301.94	

Notes:

River flats form extension of river

Level of flats considered the same as present day

Migration of water from river and river flats to adjacent groundwater until balance established between migratory flow and evapotranspiration etc - Not quantified

Run-off coefficients determined by Kellog, Brown and Root

Figure 11.1 – Water balance pre-construction of levee

Item	Area ha	Run-off coeff. or water gain coeff.	Annual irrigation use of water obtained from river (ML)	Annual evapo-transpiration losses of water obtained from river (ML)	Annual net gain/loss in river (ML)	Comments specific to item
Dry river flats	86	1.00				
High ground	86.4	0.03				Gentle to steep slopes
Creek catchment (off-site)	3100	0.02				Gentle to medium slopes, pasture, defined creek
Current Irrigation licence				170.00	-170.00	
Total					**-170.00**	

Notes:

Levee prevents overland flow to river

River flats approximately 600mm to 1200mm below average pool level in river.

Use of river water dependent on irrigation licences

Groundwater level approximately 2450mm below average pool level in river

Migration of water from river and river flats to adjacent groundwater until balance established between migratory flow and evapotranspiration etc - Not quantified

Run-off coefficients determined by Kellog, Brown and Root

Figure 11.2 – Water balance post-construction of levee/pre-development

Item	Area ha	Run-off coeff. or water gain coeff.	Annual rainfall to waterbodies (ML)	Annual evaporation losses from marina water body and waterways (ML)	Annual net gain/loss in river storage (ML)	Comments specific to item
Marina water body	8.28	1.00	25.18	91.45		
Marina road reserve	3.23	0.30	2.95			No kerbing
Residential standard allotments	31.19	0.20	18.97			Low density with rainwater tanks
Residential waterfront allotments	12.52	0.20	7.61			Low density with rainwater tanks
Residential waterfront villa allotments	0.92	0.20	0.56			Low density with rainwater tanks
Residential waterways	15.10	1.00	45.92	166.78		
Residential road reserves	10.85	0.50	16.50			Kerbed
Commercial area	0.68	0.70	1.45			High level of impervious areas
Parks	7.91	0.03	0.72			Gentle to steep slopes
Aboriginal heritage areas	1.38	0.03	0.13			Medium slope
Golf course extension	7.01	0.03	0.64			Gentle to steep slopes
Revegetation areas	23.15					Separated from river water
Landscaped embankments	6.53	0.50	9.93			1:4 side slopes
Constructed treatment wetland/anabranch	6.60	1.00	20.07	72.90		
Constructed ephemeral water areas	12.50	1.00	28.51	69.03		Water delivered from anabranch.
Constructed wetland riparian areas	24.55	0.02	1.49			Proportion contributes to ephemeral water areas
Creek catchment (off-site)	3100.00	0.02	188.54			Mostly gentle to medium slopes, pasture, defined creek
Total (not including ELMA)			369.17	400.16	-30.99	If required, final design can be adjusted to reduce this to zero
ELMA allowance available for portions of wetland areas and revegetation areas (Sec 743, 34.8 ha)					218.00	Based on approximate allocation rate of 6.3 ML/ha

Notes:

Marina, waterways and constructed wetland anabranch form extension of river

Constructed wetland isolated from river and other water bodies by embankments

Revegetation areas are modified remnants of the river flats approximately 600mm to 1200mm below average pool level in river

Migration of water from river and river flats to adjacent groundwater until balance established between migratory flow and evapotranspiration etc - Not quantified

Run-off coefficients determined by Kellog, Brown and Root

Figure 11.3 – Water balance post-development (average year)

Item	Area ha	Run-off coeff. or water gain coeff.	Annual rainfall to waterbodies (ML)	Annual evaporation losses from marina water body and waterways (ML)	Annual net gain/loss in river storage (ML)	Comments specific to item
Marina water body	8.28	1.00	16.74	91.45		
Marina road reserve	3.23	0.30	1.96			No kerbing
Residential standard allotments	31.19	0.20	12.61			Low density with rainwater tanks
Residential waterfront allotments	12.52	0.20	5.06			Low density with rainwater tanks
Residential waterfront villa allotments	0.92	0.20	0.37			Low density with rainwater tanks
Residential waterways	15.10	1.00	30.53	166.78		
Residential road reserves	10.85	0.50	10.97			Kerbed
Commercial area	0.68	0.70	0.96			High level of impervious areas
Parks	7.91	0.03	0.48			Gentle to steep slopes
Aboriginal heritage areas	1.38	0.03	0.08			Medium slope
Golf course extension	7.01	0.03	0.43			Gentle to steep slopes
Revegetation areas	23.15					Separated from river water
Landscaped embankments	6.53	0.50	6.60			1:4 side slopes
Constructed treatment wetland/anabranch	6.60	1.00	13.35	72.90		
Constructed ephemeral water areas	12.50	1.00	25.28	40.00		Delivered from anabranch
Constructed wetland riparian areas	24.55	0.02	0.99			Separated from river water
Creek catchment (off-site)	3100.00	0.02	125.36			Mostly gentle to medium slopes, pasture, defined creek
Total (not including ELMA)			251.78	371.13	-119.34	If required, final design can be adjusted to reduce this to amount
ELMA allowance available for portions of wetland areas and revegetation areas (Sec 743, 34.8 ha)					218.00	Based on approximate allocation rate of 6.3 ML/ha

Notes:

Marina, waterways and constructed wetland anabranch form extension of river

Constructed wetland isolated from river and other water bodies by embankments

Revegetation areas are modified remnants of the river flats approximately 600mm to 1200mm below average pool level in river

Migration of water from river and river flats to adjacent groundwater until balance established between migratory flow and evapotranspiration etc - Not quantified

Run-off coefficients determined by Kellog, Brown and Root

Figure 11.4 – Water balance post-development (1 in 10 dry year)

In summary, the pre development scenario indicates that no water enters the River given the levee bank in the flood plain, whilst the post development scenario indicates an average annual draw on the River of 31 ML. This is considerably less than the existing 170 ML/annum water licence which more than covers the anticipated annual draw from the river. As well ELMA water (approximately 218 ML) is available for use in portions of the wetland areas and the revegetation areas. This, together with the current water licence, considerably exceeds the anticipated water use as shown in Figures 11.3 and 11.4.

The volume of water required to fill the marina to an average depth of 2.55 metres is approximately 520 ML. This was determined by assuming a slope of 1 in 4 for residential waterfront and embankments batters and vertical walls to the marina and commercial area.

At present some 40 ML is lost by evaporation from the existing wastewater lagoons. With the removal of the lagoons it is anticipated that around 36 ML of reclaimed water will be saved and will be available for uses where mains water would otherwise have been required. The saving of reclaimed water has not been included within the water balance Figures 11.3 and 11.4.

11.2.3 Water modelling

Hydrodynamic water modelling of the marina and waterways was undertaken by Computational Fluid Mechanics Pty Ltd. The initial report prepared in February 2007 (refer Appendix I) describes the channel network modelling that was used in the analysis. The marina, at this time, was located closer to the riverine wetland. The current location however makes very little difference to the analysis as cross-sections are similar.

The water model is able to predict water flows at various locations within the water ways both under natural movements of the river levels and also with the additional assistance of pumping. Input data was derived from the preliminary design of the marina and waterways, the entrance channels and from a six month period of river water level recorded from the 1st January 2006 at 20 minute intervals. The effects of wind (within the marina and waterways) and boat movements were not specifically modelled as these were perceived to be minor, although positive, contributors to water transfer.

Consultation with the EPA established a design requirement of achieving water turnover within the marina and waterways every 10 days. The initial report modelled the system with pumping active at Water Transfer Stations 1 and 2 (refer Section 2.3.9). They transfer water from the marina and waterways to the anabranch and treated wetland. Results were also obtained for the water flows driven by natural movement (i.e. no pumping). The initial report identified that pumping is required to achieved a 10 day turn-over. A further pump is required to ensure that the north-western waterway within the existing creek achieves a 10 day turnover within this reach. Consequently a third Water Transfer Station is proposed to extract water from the river (refer Section 2.3.9) and deliver it to a water feature at the head of the north-western waterway.

A further analysis was undertaken with revised pumping capacities to re-assess the turnover and also to determine the percentage of water which passed from the marina and waterways to the river without returning via the anabranch and treatment wetland. The six-month data period allowed 18 blocks of 10 days to be examined. Table 11.1

shows the flows leaving the marina and waterways via the water transfer stations 1 and 2 to the anabranch. Based on 24 hour/day pumping over 10 days, the volume pumped exceeds the volume of the marina and waterways (520 ML) by approximately 14 %. The volume of the north-western waterway is 48 ML and the volume within the north-eastern waterway is 46 ML. In each case the volumes were exceeded by the 10 day transfer rates (refer Tables 11.1 and 11.2).

Table 11.1 – Flows through the marina and waterways

Flow from marina to anabranch (kL)	Flow from southern waterway to anabranch (kL)	Flow to the head of the north-western waterway	Total flow to the anabranch
396228	198121	51665	594349
394378	197745	51821	592123
397262	198317	51572	595579
395287	197931	51743	593218
395108	197899	51762	593007
394961	197864	51772	592825
394969	197850	51773	592819
398221	198521	51498	596742
397302	198327	51576	595629
393397	197547	51905	590944
398493	198564	51476	597057
397162	198303	51586	595465
396151	198103	51671	594254
394839	197841	51782	592680
394803	197825	51786	592628
397867	198447	51528	596314
396630	198891	51630	595521
395666	198006	51713	593672

The cumulative inflow and the backflows at the entrances are shown in Table 11.2.

Backflow quantities are indicative of the natural movement (without pumping) within the river, marina and waterways system. On average approximately 20% of the total flow entering the entrance ways is subject to backflow. When this occurs within the River system when flows are small, most of the exchange will occur within a confined area and the overall flows through the development's water-bodies will ensure that escapes to the larger river system will be small.

When river flows are high, greater amounts of the 20% backflow will enter the larger river system but dilution factors will be high because of the larger movement. At a flow rate in the river of 2,400 ML/day, the percentage of backflow to river flow is estimated at less than 0.7%. When the river flow is at its long term average of 6,600 ML/day the percentage of backflow to river flow is estimated at less than 0.3%.

Overall there is a very positive outcome on water movement.

Table 11.2 – Cumulative inflow and actual backflows at the entrances

Cumulative flow in main entrance (kL)	Backflow to river at main entrance (kL)	Backflow as % of total flow entering the main entrance	Cumulative flow at northern inlet channel (kL)	Backflow to river at northern inlet channel (kL)	Backflow as % of total flow entering the northern inlet channel
458747	176480	28	84009	30998	27
442879	171317	28	81255	29442	27
465490	242506	34	87567	41167	32
450076	193090	30	83202	33026	28
450072	127556	22	81313	21973	21
449341	114076	20	80543	19898	20
449548	99481	18	80194	16884	17
475380	113641	19	87135	18625	18
468513	124613	21	84668	21316	20
435283	139569	24	78820	24227	24
475669	253126	35	89476	42723	32
467822	105953	18	84025	17893	18
456524	256025	36	85361	44887	34
450549	29208	6	78073	5094	6
449593	57653	11	78506	10316	12
475957	49253	9	82931	8671	9
465077	54379	10	81440	9211	10
457181	43056	9	79705	7492	9

The basic data used for the modelling is as follows:

- Layout – refer Appendix I for drawing and cross-section details
- Marina and waterways surface area – 23.4ha
- Marina and waterways volume – 520 ML
- Northern inlet - 7m wide with vertical sides (vinyl sheet piling). Water depth 2.55m. Approximate depth in river 6m-8m. Location has been selected to avoid native trees with minimal interference to their root systems and enters the river where only willows are present.
- North-western waterway (along existing creek) - Water feature at Belvedere Road end. Pumping rate 60 litres/sec, pumped directly from river. Using existing golf course suction pipe adjacent to existing SA Water lagoons.
- Marina - Water transfer station at southern end (WST 1). Pumping rate capacity of 460 litres/sec, pumped from marina to wetland anabranch.
- South-western waterway - Water transfer station (WST2) at south-western end. Pumping rate capacity of 230 litres/sec, pumped from the waterway to the wetland anabranch.
- Water Transfer Stations 1 and 2 – refer Section 2.3.9 for design details
- Anabranch exit channel - Exit channel from the anabranch to the river will be 3m wide with vertical sides and extend through the existing wetland. Location has been selected to avoid native trees with minimal interference to their root systems and enters the river where only willows are present.

11.2.4 Groundwater

(A) Effects of marina waterways

Previous geological investigations in the area have shown that the proposed marina and waterways lie above a region of Coonambidgal Formation. The Coonambidgal Formation is dominated by clays and silts with some light grey sands. This soil type corresponds to a hydraulic conductivity rate of between 1 x 10^{-6} and 1 x 10^{-5}.

In its pre-developed form, the area forms a large evaporation pan drawing the potentiometric surface above the water table, thus preventing the lateral flow of groundwater from reaching the River. The evaporation pan currently occupies approximately 79 hectares with an average surface level of AHD -0.2m and lowest levels at approximately AHD -0.65m. This places the area at an average of 0.95m to 1.4m below the normal river pool level. Consequently, water currently flows from the river below the surface to the evaporation pan as shown in Fig 6.2.

As a result of the development, channels will be cut into the underlying riverine flats (Coonambidgal Formation), and the water in the channel will be at a higher elevation than that of the groundwater which will result in a transfer of flow from the marina into the groundwater table as shown in Fig, 11.5. If this occurs it will result in the groundwater table rising slightly.

The effects are expected to be local, and combined with the shallow hydraulic slopes and the low conductivity of the Coonambidgal Formation, it is envisaged that there will be little modification to the local groundwater flows from the River Murray. For this reason infiltration has been omitted from the water balance in regards to the marina, waterways, and wetland area.

(B) Council landfill

The landfill has been excavated in limestones of the Murray Group but the depth to the watertable under the site is not known.

The minimum groundwater monitoring at landfills required by the EPA is the installation of three water-table monitoring wells completed to a standard specification. Of the three, one must be up-gradient of the site which here would place it in the depot compound in the north of the site (refer Photo 11.3). The two down-gradient wells would be adjacent to Belvedere Road with the exact sites selected in the field and allowing for drilling rig access etc (refer Photo 11.4).

Studies for the Monarto Quarry Landfill near Callington, which is also in the Murray Group Limestone, showed that for average rainfall conditions about 16 mm of leachate would be generated per year in the operational area reducing to zero mm with dumping complete and the final cover in place. Callington’s average rainfall is 370 mm and Mannum’s 304 mm/year. This suggests that leachate generation at the Mannum site would be minimal and would be highly attenuated in its slow passage down to the water table. The high groundwater salinities in the Murray Group Limestones attests to the minimal rainfall recharge occurring.

A typical monitoring well is shown in Figure 11.5.

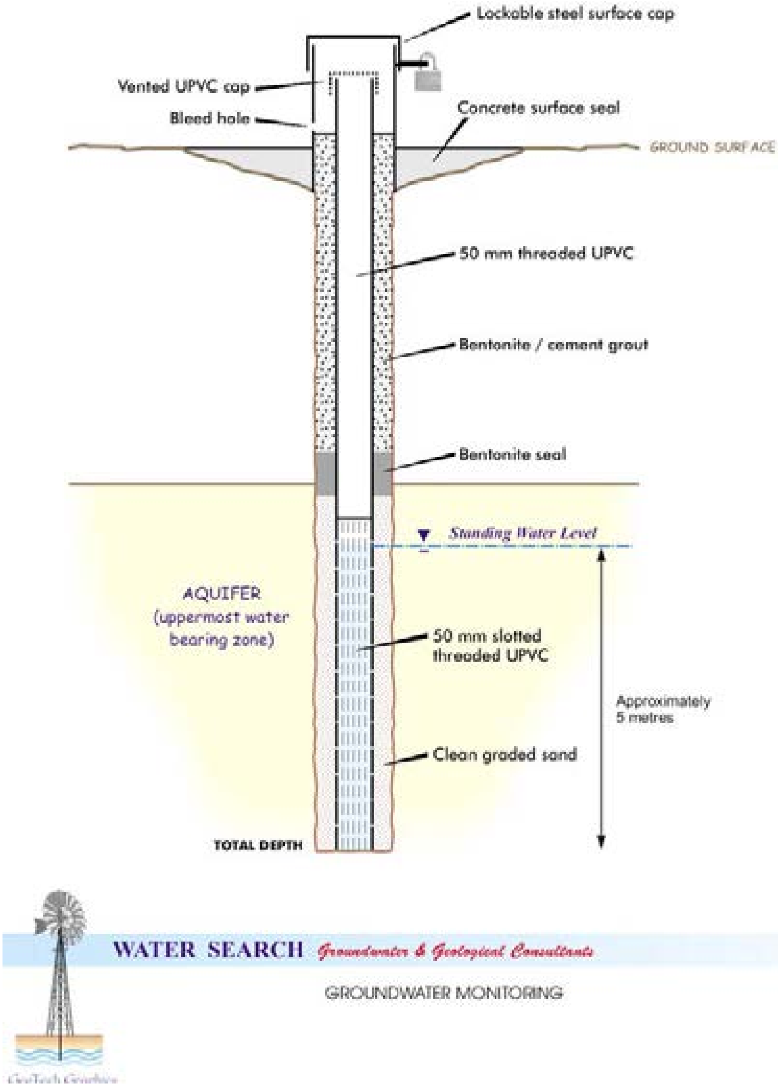


Figure 11.5 – Monitoring well construction details

Closure of the landfill area is programmed for July 2010. Final levels within the landfill area will be adjusted to prevent direct run-off to the creek which passes through the site. Detention of stormwater on the site together with monitoring of the bores will assist in the control of pollutants entering the water course.

As mentioned in Section 2.7.2 and 2.7.3 final design will give regard to the existing culvert that allows the creek to cross under Belvedere Road. Attention will be given in the final design to stormwater detention that can be provided both on the upstream side of the culvert and within the reserve on the downstream side of the culvert. These areas will give further protection to the waterways from pollutants entering from the creek.

Photos 11.3 and 11.4 show views of the landfill site where monitoring bores should be placed.

Photo 11.3 – Site of landfill up-gradient monitoring bore (within vegetated area)

Photo 11.4 – Site of landfill down-gradient monitoring bores (near Belvedere Road)

11.2.5 Floods

No development on the flood plain is allowed which increases the risk of flooding of adjacent areas. It is also a requirement that all new development be located above the 1956 flood level. Residential areas proposed for this development are all above this level, as shown previously in Figure 5.2.

In the event of flooding of the low-lying areas (encompassing the waterways, marina and wetland), floodwater will be diverted back into the river by a levee constructed south of Mannum Waters, thus protecting downstream properties.

Houseboat service points will be located above a flood level of 1 in 50 years return frequency and will be capable of isolation if inundated during larger floods. Mooring piles for houseboats will be extendable to allow for mooring at a level equivalent to a 1956 flood level.

11.2.6 Earthworks and waterways

Construction of the marina and waterways requires excavation of flood plain materials. Detailed recommendations are given in the geotechnical report for the handling of excavated material, see Appendix D. The following text outlines some of the provisions and recommendations.

(A) Banks

The marina and associated waterways will be excavated to an RL -1.8 m (that is, a water depth of 2.55 metres). The banks of the waterways will be protected from erosion by suitable plantings. The banks of the marina berths will be sheet pile.

(B) Excavations, trafficability and batters

The soils are expected to be suitable for excavation with conventional earthmoving equipment such as tracked excavators and scrapers. Temporary haul roads will be required for the movement of dump trucks due to expected poor trafficability on the soils when wet.

The following minimum batter slopes are recommended at the site:

- windblown sand (temporary and long term) - 3H : 1V
- engineered fill/natural clay (above groundwater);
  - temporary (< 4 weeks) - 1.5H : 1V
  - long-term - 4H : 1V
  - natural clay (below groundwater) - 4H : 1V
  - Natural very loose to loose sand (below groundwater) - 4H : 1V

All batters will be protected against erosion from surface water and wave action.

Normal occupational and safety requirements will apply to all excavations with appropriate shoring for vertical trenching.

(C) **Construction effects**

(i) **Potential effects**

Without adequate safeguards, it is understood that the construction stage of the project could have major environmental effects, including:

- impacts on water quality, particularly increase in turbidity, suspended solids and nutrients as a result of soil disturbance
- damage to adjacent habitats outside the actual excavation areas, from vehicle access, inappropriate spoil disposal and/or storage
- weed and plant disease spread
- dust generation affecting nearby residents
- noise generation
- increases in traffic.

The potential effects are also determined by the scale of operation and duration.

To prevent or minimize negative impacts, a Construction Environmental Management Plan (CEMP) will be prepared, which is outlined in Section 12.2

Although a CEMP is still to be prepared some comments on the management of construction activities are given in the following sections.

(ii) **General construction**

It is important to note that the project area is isolated from the river by the levee bank. Therefore most activities can proceed with minimal direct risk to the river, until the openings in the banks are created. In the first stage, the marina and waterways south of the existing sewage lagoons will be undertaken, followed by removal of the lagoons and completion of the waterways during the second stage. Excavation will precede construction of the northern inlet, southern outlet and the boat access from the river. This will allow excavation to proceed without introducing turbidity to the river.

Once excavation is complete, and compaction has taken place, the banks of the marina and waterways will be stabilized. The marina bulkheads will be sheet piled walls, while the banks of waterways will be protected by planting. Water from the river will be introduced gradually to prevent scour and resultant turbidity in the river. At this stage water will be excluded by the water transfer stations from entry to the anabranch and wetland.

Material excavated from the marina and waterways will be used to construct levee banks and as fill to form the base of roadways and raise the residential areas to design levels. Material remaining after construction of the roadways and waterfront residential areas will be used for the construction of embankments in the revegetation areas. Material excavated to form the constructed wetland will largely be used to raise the embankments that separate compartments in the wetland.

Wherever possible suitable topsoil will be identified, removed and stockpiled for spreading to achieve final design levels.

Site preparation for the first two stages of development concentrates on the marina, waterways, wetland, commercial zone, and the waterfront residential allotments. Subsequent stages concern site preparation for the high ground residential allotments, and will take place over a period of up to sixteen years for the entire project.

Ground water was encountered at a depth of approximately 1.5 m in the boreholes. This equates to around -1.6 m to -2.1 m AHD. The lower level of excavation for the waterways is -1.8 m (AHD). Some excavations are expected to slightly extend below the groundwater and dewatering from in-trench sumps should be suitable. This water will be directed to temporary ponds, where it may seep away and evaporate.

Groundwater intrusions will be closely monitored during construction. If necessary, clay lining of the waterways or a reduction of depth within the waterways can be employed along the waterways to counter any adverse conditions. It is anticipated that this may only occur at the Belvedere Road end of the north-western waterway.

Only the anabranch of the constructed wetlands will have depths equal to the waterways. All other areas will be above existing groundwater levels. Infrastructure trenches within the residential areas will be located well above groundwater levels and unlikely to have invert levels below 2 m (AHD).

The CEMP, Chapter 12 outlines the environmental procedures to mitigate any harmful environmental effects during the construction phase.

(iii) **Dust**

Dust generation from a large operation such as that proposed is also a major potential impact. Fortunately, the development is mostly separated from the existing township by high ground and significant distances as seen on Figure 2.4. These will afford considerable protection to the town from wind blown dust. Vegetation along the existing river bank is also expected to offer protection from wind blown dust from entering the river system.

Nevertheless, construction activities, in regard to dust, will be controlled by normal standards for the civil engineering construction industry and protocols of the Mid Murray Council. These are well documented within the industry. The CEMP (Chapter 12) will identify the protocols to be adopted by the earthworks contractors.

(iv) **Weeds**

Transportation of fill and movement of machinery on and off site may result in weed species being spread further on site and in the region. Weed management procedures will be implemented as part of the CEMP.

11.3 BIOLOGICAL ENVIRONMENT

11.3.1 Impact of houseboats on the River Murray

A study of the "Ecological Impact of Houseboats on the River Murray in South Australia", (Gallagher and Wigley, 2001), highlighted the environmental impacts of houseboat use. It also indicated that marinas will assist in the protection of the environment, by providing regionally based facilities, and if they are correctly located, designed and maintained. The report described how there is an urgent need for better education of river users, and how due to a lack of education and awareness damage is caused, for example:

- native timber removed for campfires
- vegetation trampled
- mutilation of trees by graffiti
- excess noise (e.g. generators, loud music, etc)
- native fauna threatened or killed by family pets
- river banks disturbed to facilitate easier access.

The report also describes how the lack of facilities results in the constant use of popular mooring locations increasing the risk of environmental degradation. It is noted to be a particular problem in the lower Murray, with issues including:

- rubbish accumulation;
- riverbank erosion;
- disturbance to native fauna, flora and important wetland areas, and
- pollution from grey water from houseboats.

A major cause of the extent and overuse of moorings along the river is the lack of suitable mooring locations.

The Mannum Waters Marina will provide much needed facilities, reducing the use or overuse of mooring sites on the river with corresponding environmental benefits. It is important to note, as pointed out in Section 11.4.1, the marina will not of itself result in an increase in numbers, but rather it will provide facilities for existing houseboats.

11.3.2 Effects on the flora habitat zones on site

(A) Riparian/wetland zone (Baseby Linear Wetland)

The existing Baseby Linear Riverine Wetlands, as indicated in Section 7, is described as having a moderate to high conservation because of its high habitat diversity. Overall, the area is described as having high biodiversity and for much of its length is in good condition. However, as is the case for most of the river front between Mannum to Wellington, there are existing management issues, particularly those areas fronting the dairy irrigation areas, including stock access, weeds etc.

With the proposed marina development, there is a need to protect the area. Therefore, a final Wetland Management Plan (refer Section 12.3.1) will be prepared which not only addresses potential impacts as a result of the development, but also the existing management issues, in order to ensure that the integrity of the area is maintained.

It is important to note that the development will not result in fragmentation of this zone. On the contrary, the establishment of the constructed wetland and revegetation areas will extend the habitat zone as well as providing a buffer.

A preliminary Wetland Management Plan was prepared by Eco Management Services (EMS, 2005). This has been modified in relation to the current development plan layout and included within the EIS. It will be further adjusted, as necessary, as part of the detailed design.

The key management issues are summarised in the following sections.

(i) **Uncontrolled public access**

Without any controls, it could be expected that that there would be a large increase in the number of people using the wetland area. In the longer term this would lead to a decline in its value, from trampling, path formation, rubbish, weed introduction, disturbance to fauna, fire, etc. This is recognised by the proponent, and the control of access to protect this area will be achieved by a number of means.

The current plan for the development was shown on Figure 2.3. Points to note are:

- There is no housing development abutting the riverine wetland.
- From the bridge crossing the waterway to the marina entrance, the riverine wetlands will be protected by a feral animal proof fence.
- There is a near continuous water barrier between the development and the wetlands. This and the placement of feral animal proof fences as required (e.g. along the southern boundary and connecting with the southern waterway), will minimise the risk of feral animals from the development, such as cats and dogs.
- Access that could occur from boats will be controlled by fencing along the base of the levee and eventually by the establishment of dense thickets of prickly species as a barrier. Signage will be placed at strategic locations, advising that the wetland area is being protected.
- As part of the development of the anabranch channel and new ephemeral wetland, a path/boardwalk route will be incorporated into the landscape plan (refer Figure 2.24). As such it would be a controlled access. Signage would be placed along the route for the information of users.

(ii) **Maintaining existing wetland hydrological regime**

There will be no changes to the existing wetland hydrological regime. As indicated in Section 7, these are significant habitat areas and the characteristics have developed around the existing patterns of inundation and drying brought about by the seasonal variation in river levels and the periodic high flows. Rather than bringing about changes, the management approach is to ensure that changes do not occur. In this regard the water levels in the anabranch channel being the same as the river will not cause changes to occur.

(iii) **Boat access to wetlands**

Boats currently have limited access to the wetland area near the proposed boat entrance to the site (refer Photo 2.8 in Section 2.3.5. With the marina basin, this is unnecessary and will be prevented. It will also afford greater protection to the nearby Aboriginal canoe trees.

Limited access is also currently available at the existing boat shed site (refer Section 3.1). Future access will also be prevented at this location.

(iv) **Rehabilitation of disturbed/modified areas**

After the marina opening is constructed, the existing boat mooring and car parking area, together with the open water front for approximately 400 metres south will be rehabilitated. Sections will be revegetated and water reintroduced to the small pool currently isolated by previous works.

(v) **Weed management**

This is a priority and is addressed in more detail in Section 12.3.4. There are a number of serious environmental weeds, which need to be eradicated and further introduction controlled.

(vi) **Feral animal control**

Feral animals such as rabbits and foxes need to be eradicated or actively managed to maintain numbers as low as possible. Measures will be put in place to minimise any potential impact of increasing domestic cats and dogs (refer Section 2.10).

(vii) **Grazing and future stock access**

Existing grazing on the property will cease. Stock will be prevented from entering from adjacent properties (refer Section 2.10) and this will further protect the existing wetland water quality

(viii) **Monitoring of ecosystem response**

Ongoing monitoring outlined in Section 12.3.1 will be undertaken to determine the effectiveness of the various controls put in place. It will also provide an early warning of any developing problems, so that remedial action can be taken. This will be based on adequate pre-development baseline data.

(ix) **Marina waterway openings**

One entrance to the houseboat basin will be developed. A water inlet channel at the northern end of the site, upstream of the development, will not be navigable and neither will a small water channel outlet to the south of the development. Each of the channels is located in an area of the levee bank where riparian trees will not be affected or where existing uses have modified the vegetation.

The location and construction of the inlets and outlets are described in detail in Section 2.3.5. No native trees, other than one dead eucalypt, will be removed. It is possible that a small percentage of the root systems of some significant river red gums may be disturbed during the construction process. However, as river red gums have very extensive shallow and deep root systems, the small losses are not expected to affect the growth and vigour of these trees.

(B) **Floodplain/swamp zone**

The flood plain is generally degraded, having been irrigated for many years through flood irrigation.

Little remains of the original vegetation due to salanisation throughout the floodplain. However, some areas would be described as a fair to good representation of a samphire/chenopod community with vegetation generally in good health. Vegetation clearance will primarily impact plant communities of this zone. A total of approximately

50 ha of vegetation will be cleared for the development with approximately 22 ha remaining. Most of the clearance will be samphire and weeds of which approx 50% is weeds (refer Photo 11.5).

Photo 11.5 – General view showing the increasing extent of boxthorn

The revegetation areas and constructed wetland will be planted with local endemic species of the original vegetation communities. A weed management program including removal of boxthorns and control of horehound will also be implemented as part of the rehabilitation works.

The environmental impacts to this zone are moderate as, although significant amounts of vegetation will be removed, a trade-off in the form of rehabilitation works mitigates the impacts from development in this area. Surrounding and terrestrial planting will be undertaken to take into account those species that prefer the drier areas of the floodplain zone.

Development of this area will not result in the loss of significant fauna habitat. Many of the species that use this zone are vagrant and highly mobile and can relocate to other areas around Mannum where similar habitat is present.

(C) **Hills and gully zone**

The impact to flora within this zone is considered to be low. There are approximately sixty mature river box in the gully, of these up to four may require removal. These are shown in Figure 11.6

Figure 11.6 – Existing trees which may require removal

Trees requiring removal will be subject to final design when every effort will be made to avoid all trees. In addition, many trees will be planted as part of the extensive revegetation and landscaping works to be undertaken throughout the development site. Additional river box will be planted in the residential parks within this zone.

Final design will be subject to normal approvals.

Weed diversity and populations on site are high. Of particular note is the number of boxthorns present. All boxthorn bushes will be removed as part of the development. Ongoing management of this species will take place if required.

Horehound is also present on site and is common on both sides of the river. Control of this weed will take place as part of the development.

11.3.3 Constructed wetlands

Section 2.8 contains a full explanation of the design basis and management plan for the constructed wetland.

(A) Objectives

The principal purposes of the wetland are:

- To rehabilitate a large area (approximately 43 ha) of degraded irrigation areas as a fauna and flora habitat.
- To improve visual amenity and provide passive recreational opportunities.
- As a water quality safeguard, with a 6 ha area of the wetland having the capacity for treating throughflows (refer Section 11.2.1).

(B) Water requirements and habitat

The wetland is designed to provide part-ephemeral flows that mimic natural cycles of inundation and dry periods, and part-continuous flows. Control of the flow through the wetland will be by diversion weirs and water pumps. The wetland is divided into separate ponds, each supplied with water from a distribution point.

The ponds will be cycled through wet and dry conditions over a period of two years. The wet period will be up to twelve months. This allows the establishment of a range of dry wetland bed plants and the completion of their lifecycle, so that a seed bank is ensured. It also provides the conditions for the establishment of emergent vegetation (macrophytes).

During periods of full inundation in early spring to late summer, macrophytes, algae and biofilms develop and these, together with the emergent macrophytes, support a diverse range of macro-invertebrates, fish, amphibians and birds.

The anabranch and levee banks of the wetland will be planted with river red gums over a lignum understorey. While the full establishment of these plantings will take some years, in time the area will come to resemble the existing riparian zone and will provide a diverse habitat for native fauna.

(C) **Nuisance insects**

Nuisance insect problems, including mosquitoes (Family *Culicidae*) and midges (Family: *Chironomidae*), usually only occur when there is insufficient predation to control numbers. Problems only occur where there are temporary water logged areas, ditches, rainwater tanks etc. it is not expected to be an issue with the marina waterways as there will be a diverse aquatic community, particularly fish, which as found elsewhere will control the numbers. Experience with constructed wetlands is that they are not sources of problems, as there is sufficient natural control, particularly if native fish are present.

11.3.4 Revegetation

As already indicated earlier in Section 2.9.3 and shown in Figure 2.39, large areas of the flood plain, adjacent the constructed wetland and riparian wetland zone (approximately 10 ha) and the existing wastewater treatment lagoons site after their removal (approximately 5 ha), will be revegetated. This will:

- Provide an important buffer zone between much of the project area and the more sensitive areas.
- Provide additional fauna and flora habitat.
- Improve visual amenity.

The areas adjacent to the constructed wetlands are saline samphire areas as described in Section 7.4.

To overcome this, the ground will be sculptured to create height diversity with low mounds, between 0.3 – 1.0 (refer Mannum to Wellington LAP, Revegetation and Vegetation Guidelines, undated). A range of species are suitable for these areas, including the shrubs *Melaleuca halmaturorum and Myoporum insulare*. As recommended in the guidelines, these could be planted in blocks. In the revegetation plan, species which are endemic to the area will be included. As many species as possible will be included.

A large part of the wastewater treatment lagoon site will also be vegetated. However, to start with this is not as saline. A detailed plan will be prepared so that as the lagoons are decommissioned, a suitable land form is left for selected species.

11.3.5 Improvements in biodiversity

Taken together, the establishment of a large wetland and revegetation of the flood plain, riparian and hill and gully zones will benefit the biodiversity of the area.

The waters of the marina will provide an environment for many submerged plants as well as habitat for a host of fish, crustaceans and other aquatic fauna. The presence of street and garden trees in the residential areas will add continuity of vegetative cover allowing bird, bat and other fauna movement between the riverfront wetland and the highland woodland.

In all, a number of local vegetation communities and fauna habitats will be established around and within the marina facilities. These are:

- flood plain vegetation which could consist of a dense shrubland of lignum (*Muehlenbeckia florulenta*) and rushes (*Cyperus gymnocaulos* and *Juncus* sp.), *Melaleuca* and Myoporum shrublands
- constructed wetland, with a range of macrophyte and riparian vegetation zones. These will offer some habitat for reed bed dwelling fauna and expand the distribution of aquatic plant species. Sheltered open water and reedy edges will offer habitat for migratory species as well as local terrestrial and aquatic birdlife
- additional plantings of river box (Eucalyptus largiflorens) within the gully and adjacent foot slopes
- mallee vegetation over the highland zone.

There will be no fragmentation of the existing important Baseby riverine habitat. The above activities will enhance the existing habitat as well as providing a buffer.

Importantly, a management plan will be developed to protect the existing Baseby riverine wetlands, including the minimisation of existing threats, e.g. weeds, grazing and willow removal. This will protect the biodiversity values of these areas.

11.4 SOCIO-ECONOMIC ENVIRONMENT

11.4.1 Population

In Chapter 8 it was noted that the population of Mannum and its immediate surrounds has fluctuated markedly over a twenty year period, due in part to the decline of traditional rural industry, and the rise in short-term visitors and retirees. The population continues to fluctuate greatly as homes that are usually vacant are occupied during holiday periods.

Mannum currently has a population slightly over 2100 people. The number of dwellings is 1200. The number of people per full-time occupied household is currently 2.21. The age distribution is skewed towards an older population than is the case for South Australia as a whole.

When Mannum Waters is fully developed, there will be an additional 560 houses, or an increase of 45 per cent in the number of dwellings. It is not possible to predict how many of the households will be occupied full-time, and how many will be used for holidays, but if the same ratio of full-time to part-time occupancy is used as is current in Mannum, the permanent population increase could be slightly more than 1000 people. If, as is likely, the proportion of new houses used for holidays is greater than at present, the increase in the full-time population will be less than 1000. However this estimate does not take into account the other housing development currently underway in Mannum. These include; Paddlesteamer Estate, Ramm Road (now releasing Stage 3) and Shearer Heights. All developments, combined, have approximately 100-150 allotments available but do not include houseboat moorings.

Peak residential population during holidays is difficult to predict, since many people share holiday homes and children make up a much more significant proportion of the short-term population than the permanent population. Using the same ratio of full-time to part-time occupancy as before (taken from the current Mannum statistics), there could be as many as 100 holiday homes. If these were fully-occupied by (for example) a family of four, the peak population would be increased by 1400.

Some increase may be attributed to permanent houseboat residence. As the occupancy rate in permanent houseboats is anticipated to be less than 2, the actual increase in population attributable to permanent houseboat occupation is not expected to exceed 100 persons. The provision of general houseboat moorings will not in and of themselves increase the overall population of holiday makers visiting the region. The marina at Mannum Waters will merely move existing houseboats off the river. This will concentrate the visitors in one area, but tourists are unlikely to remain at the Mannum Waters' mooring during their holiday. They will motor up and down the river.

11.4.2 Houseboats

(A) Model for distribution of moorings along the river

The length of River within the Council area is 140 linear miles and therefore the current supply within the Mid Murray Council Area is sufficient on a proportional basis to achieve the recommendations in the Houseboat Study.

As noted, based on anecdotal information and the distribution (refer Table 5.5), the demand for moorings is stronger closer to Adelaide metropolitan area by a ratio of around 3:1. Hence, of the additional moorings required along the River, i.e. 400, a total of 300 would be appropriate within the Murray Bridge and Mid Murray Council areas.

An increase in supply in the Mid Murray Council area in the order 150-200 moorings would be appropriate.

(B) Preferred locations for new mooring sites

The Houseboat Study did not canvass the pre-conditions for establishing new houseboat moorings, other than to identify the associated benefit of increased access to services for houseboats, as a means of enhancing environmental management, viz:

- waste pump-out facilities (black and grey water)
- higher standards for fuel distribution
- managed land areas around moorings (litter and vegetation management).

One location consideration is the regular distribution of mooring sites along the River, preferably no greater than four hour's boat driving time between each facility.

Another location logic in determining the spatial distribution of marinas, (or mooring sites), is to achieve an association between mooring sites/marinas and urban centres (defined as either Country Townships or Service Centres in the Development Plan).

The coincidence of both will:

- enhance access to services
- promote efficiency in service delivery and minimize environmental impacts.

By reference to the Mid Murray Council Development Plan, such centres in the area, and the potential distribution of moorings, based on the ratio of 3:1 would be as set out in Table 11.3.

Table 11.3 – Potential distribution of moorings, Mid Murray Council

Urban Area	Population (ABS 1996)	Moorings		
		Current	Potential Additional	Total
Country Townships:				
Mannum	2000	120	100-150	230-270
Morgan	450	45		
Service Centres:				
Swan Reach	260	-	40-50	97-107
Blanchetown	230	-		
Cadell & environs	470	-		
Other	N/A	12		
Total:	-	177	150-200	327-377

Based on the premise that additional moorings will achieve more effective environmental management along the River, and every houseboat will be required to be tied up at a registered mooring, additional houseboat moorings can be justified in the Mid Murray Council area generally, and at Mannum in particular.

(C) **Houseboat moorings – preferred location in Mannum**

Mannum is a logical location for development of additional houseboat moorings based on:

- its Major Centre designation, (together with Morgan), see Mid Murray Council Development Plan Map MiMu/1 (Overlay 1)
- the absence of a marina at Mannum of any substantial scale which has direct access to the town and which provides for itinerant boaters
- documented conflicting activities on the town's public waterfront (see Mid Murray Consolidation PAR 25 November 1999)
- Ongoing management and access issues along River Lane, which is the location of permanent waterfront dwellings and tie-up for houseboats (both private and commercial operators).

Within the Mannum township, around 100 to 150 additional moorings would assist in achieving the Houseboat Study's objectives.

Within the vicinity of Mannum township, the available locations for a marina can be divided into three options, viz:

- immediately across the River
- immediately upstream
- immediately downstream.

(i) **Across the river from Mannum township**

Land use on the opposite side of Mannum township is dominated by irrigated river flats of a substantial scale (consistently in the order of 1000 metres from the river channel) which is interspersed with shack settlements upstream of the River ferry crossing. The disadvantages of this location for a marina development are;

- the requirement to use the ferry for vehicular access to moorings, and
- the poor relationship of land suitable for housing development to the River channel itself (around 1000 metres), which creates physical, operational and commercial disadvantages.

In terms of sites of importance to Aboriginal people, there are approximately 40 sites evenly distributed along the River channel and at the interface of the floodplain and highland which is a further disadvantage.

(ii) **Upstream from Mannum township**

For a distance of 7 km immediately upstream of Mannum is the water body known as *Mannum Swamps* which adjoins the River channel and is classified as *High Conservation Value* in the *Wetlands Atlas of the South Australian Murray Valley*. The recommendations for future management for the wetlands identify *Mannum Swamps* a priority location for protection and native species regeneration.

On environmental grounds, the location is inherently unsuitable for development of houseboat moorings or a marina.

(iii) **Downstream from Mannum township**

In close proximity to the Mannum urban area, the land form downstream from Mannum provides a balance of floodplain and highland located between 170-300 metres from the River channel. Additionally, the land in the floodplain comprises largely abandoned flood irrigated pasture land which is highly degraded.

There are Aboriginal heritage sites in this locality, but they are small in number and their distribution means there is potential for them to be protected and integrated in future development of the locality.

The highland has a natural form with potential to accommodate development of facilities to service a marina and residential development. The locality adjoins town public facilities such as the golf course which is an advantage, and the town sewage treatment works which is a disadvantage, but which is capable of being adequately managed through separation distances or relocation of that facility as proposed.

Vehicular access between the Mannum urban area and the locality is somewhat circuitous, if sensitive locations such as River Lane are to be avoided. Nonetheless, it is superior in this regard compared to the area across the River that would require a ferry crossing to access services in Mannum. Additionally, direct non-vehicular access has the potential to be very convenient between a marina facility and the town centre.

Of the three locations considered for development of a marina in proximity of the Mannum urban area, an area downstream is assessed as having the highest potential for development of a marina based on:

- proximity to urban services;

- minimal potential for environmental and heritage impact;
- highest potential for environmental improvements, and
- most suitable landform for development of non-aquatic marina facilities and housing.

11.4.3 Heritage

(A) Aboriginal heritage

The preservation of Aboriginal cultural heritage has been explored and identified in Chapter 10

(B) Heritage buildings

There are no buildings of heritage significance on the site. Reschke's existing home is the only substantial structure and this will be retained within the proposed residential area. All other buildings (sheds) will be progressively removed during the development.

(C) Shipwrecks

The location of shipwrecks is discussed in Section 5.6. This identifies that the shipwrecks are located sufficiently distant from the project that there will be no impacts as a result of the development.

11.4.4 Economic effects

Details of the economic impact assessment are in Appendix J. This section summarises the findings.

(A) Estimating economic and employment effects

The principal economic effects are related to both the construction of Mannum Waters and its ongoing operation, including the purchase of lots and construction of homes on these lots. The proposed development has the potential to provide a significant economic stimulus to the Mannum region. A model was used to predict the economic effects that the project could have on the local economy over its lifetime.

The model uses an input–output method. Input–Output tables for the years 2002 and 2003, for the Murraylands region of South Australia (developed by Econsearch Pty Ltd), have been sourced as a methodology for assessing economic impacts. The economic impact assessment has been undertaken to identify the potential jobs and incomes that may be associated with the Mannum Waters development.

Job and income creation are critical elements of the social agenda for economic regions. Economic and social developments are therefore intertwined, providing a strong correlation between economic growth and social indicators such as unemployment and crime rates.

An accepted methodology for measuring economic outcomes, one that is used nationally and internationally, is to measure the value added and employment associated with investment or turnover outcomes. Value added is defined as the extent to which the local economy adds value to the product supplied, and essentially is the return to labour and capital in the region for that activity. It represents the incomes to labour and capital. It is consistent with the predominant national measure of economic activity i.e. Gross Domestic Product (GDP).

This value added and employment impact can be measured at two levels. Firstly there is the direct impact – the value added and employment contribution, or share, associated directly with the expenditure (e.g. the labour and profits involved in construction activity). Secondly there is the indirect impact – for example, that associated with the suppliers to the construction service and the spending of wages. The following construction multipliers have been obtained from the Input–Output tables for the Murraylands region.

Table 11.4 - Murraylands construction sector multipliers (2002–2003)

Sector	Units	Value
Employment	$ x 1,000	0.009676
Value added	$ x 1,000,000	0.755

The multipliers shown in Table 11.4 mean that $1 million of construction output (in 2002–2003) would have resulted in the employment of 9.6 persons (directly and through the multiplier effects). The value added (salaries, wages and profits) associated with this activity is $755,000.

The following sections estimate the employment and value added impacts of the Mannum Waters development on the region, based on the above multipliers. The following additional notes and assumptions are made:

- value added is defined as returns to capital and labour (salaries, wages and profits)
- employment is defined as full-time equivalent (FTE) employees
- as the Input–Output tables were prepared in 2002–03, they do not incorporate movements in the value of money (inflation) since that time. Without adjustment, this would result in an overestimation of the number of jobs generated per $1 million of increased production. Australia's rate of inflation has fluctuated in recent years but has consistently been below 5 per cent. A deflator of 2 per cent per annum is considered appropriate and is applied to new expenditures to adjust for inflation during the period from 2003 to 2006
- there may also have been structural and other changes in the regional economy during this time and consequently this is not reflected in the tables. For example, structural reform may have improved the efficiency of some industries thereby leading to shifts in the relationships between economic inputs and outputs
- as this assessment is based on the Murraylands region only, adjustments may have to be made for 'leakage' of economic activity from the region as in future people employed in the region, and on the project, may reside elsewhere
- the Input–Output tables provide multipliers across a broad range of industries. For the purposes of this assessment the construction sector's multipliers have been used as it is assumed that the majority of expenditure will go into capital works and other construction and economic activity.

(B) **Tourist activity and investment**

The Tourism focus for the development will take the form of the following key initiatives all of which build on existing activities enjoyed by visitors to Mannum. Information from the Murraylands Regional Tourism Profile (SA Tourism Commission) indicates that the bulk of tourism activity to the region comes from intrastate visitors who tend to stay overnight. The proximity of Mannum to Adelaide reinforces the opportunities for short term stays and the Mannum Waters development will add not only to the supply of accommodation and recreational activities but also to the range and quality of the products.

These are:

- The marina area which will provide long and short term moorings for houseboats, and adjacent picnic area, a commercial area which can provision and offer chandlery facilities for houseboats. As indicated elsewhere in this report (refer Section 5.3) houseboat numbers, registered on the river has increased by more than 40% over the past five years and the proposed marina will cater as a modern facility with sustainable environmental practices for this level of demand.
- Potential short term stay accommodation in bed and breakfast, and holiday rental of housing.
- The wetlands with a walking trail and associated interpretive signage and media.
- The Golf Course with the opportunity for improvement to the existing nine holes and an extension to eighteen holes. There may also be a future possibility of improved clubhouse facilities and accommodation associated with the golf course.

The level of Tourism related investment is taken account of in the overall development figures that are detailed later in this Section. Also, as indicated it is difficult to estimate the full impact of the tourism component in the development because the detailed nature of the future tourism at this stage is unknown

(C) **Employment opportunities**

As indicated above, analysis has been undertaken of the impact of the development on the Murraylands Region and this has been expressed in value added and employment outcomes. The impact of the development and employment outcomes are given in Tables 11.6 and 11.7. The direct impact on the project will be significant employment activities from major construction in the first five years of the development associated with the site works, marina development and infrastructure provision, in particular road construction. In concert with this and over the life of the project will be building construction employment involving the commercial area and housing.

On going employment will be directly associated with managing and maintaining the marina and its associated commercial operations including the retail, hospitality and tourism activities.

Indigenous employment is a part of the proponent's desire to involve the local workforce as much as availability and skilling allows. As the development proceeds indigenous representatives will be required on site at some excavation sites. It is anticipated that the building of the residential homes would provide direct long-term employment opportunities for the local indigenous wider community.

An on-going enterprise that can involve indigenous input and employment is the proposed Interpretive Centre. The theme of the Centre would be based on all aspects of the river and wetlands environment and the indigenous culture of the region. The Interpretive Centre would provide opportunities for indigenous involvement and also employment. The indigenous community may choose to have equity in the centre, as has occurred with many other interpretive centres, and train and then employ local indigenous people in many functions of the facility including retail, ticketing, management, cultural entertainment etc. This initiative has a high likelihood of fitting in with the Commonwealth Government Regional Partnership Agreement models and there may be an opportunity for a partnership between the indigenous community, the developer and the Commonwealth Government. Financial assistance may be forthcoming from the Aboriginal Land Trust.

(D) **Attraction and enhancement of business**

The development at Mannum Waters includes provision for:

- tavern and licensed restaurant
- general store
- public toilets
- playground and picnic area
- boat chandlery
- parking area (including provision for boat trailers)
- information centre (including interpretive centre on al indigenous culture and wildlife)
- marina offices (including provision for commercial boat operators).

The decision to provide a limited range of retail and commercial services is deliberate because it reduces the potential for Mannum Waters to 'compete' with established services in Mannum, such as the store and the hotel. With an increase in the number of residents and visitors, it is considered that existing services will not be adversely affected. With this in mind, there will be two major impacts on the local area and regional business through multiplier impact. This will be through the development and operational phases of the project.

(i) **The development phase**

The economic contribution to be made by the project during the development phase will depend on the final nature and scale of the project. However, for the purposes of this economic assessment, the assumptions in Table 11.5 are made.

Based on these assumptions and economic multipliers, the annual economic impacts shown in Table 11.6 are estimated (an inflation factor of 2 per cent per annum has been applied to account for inflation since 2003).

Table 11.5 – Development schedule (2006)

Year	Construction capital expenditure ($)	Maintenance expenditure ($)	House construction numbers	Housing construction value ($)
2008/2009	7,500,000	375,000	0	0
2009/2010	7,500,000	750,000	90	18,000,000
2010/2011	1,200,000	810,000	85	17,000,000
2011/2012	650,000	843,000	78	15,600,000
2012/2013	650,000	875,000	25	5,000,000
2013/2014	650,000	908,000	25	5,000,000
2014/2015	650,000	940,000	25	5,000,000
2015/2016	650,000	973,000	25	5,000,000
2016/2017	650,000	1,005,000	25	5,000,000
2017/2018	650,000	1,038,000	25	5,000,000
2018/2019	650,000	1,070,000	25	5,000,000
2019/2020	650,000	1,103,000	25	5,000,000
2020/2021	650,000	1,135,000	25	5,000,000
2021/2022	650,000	1,168,000	25	5,000,000
2022/2023	650,000	1,200,000	25	5,000,000
2023/2024	400,000	1,220,000	25	5,000,000
2024/2025	0	1,220,000	16	3,200,000
Total	**24,400,000**	**16,633,000**	**569**	**113,800,000**

Table 11.6 – Estimated economic and employment impact

Year	Full-time equivalent jobs[1]	Value added ($)
2008/2009	72	5,970,000
2009/2010	234	19,400,000
2010/2011	173	14,340,000
2011/2012	155	12,850,000
2012/2013	59	4,890,000
2013/2014	60	4,970,000
2014/2015	60	4,970,000
2015/2016	60	4,970,000
2016/2017	61	5,060,000
2017/2018	61	5,060,000
2018/2019	61	5,060,000
2019/2020	61	5,060,000
2020/2021	62	5,140,000
2021/2022	62	5,140,000
2022/2023	62	5,140,000
2023/2024	60	4,970,000
2024/2025	40	3,320,000
Total	**1,403**	**116,310,000**

1 Note: The above estimated employment impacts are annual and not cumulative i.e. employment associated with the project is expected to peak at 224 in 2010/2011.

(ii) **The operational phase**

The Mannum Waters development will provide a continued economic contribution to the local economy after the construction has been completed. Expenditure by the new residents on local goods and services is an example of the continued economic impact. By the completion of the development, it is expected that there will be an average population increase of approximately 900 persons. This figure is based on 569 new houses, with an expected lower than average number of occupants per household due to retirees and holiday housing.

Based on the median weekly household income of $500 for South Australia, and assuming an initial leakage of 50 per cent, it is estimated there could be a direct injection into the local economy of up to $8.6 million annually. This also allows for income to permanent houseboat dwellers.

The overall economic impact of the development in full operation is difficult to estimate as the nature of future tourism and other industry development is unknown. However, as already noted, the Input–Output tables for the Murraylands region provide multipliers across a broad range of industries. Regional value added and employment multipliers for the retail sector have been extracted from the 2002–2003 tables and are shown in Table 11.7.

Table 11.7 – Murraylands economic multipliers

Sector	Employment multiplier	Value added multiplier ($)
Retail	0.009676	0.738

Interpreting the economic multiplier in Table 11.7, every $1 million spent by residents or visitors, could impact on the economy by:

- an additional $738,000 in value added (salaries, wages and profits)
- an additional nine jobs per annum (adjusted for inflation).

Table 11.8 shows the estimated economic impacts for the operational phase of the Mannum Waters development.

Table 11.8 – Estimated operational economic impacts

Item	Employment (FTE/y)	Value added ($/y)
New resident expenditure of $8.6 m per year	77	6,300,000

(E) Costs of infrastructure to government

(i) **Traffic**

Mannum is a growing community and over time this growth will generate additional traffic movements. A traffic and parking report was prepared by Murray F Young and Associates for Mannum Waters to consider the impacts both externally and internally to the development. The report is contained in Appendix K.

The review indicates that the proposed development will cause relatively low increases in the traffic volumes for the Adelaide-Mannum Road and that these will not be a traffic capacity issue on the main road (refer Section 11.4.5).

(ii) **Wastwater treatment**

The proposal to treat waste water through a new plant, to be constructed by the proponent, will minimise costs to the State Government and the process of shifting the wastewater treatment lagoons off the Murray River floodplain is a major benefit.

(iii) **Water and power**

All internal water and power reticulation will be the responsibility of the Development at its cost and any necessary new or upgrades to trunk services to the site will be the subject of augmentation negotiations.

(F) **Long term costs and benefits to Council**

The development can minimise much of its externality impacts.

Major capital investment in stormwater can be contained within the site with no external new developments by Council. On-going maintenance of stormwater will be minimised by sustainable design practices.

The overall design of the streets, reserve areas and landscaping will provide a manageable, low maintenance and sustainable area for future maintenance by the Council.

The proposed waste water plant is seen as a major benefit to the town of Mannum. The benefits of the plant will be removal of the wastewater treatment lagoons and additional reclaimed water to irrigate the golf course and other reserve areas.

The marina will remain as a private operation with on-going costs and possible upgrade activities in the future met by the fees from users and private capital investment based on commercial decisions. A major benefit of the marina is the location of houseboats away from the river frontage to a more controlled location.

As indicated in Section 11.4.5 the development will have an impact on traffic at the construction stage. In addition, when fully completed, the 569 houses on site will generate traffic at the estimated rate of 3 to 4 trips per day as well as other traffic associated with use of the marina and its associated activities.

Consequently, there will be additional traffic travelling through the township, with significant impacts at the intersections of:

- Belvedere Road/Ramm Road/Berryman Avenue
- Adelaide Road/Ramm Road.

The capacity of these intersections is not regarded as an issue but minor works including marking, signage, street lighting and possibly a roundabout may need to be considered. As these are issues which relate to the existing road network, solutions need to be explored in conjunction with Mid Murray Council.

Also noted is a minor access road which enters Belvedere Road on the north side near the development. The access road has poor site distance which may be corrected during upgrades of Belvedere Road.

A major benefit to the recreation resources of the Council will be the possible upgrade of the Golf Course to a higher standard and an additional nine holes. This opportunity will be the subject of negotiations between the proponent, Mannum Golf Club and the Council and it also may involve other facilities such as accommodation and club house. There will be on-going advantages to Mannum in having higher standard golf facilities as it will provide an attraction to other long and short term users.

(G) **Benefits of construction program**

The benefits of the construction program are outlined in the Development Phase of the project as indicated previously in this Section. The development will contribute 1,403 man-years and $116 million of value adding over the projected seventeen year period out to 2024/25.

(H) **Development of financial strategies**

The proponent is a company formed with a range of shareholders who have experience in development projects. The consortium consists of equity capital and the ability to raise the necessary construction funding in accordance with the market demand.

The proponent will be responsible for the provision of all internal infrastructure to support each stage of the project.

The infrastructure responsibilities of the proponent are to:

- construct and install at its cost all infrastructure associated with the residential development;
- construct the marina berths and associated infrastructure;
- construct all waterways, edge treatments and marina entrance required for the development; and
- construct the wetlands area and associated infrastructure, embankments, revegetation areas;

All of the works are to be undertaken on a staged basis to ensure the economic sustainability of the development program.

The proposed development will require investment on infrastructure such as entrance road upgrades, electricity supply, remediation of waste water treatment lagoons, waste water treatment plant and water supply. Discussions have taken place with the providers of these utilities in order to ascertain the scope of works required and the quantum of charge that may be anticipated once a more detailed engineering design has been undertaken. Discussions will continue to occur with the State Government agencies in respect to assistance; as such investment would have significant positive multiplier effects within the economies of the local and wider community.

The maintenance of the marina berths and associated infrastructure will be the responsibility of the Community Corporation. The Corporation will change marina berth owners a levy to cover costs including maintenance.

The maintenance of waterfront jetties will be the responsibility of the individual waterfront allotment owners.

The Council will be responsible for the maintenance of public facilities, park reserves, roads, toilets and all waterways not being part of waterfront land titles and marina berths. The Proponent proposes the Council establish a Waterways Long Term Maintenance Fund as follows:

(l) **Waterways long term maintenance fund**

A special purpose fund to provide for the long term maintenance of the marina waterways and edge treatments will be funded by allocating 50% of rates raised from all rateable marina berths and a levy on owners of waterfront jetties. Based on a contribution of $40,000 p.a. to the fund from the share of rates the fund would increase in value to $520,000 after 10 years and $1.4 million after 20 years. This compounding fund should be more than sufficient to provide for the long term maintenance of the marina waterways, entrance and edges.

11.4.5 Noise

An environmental noise assessment of the proposed Mannum Waters development was undertaken. The assessment was based on an understanding of the residential layout, water treatment plant and the houseboat zone, which includes the light commercial zone. A copy of the report is contained in Appendix L.

Noise sources with the greatest potential to cause noise annoyance to residences within the development are considered to be traffic on the proposed roads, equipment at the wastewater treatment facility, on-board houseboat equipment, and noise from activities within the commercial area. The principal findings of the analysis included the following:

- the expected nature and number of traffic movements along roads within the development will result in traffic noise levels at residences that, with no specific acoustic treatment in place, will be well below the ‘desirable ranges’ of the most recent Road Traffic Noise Guidelines (Transport SA)
- the wastewater treatment equipment will be located approximately 300 m from the nearest residence, and no specific acoustic treatment is contemplated. Noise levels at the closest residence from the equipment are predicted to be approximately 35 dB(A). This level is well below the 45 dB(A) recommendation of the World Health Organization (WHO) to protect against sleep disturbance.
- noise levels from the use of equipment on houseboats would be controlled by providing mains power access to moored houseboats, and ensuring that on-board generators are not used within the marina
- the commercial area will be designed to ensure that the noise from each activity within the area achieves relevant noise criteria when measured at the closest residences.

11.4.6 Community services and infrastructure

Mannum Waters will be developed over a period of some 16 years. In other words, essential services such as health, education, fire, police and aged care services will not face a sudden population increase.

(A) Community services

(i) Health services

The Board of the hospital has indicated that the staged development of Mannum Waters can be accommodated by its existing plans for the provision of in-patient and general practitioner services.

(ii) Educational services

It is unlikely that Mannum Waters will have a significant effect on the number of school-age children living in the area. Families with school-age children tend to live near centres of employment, not rural towns.

The existing school and TAFE facilities are capable of accommodating a small increase in numbers, and existing arrangements for pupils to attend regional schools can also accommodate an increase in numbers.

(iii) Emergency services

Policing services for Mannum form part of the Local Service Area (LSA) which extends from Murray Bridge to Mount Barker, some 17,000 km^2. There is a police station in Mannum, which operates during business hours from Monday to Friday.

Police have expressed a concern that the Mannum Waters development may increase the number of vacant houses, which tend to attract vandals. Mannum Waters will be developed over a period of some 16 years: in other words, there will not be a sudden increase in vacant houses. Mannum Waters will also employ an on-site manager and will have a significant resident population. These factors will mitigate against a rise in vandalism and larceny

(B) Infrastructure

Major upgrades will be made to the waste water system for the Town of Mannum, the electricity supply, the water supply, the sealing of Belvedere Road from the northern access of the Mannum Waters development to the town as well as other traffic management and safety measures. These are fully described in Chapter 2.

(i) Electricity supply and public lighting

Current power lines which traverse the site will be removed. New underground electrical services will be provided by the proponent in accordance with the normal land development requirements. Adjoining users will be connected to the new services at the southern end of the site.

ETSA utilities have indicated that augmentation is possible from the Mannum sub-station with minimum impact on major services. It is likely that augmentation of the electrical supply can be undertaken in stages.

Public lighting will be supplied as a normal provision at each stage of the development.

(ii) **Water supply**

Water supply will be constructed to the requirements of SA Water by extension of the existing Mannum water supply along Belvedere Road. Normal construction techniques and environmental controls will apply.

On-going operation and maintenance will be the responsibility of SA Water.

(iii) **Roads and traffic generation**

A traffic and parking report was undertaken by Murray F Young and Associates for the proponent concerning the proposed development and is included as Appendix K.

Construction

During the construction stages of the project the major movement of material for earth works will be on-site.

There will be a need to transport construction materials to the site for the marina and for the construction of buildings, roads and landscaping. It is possible to direct heavy vehicle traffic to a defined route that lessens the impact on the town and local roads. The number of truck and heavy equipment movements has been estimated in Table 12.2 as 18 trips (9 to the site and 9 from the site) per day on those days in which construction is occurring.

Pavement conditions of the existing road network will be monitored to ascertain any remedial measures that may be required as a result of heavy vehicle traffic and hours of operation will be restricted to avoid affecting the amenity of adjacent residents if this becomes necessary. Traffic will be generated by housing construction but this will be staggered over many years and not considered a significant impact.

Long term

Traffic generation at Mannum Waters will be less than that generated by a standard residential area and is estimated at around three to four trips per dwelling per day. The details of this assessment is contained with the consultant’s report (refer Appendix K)

On completion of the full development, it is estimated that the peak hour trip rate will be approximately 120 trips (both in/out) due to the residential allotments and 50 trips (both in/out) due to the houseboats. This is a total of 170 trips per hour both in and out of Mannum Waters. Of these trips approximately 75% are expected to use the main entrance and 25% secondary access road

Based on 85% of traffic travelling to and from Mannum and the remainder to and from Murray Bridge the split would be:

- main entrance - 100 vehicles per hour to and from Mannum and 30 vehicle per hour to and from Murray Bridge.
- secondary access – 30 vehicles per hour to and from Mannum and 10 vehicles per hour to and from Murray Bridge

Road design

Preliminary recommendations have been made within the traffic and parking report for road design components and parking. These have been adopted within the proposal (refer Section 2.7). Further recommendations will be provided during final design of the road network which will be undertaken in accordance with accepted practice.

11.4.7 Resource management

Important natural resource management initiatives are included in the development as described in the following sections.

(A) Water

Measures to conserve water use include:

- Stormwater - As described in Section 2.7.2, a range of water sensitive urban design measures are incorporated into the design, both to reduce the draw on the mains and river and protect river water quality.
- Reuse of reclaimed water - It is intended that all wastewater will be reused. Reclaimed water to Class B quality standard would be available for use at the golf course as at present and also for other irrigation purposes. Depending on the availability of reclaimed water it is also possible that reclaimed water could be returned to a section of the residential area as Class A quality water for the flushing of toilets and other garden uses. This consideration will be subject to final design and negotiations with SA Water as the development of the new wastewater system proceeds.

(B) Energy conservation

(i) Building design

A whole-building design or a systems approach to development is proposed as part of the design guidelines, which considers the interaction of all elements of the building site, building envelope, mechanical systems, and occupants to help achieve optimal energy performance. The key is to reduce the house load (energy use) using the best combination of:

- conservation (insulation, efficient lighting and appliances, house orientation)
- insulation (solar gain)
- thermal storage (mass in walls and floors which helps keep the house a more constant temperature).

The emphasis on each should vary on a site-by-site basis. Most energy-efficient homes have four basic elements in common:

- a well-constructed and tightly sealed thermal envelope with appropriate ventilation
- proper design and installation of heating and cooling systems (properly sized, high-efficiency, energy source, ventilation and ductwork)
- energy-efficient doors, windows, and appliances
- home orientation and placement of building elements to maximize natural heating and cooling efficiency.

For typical design guidelines refer comments below in (E) of this Section. The design guidelines will supplement the House Owner's Charter and indicate and encourage specific ways that individual house owners and builders can achieve energy efficiencies in the development of sustainable housing.

(ii) **Pumping**

Power will be required to run the pumps located at the water transfer stations. These pumps are particularly efficient as the lift of water from the marina water-body and the water ways to the anabranch is very small (< 1m). At this stage, investigations into alternative power supplies (i.e. solar and wind) has not yielded an acceptable alternative solution to the normal reticulated power supply. The considerable amount of revegetation within the development will yield significant carbon credits however an alternative power source will be further investigated during detailed design.

The amount of pumping required is unclear in regard to maintaining an acceptable quality within the development's water-bodies. Based on full-time pumping the annual costs are estimated at less than $14,000/annum.

(C) **Irrigation systems**

Irrigation systems throughout the development for the maintenance of open spaces will adopt water saving techniques. The following design guidelines and standards apply to irrigation design in the development:

- water wise design principles should be incorporated into irrigation designs for planting and grass areas
- water usage shall be in accordance with SA Water legislation, with respect to watering times and hours
- where in-ground irrigation is installed within grass, no part is to protrude above ground level except for pop-up sprinklers during operation
- the location and type of spray outlets should be selected to avoid water spray onto roads, crossovers and paths and other paved areas
- irrigation controllers and valves shall be installed within the reserve property boundary
- lateral pipe work shall be buried a minimum of 300mm below ground level
- mains pipe work shall be buried a minimum of 450mm below ground level
- the intent of these provisions is to ensure that earthworks and drainage systems are developed to maximise the on-site infiltration of stormwater and water from irrigation and to prevent any lateral adverse impact on existing wetlands, watercourses and water bodies
- where a site is adjacent to a natural aquatic system, earthwork design shall provide for surface runoff to be contained within the site rather than into the natural system
- earthwork design shall incorporate features and functions of the landscape's natural drainage system, wherever possible and shall maximise onsite retention and infiltration of rain and water from irrigation. Gradients for public grass areas shall be equal to or flatter than 1:6 and equal to or flatter than 1:3 for planted areas. Run off of hardstand areas shall drain to adjacent landscaped areas
- irrigation within planting areas shall be by emitters, bubblers or soaker type hose

- grass shall be irrigated using pop-up sprays or gear drive sprinklers. Sub surface irrigation may also be considered

The intent of these provisions is to ensure that irrigation systems are designed and installed to provide reliable water sources, to minimise water usage, to prevent damage to irrigation equipment and ensure cost-effective maintenance of irrigation components.

(D) **House owner's charter**

The House Owner's Charter is an encumbrance on the Land Title to provide a mechanism for ensuring that the development continues to have efficient use of resources.

A House Owners Charter will be put in place by the proponent for all residential allotments offered for sale within the development. The charter will cover items including building design and materials, planting species and fertilisers, and owners obligations in respect to a range of planning and management issues such as:

- general - number of dwellings and time limit to build
- site planning - set back distances, levels, solar access, number of storeys, privacy
- built form - general appearance, roof pitch, external fixtures, eg. visible antennas, blank walls, retaining walls
- environment - energy rating, water conservation, passive initiatives, other energy efficiency measures including insulation and the installation of plumbed in rainwater tanks
- fences
- landscaping.

The charter will vary depending on the location and style of each allotment. For example, the waterfront allotments will incorporate more stringent land use items to ensure the protection of the water body that adjoins these allotments.

In broad terms the charter will assist in:

- creating an attractive, high quality residential development that complements the adjoining township of Mannum
- protecting the rights of residents with respect to adjacent development
- creating an environmentally conscious development which will protect the environment and help to reduce household running costs
- protecting, as far as possible, the views enjoyed from each allotment and the views available from the public precincts within the development.

When allotments of land are sold within the development, the charter will be attached to the Certificate of Title, and will act as an agreement between the landowner and the proponent. This will require that all developments will be undertaken in accordance with the Charter.

It is proposed that the planning provisions of the Charter would be embodied in the Council Development Plan and be addressed in a Plan Amendment Report process for the site if the proposal is approved. This will allow Mid Murray Council to maintain statutory planning control over the development outcomes on the site in the future.

As such the design and construction of all homes within the development will need to comply with both the relevant Council Development Plan and the Charter.

A typical House Owner's Charter is shown in draft form and included in Appendix B.

(E) **Design guidelines**

In addition to the charter, design guidelines will be put in place to ensure that development across the whole project is consistent and of a high quality. The guidelines would be prepared and disseminated by the proponent and would be consistent with the aims of the Charter. Unlike the Charter, the guidelines would be advisory rather than mandatory. While not all of the items incorporated in the design guidelines will be specifically included in the charter, the guidelines will demonstrate to prospective purchasers the style and standard of development intended.

The guidelines, reinforced by the House Owner's Charter, will ensure that environmentally sustainable design and construction practices are utilised throughout the development. An overview of these initiatives is provided below:

- Orientation and winter solar gain:
  - specific building envelopes should be utilised to ensure that the benefits of capturing northern sunlight through the winter months is achieved.
- Water:
  - the proponent recognises the importance of ensuring that homes, developed on the site, embrace water smart initiatives; and
  - through the charter and the design guidelines, to require specific items such as rainwater tanks, smart flush toilets and water efficient household tapware.
- Ventilation, zoning and sealing:
  - the design envelopes and courtyard spaces should allow for through ventilation to cool homes with minimum use of mechanical air conditioning systems; and
  - through the design guidelines outline the advantages of adequately sealing all external openings and zoning the house.
- Building materials and construction:
  - the use of low energy embodied construction materials will be encouraged; and
  - building materials will also be selected based on the thermal performance they can achieve.
- Appliances:
  - within the design guidelines energy efficient appliances will be encouraged based on current industry standards and star ratings.
- Renewable energy supply:

- housing envelopes and roof pitches will be established that provide for the use of PV cells by owners.

- Landscaping:
  - as outlined within the landscape design guidelines (refer Appendix E), schedules will be provided detailing appropriate plantings that provide an attractive, low impact and water efficient environment.

(F) Marina

The proponent has initiated discussions with the Mid Murray Council in respect to the management of the Marina. Council has established a Mannum Waters Working Group which is meeting on a monthly basis. The Council is currently considering the proponent's proposals. At this stage agreement on the long-term ownership and management arrangements appears assured following appropriate considerations.

This section outlines the proponent's proposal to the Council.

(i) Marina management

The proponent would establish a Community Corporation under the provisions of the *Community Titles Act 1996* in respect to marina berths and the marina water-body , with the Scheme Description and the By Laws covering the operation and management requirements in respect of the use of the marina. Ownership of the main boat entrance and waterways serving the residential and commercial areas would be transferred to the Council.

Key elements of the Community Corporation are:

- a Community Corporation will administer the by-laws and manage the common land and any fixtures erected on it
- owners of mooring berths automatically have membership of the corporation
- the Scheme Description will provide the prospective purchaser with an overall view of how the scheme is to be developed and the end result
- the By-laws will set out the obligations of the corporation in administering the scheme and will be the rules by which the scheme is to be run
- a Community Corporation can impose a penalty of up to $500 for breaches of a by-law which must be paid to the Community Corporation
- the Community Corporation will employ a Community Corporation Manager to manage the Community Corporation
- the construction and management of the marina berths would be the responsibility of the proponent for an initial period and thereafter the Community Corporation.

The Council would be required to appoint an officer of the council to be the Marina Manager who would have responsibility for the care, control and management of the waterways and other facilities within the development, particularly in respect to safe navigation and public safety. The Marina Manager would liaise with the Community Corporation Manager to facilitate the overall management of the marina complex. The costs associated with the Marina Manager would be met from the rating revenue the council receives from the Marina berths and waterfront allotments.

The proponent will develop a procedure and response action plan to manage spillages and pollutants that enter the marina or waterways and the remediation of the waterways affected. The Marina Manager would be responsible for reporting any spills or incidents that present an environmental risk to the appropriate authorities including Council and the Environment Protection Authority. The Marina Manager would also be responsible for the deployment of any immediate clean up measures and procedures including booms and other containment measures.

All specific environmental reporting, monitoring, response and management would be set out in the operational environmental management and maintenance plan (OEMMP) which would be the responsibility of the Marina Manager to implement, so as to satisfy the General Environmental Duty of Care under the *Environment Protection Act 1993* (refer Section 12.3).

The proponent will establish a marina berth to be utilised solely by the Department of Transport or Emergency Service personnel. It will be the Marina Manager's responsibility to ensure this berth is kept free of unauthorised vessels at all times.

(ii) **Marina owner's charter**

The recreational marina berths and the marina water-body would be subject to conditions of use that would be reflected in a Marina Owner's Charter. This would include the Scheme Description and By Laws under the Plan of Community Division. The Community Corporation Manager and Marina Manager would be responsible for the enforcement of the conditions of use.

The draft points to be incorporated into the Marina Owner's Charter are included in Appendix C.

The Scheme Description and By Laws would include the following conditions:

- vessels are not to exceed 4 knots in the marina or waterways and must comply with other Department of Transport restrictions that apply at all times
- water skiing or similar towing of people is prohibited in the marina and waterways
- no major repairs to vessels are to occur in the Marina facility with any minor repairs to be undertaken with the consent of the Community Corporation Manager and Marina Manager
- hire vessels may only berth in the facilities allocated to them
- all vessels are to be secured at all times when not in use
- damaged or sunken vessels must be promptly removed
- no refuse, pollutants or other materials are to be dumped or otherwise disposed of n the water of the marina facility
- a register of ownership of vessels is to be kept by the Community Corporation Manager
- visiting vessels must only moor in the casual berths and pay the applicable daily mooring charge

- noise levels are to be within normally accepted limits as prescribed by the Environment Protection Authority (SA).

11.4.8 Houseboat numbers and requirements

(A) Affects on houseboat numbers

As indicated earlier, Mannum Waters will provide permanent moorings for up to 156 houseboats. The development will not increase the total number of houseboats on the river; it will merely provide off-stream moorings.

Commercial and recreational houseboat operators may choose to locate at Mannum Waters, or they may choose other locations. However, if the proposal to regulate houseboat operations is enacted, so that every houseboat will need to be moored at a suitably equipped facility (i.e. one with sewage facilities), Mannum Waters may attract houseboat owners and operators from local and regional sites on the River Murray.

The Boating Industry Association in South Australia conducted a survey of all vessels on the South Australian section of the River Murray greater than 6m in length and which had galley and/or sleeping facilities. Just short of 2000 vessels that fitted these criteria were counted. About 1000 vessels were recorded in the lakes and Coorong area, and the other 1000 between Wellington and the border. If houseboats become regulated it is likely that Mannum Waters will receive more visitors primarily for the waste and sullage facilities.

(B) Houseboat requirements

Houseboats require a number of resources to enable them to move up and down the River. They are:

- drinking water, which is typically stored and sourced from towns water supplies and piped to kitchen and bathroom and accessed through a separate tap to the washing water. Storage of drinking water on Murray River houseboats is around 400 L (Langinestra 2003)
- water for toilet flushing and washing purposes is pumped direct from the Murray River (or other water body where the vessel is located)
- human waste (from the toilet) (i.e. blackwater). Generated waste blackwater is stored in a tank of around 800 L until it is off-loaded at a designated pump-out facility. Vacuum discharge will be available for all boats moored within the marina
- washwater from the kitchen, laundry and shower (i.e. greywater). This is discharged direct and untreated to the water body where the vessel is located; however this may change under the proposed Code of Practice for Vessel and Facility Management: Marine and Inland Waters 2005. It is the intention at Mannum Waters to require boats permanently moored in the Marina to be equipped with greywater storage for vacuum discharge or approved treatment facilities.

11.4.9 Recreational activities

Because Mannum is a “River Town” a great part of its recreational activity both for the resident and the visitor centres is on or adjacent to the River Murray. The opportunity to moor and launch various craft and its proximity to Adelaide makes Mannum an ideal location for river based recreation such as skiing, fishing and houseboat related activities. The close proximity of Adelaide reinforces the opportunity for visitors to include river based recreation in day or weekend trips.

In addition to the river the town has two major ovals. One is at the showgrounds and the community oval is adjacent to joint use facilities involving the swimming pool, secondary school and community centre.

The Town has active sporting club activities centred on baseball, basketball, bowling, cricket, motorcycle, pistol and shooting, football, golf, Little Athletics, netball, riding, rowing, squash and tennis. The new development will provide an influx of population that will support the existing town's sporting club activities.

The Mannum Waters development adjoins the Golf Course which currently has 9 holes and there is an opportunity for the development to include an expansion of the current Golf Course with an additional 9 holes and improvements to layout, fairways irrigation and greens. The standard of the course could be improved and parts incorporated into residential areas or shorter term accommodation. The proponent would be open to opportunities for partnering on these types of initiatives.

The Mannum Waters marina is of course a focus of the development and a major opportunity is created for the more secure and sustainable accommodations of houseboats "off the river". This is seen as a major benefit to Mannum as a houseboat focus and a significant access to the river itself. Allowance for a boat launching ramp and associated trailer parking area is made within the public access area of the Marina. The associated commercial areas will have security lighting that will be sensitive to environmental and residential considerations.

The Mannum Waters development will provide significant areas of open space including the wetlands area which will be available for passive recreation using a walking trail that will have some restricted use in keeping with its environmental sensitivity. Other passive parks will be provided where necessary with relevant infrastructure such as children's playgrounds. A picnic and playground facility will also be provided within the commercial area of the development where there is likely to be the major impact from visitor access.

It is emphasised that open space and recreation within the residential areas of the development will be passive with emphasis on local use by residents. Other areas associated with the main houseboat activity in the marina, are away from residential areas and as mentioned previously will be controlled by navigational elements in the form of a Charter. All waterways that are used by residents and visitors will be subject to the standard navigational and safety requirements.

11.4.10 Interpretive trails

As mentioned previously a wetland will be constructed through which water from the marina development and waterways will flow before being discharged back into the River Murray. The remaining flood plain will be landscaped and planted with native species. A boardwalk and interpretive trail will meander through the flood plain and constructed wetland

An excellent opportunity exists in relation to the wetland area to develop the interpretive walking trail, complete with information on flora, fauna and indigenous and non-indigenous heritage.

Whilst the proponent is interested in providing public access to the trail and wetlands it will be necessary through its design and management to ensure that access does not impact unduly on the sensitivity of the area. Access to the overall area will not be allowed and there will be no public access to the River Murray River. The trail will only pass through a part of the wetland and measures can be taken to manage its use. At certain times (at night or if there is a particular threat such as a fire ban day) it will be necessary to close off the public access.

It is considered that the interpretive trail and access to the wetland will be a useful opportunity for education and monitoring projects by local students

11.4.11 River access

There will be land access to the river for exceptional or emergency purposes but this will be behind a security gate from the marina area.

All existing access to the River Murray from the Mannum Waters land will be restricted to one point and there will be no public access. Houseboats will not be allowed to moor on the river fronting the Mannum Waters land. Responsibility for managing this will rest with the Marina Management which will have a vested interest to restrict this area and to encourage the use of the Marina.

Water access to the river for all craft will be via the main channel as described in Section 2.3.5

11.4.12 Amenity

(A) Local amenity

The overall development will make a marked change to the local amenity of the development site and the surrounding area. In particular:

- the removal of the wastewater treatment lagoons and overflow from the flood plain and the replacement by the marina water body and the opening up of the aspect to the vegetation that is adjacent to the River Murray
- the protection of the sensitive area fronting the River Murray by removal of weeds and introduced vegetation and rehabilitation of degraded areas
- the conversion of degraded river flats that were previously used for pasture into an attractive wetlands area
- the improvement of Belvedere Road as the only vehicular access to the site
- the creation of an attractive, landscaped housing estate that integrates with the township of Mannum and in particular only allows pedestrian access into sensitive areas such as River Lane
- the provision of areas of open space within the residential area and preservation of areas of aboriginal heritage.

(B) **Mannum Waters residential character**

The proponent proposes to have a House Owner’s Charter” in order to maintain an environmentally and aesthetically cohesive development. In addition the proponent has the capacity to market the project as house and land packages and this can give them significant control over the style of house and the placement of housing on individual allotments as well as the design of the overall streetscape and particularly the landscaping with emphasis on local flora. The proponent can also develop housing styles so that there is a choice of housing and particular care and attention will be made with those houses that interface with the sensitive waterfront/canal area of the development and the open space.

(C) **Integration with Mannum township**

Road access to Mannum will be restricted to Belvedere Road and this road will be upgraded. Whilst access from the site through the southern part of Mannum has been restricted to pedestrian traffic it is considered that walking and bicycle trails will make full use of the opportunity to walk and ride from River Lane through the new development and the public areas of the Marina and via the commercial area to the interpretive opportunities in the wetlands.

(D) **Effects on character and lifestyle**

It is expected that the development will build on the lifestyle of Mannum which is perceived as still a small country town on the banks of the River Murray with a strong holiday atmosphere enjoying the recreational qualities of the river and to an increasing extent catering for people who not only have the opportunity to work in local industries but also wish to retire to a quiet location.

(E) **Adjoining/adjacent land uses**

Because of its location it is not expected that the Mannum Waters will have any impacts on adjoining land uses. Cropping and grazing on adjoining properties to the north-west and to the west are low intensity uses and can be buffered from the impact of the development by distance. The town to the north is not directly accessed by the development and is largely buffered by topography and the existing golf course. Any proposed extension of the golf course will further provide buffering with existing uses in the town

(F) **Visual**

For much of the distance along the river boundary, views into the development are screened by the dense vegetation that exists along the bank and within the riverine wetland. A significant view into the site will be obtained at the main boat entrance.

The visual impact of the proposed development has been assessed with reference to views from the river, the opposite bank and the proposed main access road (refer Table 11.9)

Table 11.9 – Visual assessment (1)

Photo Point Location		Physical Characteristics			Design Strategies
Photo	**Comment**	**Features**	**Consequences**	**Comment**	
11.6, 11.7 & 11.8 View from river 150 metres from bank	Typical view of locality from River	Dense river-bank vegetation in excess of 5 metres	Views of locality concealed by vegetation, notably intermittent views only of the highlands.	Other than the boat entry to marina basin, the views of the development will be concealed by: (a) riverside vegetation; and (b) because no development is proposed on the northern escarpment. Views of entrance road are concealed due to variation of the road's alignment that follows topography and contours.	Establish tall, high canopied trees as a backdrop to proposed commercial area.
11.9 View from river 150 metres from bank		High & low canopies. Note break in continuity of canopies in vicinity of existing 5 berth marina.			
11.10 Escarpment 250 metres from river bank near River Lane	View of riverside vegetation indicating distribution, density and height.				
11.11 View from river at proposed entrance					

Photo 11.6 – View from the opposite bank of the river looking south-west

Photo 11.7 – View from the opposite bank of the river looking west

Photo 11.8 – View from the river approximately 800 metres south of the proposed main entrance

Photo 11.9 – View from river approximately 400 metres south of the proposed main entrance

Photo 11.10 – View the to site from escarpment above River Lane

Photo 11.11 – View from river at the proposed boat entrance

Photo 11.12 – View from river bank near the proposed entrance looking south

Table 11.9 – Visual assessment (2)

Photo Point Location		Physical Characteristics			Design Strategies
Position	**Comment**	**Features**	**Consequences**	**Comment**	
11.12 Riverbank towards south	View to opposite riverbank	Dense riverbank vegetation in excess of 5 metres high. High and low canopies.	Combination of riverside vegetation on both sides of River will conceal views of development from opposite riverbank.	No. Impact from development.	Nil
11.13, 11.14, 11.15 & 11.16 Various positions along the alignment of the existing farm access track off Belvedere Road	Follows alignment of existing farm access track from Belvedere Road to riverbank	New roadway located above 1956 flood level with changing views of distance river bank. Existing mature trees along farm track. Existing packing shed on farm track.	New roadway alignment with minimal physical change. Waterway proposed to be extended (refer Photo 11.15) to within 50 metres of Belvedere Road.	Attractive, effective and legitimate method of providing the development with a marine character without compromising the River's landscape character. The proposed commercial area coincides with dominant vista and riverside vegetation break. This will enhance the vista and create a clear point of destination for visitors.	Maintain mature trees along farm track and remove packing shed. New planting along roadway and in proposed commercial area to complement existing plantings. Final positioning of entrance roadway to meander along land contours to mitigate visual impact from the River when viewed through the main boat entry.
11.17, 11.18, 11.19 & 11.20 At southern end of River Lane	Location of wastewater lagoons, riverside vegetation and adjoining shacks.	Elevated wastewater lagoons on floodplain enclosed by security fence, continuous vegetation along riverbank	Views from River Lane vista to proposed development marina basin and residential development.	Enhanced views from River Lane with removal of lagoons. View of riverside vegetation to be retained. and enhanced with view of waterway.	Open tree plantings through park at termination of River Lane.

Photo 11.13 – View of main access to development from Belvedere Road

Photo 11.14 – View from existing access track across the site of the proposed western waterway

Photo 11.15 – View of work shed adjacent to existing access track

Photo 11.16 – View across the site of the proposed waterway to the existing access track near the work shed

Photo 11.17 – Sludge lagoons near River Lane and neighbouring shacks

Photo 11.18 – Rear boundary of neighbouring shacks

Photo 11.19 – View from wastewater lagoons to the south through the river flats

Photo 11.20 – View from the northern high ground across the lagoons to the river

An artist's impression of views from the rive and northern boundary are shown in Figures 11.7 and 11.8

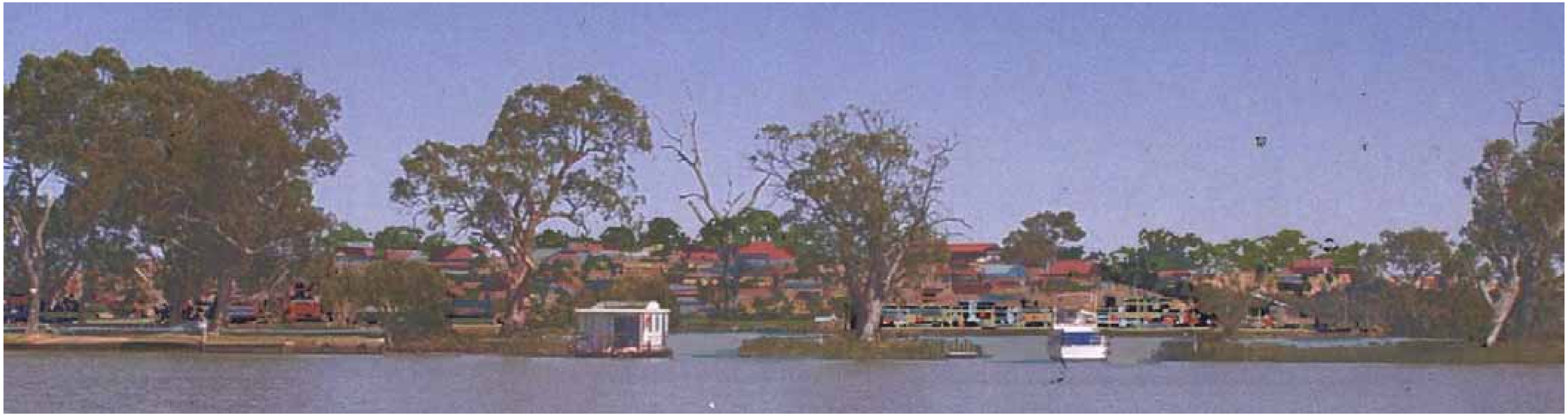


Figure 11.7 – Artist's impression of the view into the development at the proposed boat entrance

Figure 11.8 – Artist's impression of the view into the development from the existing township across the ravine on the northern boundary

11.4.13 Land tenure arrangements and access

During the development construction phase, tenure to the land currently held by the proponent will remain with the proponent.

Titles to land within the development area not currently owned by the proponent will be transferred to the proponent prior to construction commencing.

The land proposed for the new wastewater treatment plant is currently being investigated by SA Water. SA Water will carry out its own probity processes covering the new treatment plant and its location. On completion of the plant the existing SA wastewater treatment area would be decommissioned and the land transferred to the proponent subject to appropriate negotiations. In addition, the proponent, subject to final negotiation, would transfer a portion of the development area to the Mid Murray Council for a future extension to the golf course.

Land tenure would transfer to purchasers of residential and commercial allotments, in Torrens Title format, upon issue of titles by the Lands Title Office. Public areas, such as reserves, road reserves, waterways, wetland areas, revegetation areas and community facilities, would be transferred to Council upon deposit of plan at the Lands Title Office.

The land tenure arrangement for the marina berths and associated facilities would be managed through a plan of community division. Limited access will be available to the public subject to security controls.

Ownership of Aboriginal cultural heritage sites will be transferred to the Mid Murray Council as public land. Access to these areas will be restricted in accordance with the requirements of the Mannum Aboriginal Community Association Inc.

11.5 CLIMATE CHANGE

The viability or function of the development will not be significantly affected by climate change. The effects of climate change have been considered in design. The key points arising from climate change are as follows:

- Physical
  - Operating water levels will not suffer significant change when compared to current levels as river levels are managed throughout the River Murray system. The most significant impacts are still likely to be drought and limited flows in the river. National planning is seeking to manage flows and this can be expected to improve in future years. Also contrary to popular belief, the average evaporation measurements over the last 50 years throughout the planet have decreased even though increases in average temperatures have been recorded[1]. The idea that increased temperatures will necessarily increase evaporation is not currently supported by science. Nevertheless, the waterways and marina basin will be constructed to a depth of 2.55m which is 1.8m below sea level. A drop in level of

[1] Australian Academy of Science, National Committee for Earth System Science, Proceedings of a workshop held at Shine Dome, Australian Academy of Science, Canberra, November 22-23, 2004

1.75 m could be experienced at the development without unduly impacting on the operation and structures.

- If they occur, changes in the frequency of larger floods will not impact adversely on the marina, waterways, wetlands and revegetation areas. The design of these areas will allow infrequent submersion. On the other hand, residential areas have been located above the 1956 flood level in accordance with normal planning requirements.
- Changes in rainfall pattern or volume should not affect the overall water balance described in Section 11.2.2 as the land has associated with it a surplus water entitlement. The large constructed wetland, as part of the wetland management plan, can be managed to use less water as required to adjust to new water regimes and this will allow the status quo to be maintained.
- Through-flows will not be affected due level variation, wind and other climate changes as the water transfer pumps linked with field monitoring will continue to meet the water quality requirements.

- Residential

  A number of water and energy conservation measures have been detailed within Section 11.4.6 as they relate to housing design, water usage, pumping and general design. The provision of a House Owner's Charter and Design Guidelines will assist in the realisation of these principles. These principles have been establish to specifically target items which are either a cause of climate change or which require treatment to minimise the effects of climate change

- Carbon emissions

  The following are areas of the development in which planting may occur:

  - Constructed wetland - 43.6 ha. These are naturally highly productive systems and therefore would have high rates of carbon sequestering
  - Revegetation areas - 23.2 ha of woodland
  - Parks and detention ponds -7.9 ha
  - Embankments - 6.5 ha
  - Road reserves - 5 ha
  - Golf course extension - 7 ha

  Collectively there are approximately 93 ha available for public planting. In addition the marina basin and waterways will be fringed by aquatic vegetation and will also act as a carbon sink. Currently, the whole of this area is grazed and the new revegetation will have a much greater floral biomass than the existing samphire and weeds.

  Because of the scale of the proposed wetlands, the revegetation areas, reserves and parks within the urban areas, street tree planting and the likely planting by residents in the individual allotments, this development may not have a large carbon footprint and in fact may be in balance. This comment is based on the basic assumption that the average carbon emission from one person/annum is 28 tonnes and that one tonne/annum may be offset by the equivalent of 4-5 trees. These figures are subject to scientific debate but have been suggested following a review of available literature. In the case of Mannum Waters, a number of factors would affect the carbon emission/person and may make it lower than stated i.e. retiree lifestyle, less traffic movements and the energy efficient design guidelines. On the other hand the number and type of equivalent tree planting may require a larger number of plants than indicated to offset the carbon emissions. However, the assumptions do provide a reasonable basis for an initial assessment of the value of the proposed planting to offset carbon emissions.

Bearing in mind the lower occupancy rates due to holiday homes and retirees, the average daily equivalent population of Mannum Waters is estimated at approximately 900. Approximately 120,000 trees or the equivalent vegetation would be required to counter the carbon emissions.

Assuming that one half of each residential allotment will be planted, the total area available for planting within the development will be approximately 100 ha. This equates to an average density of 1 tree/8.5 m^2 within the planted areas. Over the life of the development it is possible that the development could reach this target. Consequently, the carbon footprint should be low.

12 Environmental management – construction and operational

12.1 PREPARATION AND IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLANS

A number of specific environmental management plans are required for the development and operational stages of the project, as follows:

12.1.1 A Construction Environmental Management Plan (CEMP)

A Construction Environmental Management Plan (CEMP) will be prepared prior to the commencement of site works. The purpose of the CEMP is to manage and mitigate the potential adverse effects related to the construction activities. The CEMP incorporates a Soil Erosion and Drainage Management Plan (SEDMP) and a Traffic Management Plan, and also covers a number of additional issues as discussed below. It is intended as an overall management plan incorporating environmental, quality, occupational health and safety, and public safety issues related to construction, in an integrated approach to ensure appropriate construction management.

12.1.2 Long-term Environmental Management and Maintenance Plan (EMMP)

This will identify long-term management requirements and arrangements. In this instance it will also include:

- a Wetland Management Plan, for:
    - the operation of the constructed wetland, which is developed as part of the design of the wetlands
    - the protection of the Baseby linear wetland.
- a Revegetation Plan, involving:
    - a staged vegetation establishment programme
    - a maintenance programme, during the establishment phase (2-3 yrs)
    - a long-term weed management and feral animal management plan (linked with that for the constructed wetland and linear wetland).
- an Environmental Management Plan for Wastewater

  While subject to the requirements of State Government Agencies, this will likely require:

    - the prevention of ground water and surface water contamination

- litter control, dust control and sanitary conditions generally
- odour and noise control
- fire safety
- security
- an Irrigation Management Plan, prepared in accordance with EPA Guidelines (EPA 2002) and defining the sustainable reuse of the reclaimed water, management and monitoring and outlining all the measures/safeguards incorporated into the plan to ensure that no wastewater can reach any watercourse, particularly the River Murray
- the identification of all of the design features and response strategies to ensure that no wastewater spill from the treatment plant or mains (eg as a result of power failure) could reach any watercourse.

- a spill contingency plan for the containment and clean-up of oils and wastewater for the marina waterways
- a landscaping plan for developed areas.

12.2 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

12.2.1 Key environmental objectives of CEMP

With respect to environmental protection, the key objectives of the plan are:

- to minimise erosion and soil loss, in order to prevent or minimise any turbidity, sedimentation of the River Murray
- to prevent or minimise the disturbance of any flora and fauna habitat outside the construction area
- to minimise the effects of noise and dust on adjacent areas
- to maintain high standards of public safety throughout the construction period and for the contractors engaged on the project
- through good site management, minimise the potential for environmental impacts
- through good site management, minimise downtime during construction, loss of materials and provide for more cost effective site remediation.

12.2.2 Implementation, roles and responsibilities

The following notes define roles, responsibilities, and indicate how the plan will be implemented and managed. To do this reference has been made to previous EIS documents, particularly that of the Ceduna Marina EIS which has provided an appropriate format.

The preparation of the CEMP is the responsibility of the proponent. It will involve the development of a specification, outlining all issues to be covered, the standards that need to be achieved and monitoring requirements that must be included in an Environmental Management Implementation Plan (EMIP). This is to be produced by the Contractor engaged to undertake the works.

The CEMP would address a wide range of issues, and would be prepared in accordance with available guidelines, particularly the EPA Code of Practice and would be submitted for approval by the EPA, before the commencement of any construction activities.

All site works will be undertaken under AS 2124 1992 (General Conditions of Contract).

The involvement of the various parties is shown in Table 12.1:

Table 12.1 – Responsibilities of various parties

Member	Role	Responsibility
The proponent	Principal	Ensure that all construction and ongoing operational aspects of the development are undertaken and implemented in accordance with the conditions of development approval. Overall responsibilities for environmental performance (duty of care under Section 25 of the Environmental Protection Act 1993).
To be determined by tender or other means. Contractual conditions to be AS 2124 1992.	Contractor	Responsibility for environmental performance (duty of care under Section 25 of the EP Act 1993). Compliance with all provisions of the CEMP. Preparation and implementation of environmental management implementation plan (EMIP) for the site.
The proponent	Design and Documentation, Construction Superintendent	Design and documentation of earthworks, wetlands and all land division infrastructure. Monitoring and assessment of Contractor's performance against provisions of the CEMP.
Eco Management Services Pty Ltd	Environmental Advisor	Reviewing design documentation for compliance with the CEMP and monitoring. Ensure that the CEMP addresses all the issues raised. Monitoring and assessment of Contractor's performance against provisions of the CEMP. Preparation of compliance reports (as required).
Mid Murray Council	Compliance	To ensure the Construction Environmental Management Plan is being followed and adhered to by construction Contractors.
Mid Murray Council	Compliance	To ensure the Construction Environmental Management Plan meets the requirements of authorities and legislation e.g. DLWB&C, River Murray Act, EPA conditions, etc.
Mid Murray Council	Compliance	To ensure that native vegetation is protected during the construction phase as well as following completion of construction.

Other specialist input will be provided, as required, by:

- Computational Fluid Mechanics, advice on hydraulic behavior of the waterways
- Watersearch, advice on groundwater issues
- Murray F Young and Associates, advice on traffic requirements

The development and implementation of the plan will involve the items discussed in the following Sections

(A) **Implementation of environmental management measures**

Based on the specification included in the CEMP, prepared by the proponent, all environmental management requirements during construction will be documented in an Environmental Management Implementation Plan (EMIP), to be produced by the Contractor prior to commencing site works. It will detail how the Contractor will implement and manage environmental aspects of the project. This plan will form part of an overall Quality Plan, which also addresses safety, operating procedures, inspection and test plans and checklists.

The Contractor's environmental management responsibilities for the proposed site works will include:

- preparation of an EMIP in accordance with the requirements of the CEMP to show how the environmental requirements for the project will be met
- carrying out the work in accordance with the EMIP and the provisions of the CEMP
- updating and improving the EMIP as required to ensure that it remains current.

A number of strategies will also be employed via the CEMP to ensure appropriate implementation of the CEMP and thus management of the construction activities. These include:

- risk management will be employed to appropriately identify, manage and mitigate construction risks. This process ensures that all of the various risks are identified, assessed and managed appropriately
- development of policies will clearly communicate the commitment and expectations of Mid Murray Council and Planning SA in relation to the project. The following policies will be developed specifically for the project:
    - Environmental Policy.
    - Occupational Health and Safety Policy.
    - Quality Management Policy.
    - Drug and Alcohol Policy.
    - Hours of Work Policy.
    - Industrial Relations Policy.
    - Return to Work Policy.

(B) **Induction and training**

Project specific training or certification requirements for all site personnel (Superintendent's Representatives, Consultants, Contractor's personnel and subcontractors) will be the responsibility of the Contractor. Appropriate training records and certificates as appropriate shall be maintained by the Contractor and provided to the Superintendent prior to commencing site works.

It will be the responsibility of the Contractor to ensure that all project personnel are aware of environmental management requirements and procedures.

(C) **Inspection and monitoring**

A representative of the Superintendent and Environmental Consultant will undertake regular inspections of the Contractor's activities.

Monitoring for dust, dust contents, noise and surface water quality will be carried out by the Superintendent and Environmental Consultant.

(D) **Assessment and reporting of environmental performance**

Reviews of environmental performances will be undertaken by the Environmental Consultant (protection of habitat, water quality) and the Superintendent or his representative (dust, noise traffic etc.). The Contractor will be instructed on the outcomes of reviews immediately. Summary review reports will be prepared monthly. The reports will be provided to the Contractor, the Principal and the EPA.

Environmental incidents and emergencies will be reported immediately to the Principal (and if necessary the EPA) by the Contractor or the Superintendent.

(E) **Auditing**

The performance of the project against the CEMP will be audited by a suitably qualified and experienced environmental auditor (independent of the parties listed above), three months after commencement of site works. Additional audits shall be undertaken thereafter at six monthly intervals.

Environmental audit findings will be submitted to the parties listed above. If necessary, the CEMP will be amended and the amendments implemented.

(F) **Project meetings – stakeholder consultation**

Project meetings will be held regularly (eg. monthly) on site with key stakeholders which could include representatives from, Council, EPA, Catchment Board and the parties listed above as a forum to provide advice on project management and delivery issues.

It is important to note that the construction and establishment period will take up to 2 years and the project up to 16 years until it is fully developed. The clear identification of responsibilities and roles, and the process outlined above is to ensure that high standards of operation and compliance are maintained throughout the construction period. The regular contact with and liaison with the contractors is to ensure a proactive approach to site management, identifying at an early stage any developing problems, enabling remedial action to be taken.

12.2.3 Issues, structure of the CEMP

The CEMP consists of a family of management plans, including:

- soil erosion and drainage management;
- aboriginal heritage management;
- general environmental management incorporating noise, dusts, pest plants and animals;
- riverine construction and dredging management;
- entrance construction;
- groundwater management;
- vegetation management;
- traffic management;
- emergency response, covering fire, spills, explosions and flood;
- quality management;
- occupational health and safety management;
- site access and public safety management.

As appropriate, specific plans will be submitted to the relevant government agencies for approval prior to implementation.

12.2.4 Construction sequence

The likely construction sequence is outlined below.

(A) Stage 1

- prepare construction environmental management plan (CEMP) for Stage 1
- construct 3 m levee bank from existing levee bank along SW boundary 2m in from boundary
- construct silt fence along SW boundary 1 m in from boundary
- after construction of levee and silt fence construct feral animal proof fence on SW boundary
- remove boxthorns and destroy
- strip topsoil from construction areas and stockpile in future re-vegetation areas
- construct minor 2m levee bank from existing levee bank along the southern boundary of existing SA Water crown land to provide protection until commencement of stage 2 and vacation by SA Water
- maintain existing levee bank and new levee banks during construction to contain entire site
- proceed with earthworks in accordance with soils report and environmental management plan

- once infrastructure complete fill new waterways through small pipe diameters i.e. low velocity flows. Allow to settle.
- construct southern channel outlet from new wetland to the river
- construct main marina entrance and maintain minimum transfer pumping to the new wetland to induce flow away from the river at the entrance and to avoid silt to the river.

(B) **Stage 2**

- prepare construction environmental management plan (CEMP) for Stage 2
- maintain minor levee constructed in Stage 1 until infrastructure work of Stage 2 is completed
- proceed with earthworks in accordance with soils report and environmental management plan
- once infrastructure complete fill new waterway from the river with small diameter pipe i.e low velocity flows. Allow to settle.
- construct northern inlet channel from the river
- open waterway to the marina and maintain transfer pumping to the new wetland via the south western waterway.

(C) **Stage 3 onwards**

Normal construction methods will be adopted during these stages with appropriate environmental management plans for each stage.

Gross pollutant traps and areas where construction stormwater flows can be detained will be provided in Stages 1 and 2 and these will assist control during the later stages.

For timing of the construction sequence refer Table 2.2.

12.2.5 CEMP elements

(A) **Soil Erosion and Drainage Management Plan**

(i) **Preliminary earthworks**

In order to reduce the impact of the proposed site development the following measures will be taken into consideration during the final design stage, construction period and ongoing use of the site:

- the depth and extent of excavation for the proposed development will be minimised where possible to limit exposure of subsurface soils
- topsoil stripping and general disturbance will be limited where possible to maintain the existing vegetation cover. Approval will be sought for the removal of any native vegetation. In areas were stripping and excavation is required, soil materials will be replaced in their natural order in the soil profile to ensure that the material of higher salinity does not become the surface layer. Surface clay, subsurface clay and

shale/sandstone will be stockpiled separately during excavation works prior to placement during the fill operation in their natural order

- consideration will be given to stabilisation or revegetation of exposed soils and stockpiles if they are to remain exposed for extended periods during construction
- standard methods will be applied to the proposed development to reduce the impact of water runoff and subsequent erosion during and following the completion of construction works
- the final development levels for unpaved areas will be designed with grades of at least 1 degree to minimise surface water ponding.

Figure 12.1 – Collage of sedimentation retention techniques

(ii) Construction soil and water management plan

A Construction Soil and Water Management Plan will address issues associated with sedimentation and water quality. Mitigation measures included in the plan may include:

- diversion of clean stormwater runoff around construction sites (where possible)
- installation of the drainage system to occur as soon as practicable following the commencement of the construction activities
- installation of sediment traps and sedimentation retention basins
- installation of oil, grease and sediment traps to treat runoff from hardstand work areas
- use of hay bales and silt fencing
- truck wheel washing/shakedown facility or equivalent
- use of crushed rock or similar material on construction site and parking
- control of pH levels from concrete batching areas
- bunding of temporary fuel and chemical storage areas in accordance with EPA requirements.

(B) **Dust**

Air emissions during construction will relate to dust generated by soil handling, vehicle movements and earthworks, as well as emissions from plant and equipment used during construction.

The Environmental Management Implementation Plan is discussed in Section 12.2.2. It will provide various measures for minimising potential dust during construction. These are outlined below:

The following dust and fugitive emission mitigation measures would be employed:

- cleared areas and internal access routes would be managed using erosion control procedures (watering, slope minimisation, rehabilitation, etc)
- the management of all internal access roads would be designed to ensure the strict control of all transport activities. In general, operations at the site would aim to minimise the handling of material and to keep heavy vehicle trip distances as short as possible. In addition, attention would be paid to avoid and clean up any spillages that may contribute to dust generation
- water sprays would be used across the site to suppress dust as required
- worksite fencing would incorporate dust control barriers
- plastic sheeting or spray grasses would, where necessary, be used to cover excavation faces, stockpiles and any unsealed surfaces which may be exposed for extended periods of time
- Dust will be controlled by regular light watering particularly in heavily trafficked areas and on hot, dry or windy days
- Regular monitoring will be conducted, including visual inspections and assessment of weather conditions, particularly during construction phases.

(C) **Stockpiles**

The following stockpile management measures would be employed:

- the size of stockpiles and slope of stockpiles will be in accordance with the recommendations of the geotechnical engineers
- water sprays would be used to suppress wind erosion at all stockpiles as required
- inactive stockpiles would be temporarily stabilised with cover crop or similar.

(D) **Spoil removal**

The following spoil management measures would be employed:

- it is intended that all on site spoil will be reused *in situ*. As such, no off-site spoil disposal is anticipated. Should off-site disposal be required, all spoil entering or leaving site would be securely covered and material disposed of to a licensed landfill
- a vehicle wash-down pad or equivalent would be used to remove soil material from vehicles prior to leaving the site
- no queuing of trucks outside work sites would be permitted.

(E) **Combustion emissions**

The following combustion emission mitigation measures would be employed:

- diesel engine maintenance
  - minimise leaks, inspect fuel filters regularly
  - change oil as recommended
  - replace clogged or damaged filters
  - replace cracked hoses, keep radiators clean of dirt
- adjust valve “lash” to maximise fuel-air mixture usage
- Idling time would be minimised for all heavy vehicles. Engines would be switched off when not in use
- vehicles and fixed plant would, where appropriate, be fitted with properly maintained emissions control equipment.
- all construction equipment would be fitted with emission controls and would be well maintained and serviced regularly
- vehicles would be registered and would comply with normal vehicle emission requirements

(F) **Separation between construction and developed areas**

Separation between construction and developed areas will be used to minimise interaction between construction and the developed areas. In the case of later stages, interaction with the previously completed stages will also be minimised. The separation will provide improved public safety and minimise potential environmental effects, including dust. Further, it is intended to achieve a general amenity within the completed stages of a completed development, so that the whole of the site does not look or feel like it is still under construction. Staging has been planned to minimise the interaction between stages and each stage will be a compact and defined area, in order to provide the opportunity for separation between construction areas and public spaces.

Once the site is established, air pollution from dust is expected to be negligible as the site will be developed such that there will be no exposed areas of soil left without some form of vegetation cover.

Vacant house lots will, where necessary, have plantings to assist in dust suppression.

Air pollution related to activities conducted on the land after construction is not expected, given the general nature of the proposal. Nevertheless, any activity proposed in the future that might result in air pollution will require approvals and be regulated via the normal processes of development assessment and EPA approvals. Such licensing may require air quality impact assessments using design ground level pollutant concentrations (DGLCs), in accordance with the relevant EPA guideline (EPA 386/03).

(G) **Contaminated soils**

The results of the laboratory testing indicated that the concentrations of PAH compounds, TRH compounds, BTEX compounds, OCP compounds, chlorinated hydrocarbons, cyanide, PCB compounds, phenol, cresol and selected heavy metals in all samples tested were generally below laboratory detection limits or the adopted site criteria (NEHF exposure setting A and WF criteria). On this basis no specific contamination mitigation or management measures are necessary for the proposal.

Remediation work may, however, be required once the SA Water lagoons have been decommissioned. A separate study will be undertaken for the SA Water site and the appropriate works undertaken.

(H) Transport of construction materials

As outlined above, import or export of spoil on or off site is not expected to occur. The development of the land divisions will be in multiple stages and the impacts on the local traffic and residential areas will be minimal for each stage. Any on-site storage will be contained in designated areas out of view of the public.

The Site Construction Management Plan will provide specific measures for minimising the effects of transport and storage of construction materials on the local amenity, including:

- construction traffic management. A traffic management plan will be developed to control construction traffic and to minimise and control interaction with public roads. Construction traffic within the construction areas will be limited to designated haul roads and appropriate maintenance of the haul roads will minimise potential effects on the local amenity. The majority of the filling will occur to the east of the site away from the existing township and construction traffic will be limited to the defined construction areas. Thus in general construction traffic, other than that required for building developments, will not be allowed on the developed land or internal roads
- separation between construction and developed areas will be used to minimise interaction between construction and the existing town. In the case of later stages, interaction with the previously completed stages will also be minimised. The separation will provide improved public safety and minimise potential environmental effects, such as construction noise and dust. Further, it is intended to achieve a general amenity within the completed stages of the development, so that the whole of the site does not look or feel like it is still under construction
- staging has been planned to minimise the interaction between stages and each stage is a compact and defined area. The connection between stages of waterways is in areas of narrower waterways in order to minimise the effects of opening subsequent stages on users of the existing waterways. The commissioning of waterway stages will be performed to eliminate water surges by flooding of the waterway in a controlled manner to obtain equalisation of water levels prior to opening the new stage of waterway
- site access controls including fencing, signage and procedural controls will be used to prevent public access to the construction areas. A separate dedicated access will be provided for construction personnel and traffic. The access will be stabilised to minimise sediment transport onto public roads and any material that is transported will be removed as soon as practical
- landscaped mounds will be use where appropriate to control noise and reinforce the separation between construction and completed areas of the development. Noise

monitoring will be used to ensure all equipment meets the relevant noise emission criteria

- control of construction traffic to the designated haul roads and appropriate maintenance of the haul roads will minimise potential dust issues. Regular light watering will be used to suppress dust on haul roads or other potentially dusty areas. Completed areas will be landscaped as soon as practical to prevent dust associated with windblown erosion.

Table 12.2 identifies the range and quantities of materials involved. Being aware of the scale of activities will assist in ensuring that adequate measures are taken and also provides an assessment of construction traffic. Conventional materials for the construction of the land division will be sourced from known suppliers.

Table 12.2 – Construction materials and heavy vehicle movements

Item	Qty	Unit	Source	Heavy vehicle movements to/from site
Earthworks - General				
Strip and stockpile topsoil	40,000	m^3	On site	4
Cut to fill	350,000	m^3	On site	35
Cut to stockpile	130,000	m^3	On site	13
Cut to overburden	80,000	m^3	On site	8
Stockpile to fill	130,000	m^3	On site	13
Overburden to fill	80,000	m^3	On site	8
Spread topsoil	40,000	m^3	On site	4
Earthworks - Wetland				
Strip topsoil	40,000	m^3	On site	4
Cut to fill	120,000	m^3	On site	12
Spread topsoil	40,000	m^3	On site	4
Access Roads				
Lime stabilization	9	Tonne	SA	4
Sub-base, quarry rubble	3,600	m^3	SA	720
Base, fine crushed rock	2,300	m^3	SA	460
Double bituminous seal	6,200	m^2	SA	20
Mountable kerb and gutter, concrete	160	m^3	SA	64
Median strip, concrete	150	m^3	SA	60
Internal Residential Roads				
Lime stabilization	21	tonne	SA	8
Sub-base, quarry rubble	21,000	m^3	SA	4,200
Base, fine crushed rock	17,000	m^3	SA	3,400
Double bituminous seal	45,700	m^2	SA	160
Mountable kerb and gutter, concrete	1,260	m^3	SA	150
Marina Road				
Lime stabilization	160	tonne	SA	32
Sub-base, quarry rubble	7,000	m^3	SA	1,400
Base, fine crushed rock	4,800	m^3	SA	960
Double bituminous seal	12,600	m^2	SA	40
Belvedere Road				
Sub-base, quarry rubble	1,900	m^3	SA	380
Base, fine crushed rock	1,700	m^3	SA	34
Double bituminous seal	4,500	m^2	SA	16
Shoulders, quarry rubble	280	m^3	SA	60
Road Accessories				
Street signs	40	Each	SA	16
Traffic signs	20	Each	SA	8
Line marking	10,000	Lin.m	SA	24
Ramps, concrete	30	Each	SA	12
Street furniture	1	Item	SA	6

Item	Qty	Unit	Source	Heavy vehicle movements to/from site
Footpaths				
Pedestrian/cycling routes, concrete	420	m^3	SA	16
Suburban, block	600	m^3	SA	240
Walking trails, quarry rubble	270	m^3	SA	120
Boardwalks	400	Lin.m	SA	200
Bridges				
Structures	2	each	SA	60
Stormwater				
Side entry pits, concrete	230	m^3	SA	46
150 mm PVC back-of-block pipe	2,100	Lin.m	SA	24
300 mm Blackmax pipe	4,500	Lin.m	SA	50
450 mm Blackmax pipe	900	Lin.m	SA	24
600 mm Blackmax pipe	200	Lin.m	SA	24
Modify culvert beneath Belvedere Road	1	Lin.m	SA	24
Gross pollutant traps, concrete	40	m^3	SA	16
Headwalls, concrete	10	m^3	SA	16
Minor detention basins	8	Item	SA	
Connections	560	Item	SA	12
Water Supply				
Headworks	1	Item	N/A	Off site
100 mm Blue Brute water mains	9,000	Lin.m	SA	50
Hydrants	100	Each	SA	12
Allotment connections	560	Each	SA	12
Houseboat connections	150	Each	AUS	20
Wastewater				
Allotment connections, PVC	560	each	SA	24
150 mm gravity sewer, PVC	8,700	Lin.m	SA	50
Maintenance holes, concrete	150	m^3	SA	60
Maintenance shafts, PVC	100	each	SA	24
75 mm HDPE pressure main	1,100	Lin.m	SA	24
110 mm HDPE pressure main	600	Lin.m	SA	24
200 mm HDPE pressure main	800	Lin.m	SA	24
Pumping stations with emergency generator	7	Each	SA	30
Houseboat vacuum service points	150	Each	AUS	20
Vacuum sewer suction pipework, PVC	1,800	Lin.m	AUS	10
Vacuum sewer headworks	1	Item	AUS	24
Connection of existing sewer	1	Item	SA	2
Wastewater treatment plant	1	Item	SA/AUS	Off site
Reclaimed water				
Pumping station	1	Item	SA	6
Distribution pipework, HDPE	1	Item	SA	15
Golf Course River Water Supply				
Relocation of pumping station	1	item	SA	6
110 HDPE pressure main	40	Lin.m	SA	6
Marina				
Vertical bulkhead vinyl sheet piling	1,800	Lin.m	AUS	18
Houseboat service points	80	Each	AUS	16
Mooring poles	300	Each	SA/AUS	20
Security gate and signage	1	item	SA	2
Commercial Area				
Parking areas	1200	m^2	SA	30
Traffic management	1	Item	SA	
Signage	1	Item	SA	2
Vertical bulkhead vinyl sheet piling	1	Item	SA/AUS	10
Landscaping treatments	1	Item	On site	
Cultural Areas, Parks and Revegetation Areas				
Protection to cultural areas	1	Item	SA	6

Item	Qty	Unit	Source	Heavy vehicle movements to/from site
Park furniture	1	Item	SA/AUS	6
Tree planting (mature trees)	600	each	On site	
Tree planting (medium pot size)	9,000	each	On site	
Shrub planting	5,000	Each	On site	
Wetland items				
Diversion structures	1	Item	SA	16
Planting	1	Item	On site	
Field station	2	Item	SA/AUS	8
Waterways - General				
Bank treatment	5,400	Lin.m	On site	
Water transfer pumping stations	3	Each	SA	12
River/waterways culvert interfaces	2	Item	SA	6
River/waterway entrance	1	Item	SA	20
Common Trenching				
Excavation and backfill	10,100	Lin.m	SA	400
Conduits, PVC	2,600	Lin.m	SA	24
Telstra				
Slabs	710	each	SA	24
Power supply				
Headworks	1	item	N/A	Off site
Reticulation, connections and street lighting	710	each	SA	80
Miscellaneous (provision undetermined)				
SA Water existing site remediation	1	Item	SA	20
Reclaimed water winter storage	1	Item	SA	10
Golf course extension (contribution)	1	item	On site	
Other			SA	400
Total site movements over 840 construction days (16 year period all stages)				15,398
Heavy vehicle (delivery trucks etc) movements to/from site/construction day (Ave.)				18

(l) Weed management

Disease and pest plant control will be based on the following strategies:

- liaison will be maintained and advice sought from local Animal and Plant Control (APC) Officer
- in the event that spoil removal is required, this will occur in a controlled manner and only to designated sites
- construction equipment and vehicles will be cleaned before leaving site
- vacant land will be slashed regularly at appropriate times to reduce seed set
- the perimeter of the site will be treated (with advice from APC Officer) regularly to maintain buffer zones
- stock movement will be restricted to and from infested areas
- biological control agents will be introduced as necessary (with advice from APC Officer) to help control specific weeds.

(J) Aboriginal artefacts

(i) Avoidance of areas of archaeological and cultural sensitivity

Following surveys of the site, conducted with representatives of the indigenous people of the area, cultural heritage sites were documented and mapped (refer to Figure 10.1)

The design of Mannum Waters takes into account the location and extent of these sites, and incorporates a number of open spaces over these sites. As such, development will avoid areas of archaeological and cultural sensitivity.

In order to further the integrity of the sites, some may be covered in topsoil and revegetated to stabilise the covers. Other preservation techniques will be adopted in consultation with MACAI.

(ii) Overall project timing

Ongoing surveillance, with the assistance of MACAI, will be undertaken throughout earthworks in accordance with agreed principles. In the event that any additional artefacts are identified standard procedures will be in place to take the appropriate action for each artefact.

(iii) Stop work provision

All Aboriginal objects and places are protected in South Australia. If Aboriginal archaeological material or deposits are encountered that are not described in this report, works within a 100-metre radius of the find would cease immediately, to allow a qualified archaeologist to make an assessment of the find. The archaeologist may need to consult with SA Government's Aboriginal Affairs and Reconciliation Division and the Mannum Aboriginal Community Association regarding the finds.

(K) Entrance channel

There will be one entrance to the houseboat basin. This is located in areas of the levee bank where there are no riparian trees or where existing uses have modified the vegetation.

Excavation of the boat access and water inlet and outlets may cause the severing of a small percentage of roots of nearby river red gums. However, as river red gums have very extensive root systems, the small losses are not expected to affect the growth and vigour of these trees.

Mitigation measures will be as follows:

- the marina and waterways access opening is to be located at the existing on-stream mooring site where the river bank is already modified and disturbed. Two channels will be excavated, one on either side of an existing stand of river red gums, to avoid the necessity to remove the trees.
- large mature trees will be avoided and vegetation disturbance largely restricted to the removal of willows.

- Excavation will precede construction of the water inlet and outlet, and the boat access from the river. This will allow excavation to proceed without introducing turbidity to the river.
- Once excavation is complete, and compaction has taken place, the banks of the marina and waterways will be stabilised. The marina edges will be sheet piled walls, while the banks of waterways will be protected by planting.
- Water from the river will be introduced gradually to prevent scour and resultant turbidity in the river.

(L) **Dredging impacts**

Dredging required to construct the entrance channel will potentially increase turbidity levels. Various strategies exist to minimise the effects of turbidity. These will include timing dredging events to coincide with periods of low water movement, use of a cutter-suction dredge where possible in soft sediments, and where necessary, the use of shrouds around the area being dredged.

Investigations close to the levee bank revealed an interbedded sequence of clays, sands and silts typical of recently deposited alluvial sediments found in the River Murray valley. No sample recovery was possible below a depth of 1.4 m, which suggests that below this depth loose or very loose sands exist.

Given the small volume of sediment to be excavated, the short duration of the dredging and the relatively coarse nature of the sediment, it is very unlikely that increased turbidity will produce any substantial problems for aquatic flora or fauna or for the amenity of the river generally.

If needed, metal shields will be placed around the section of channel being dredged as a silt curtain, so that only a single pulse of turbidity occurs when the shields are removed.. Given the coarse nature of the material to be removed, it is not expected that it would be necessary to employ this procedure to maintain turbidity levels within acceptable levels.

(M) **Batter construction**

Batters will not exceed 1 vertical to 4 horizontal without additional protection as outlined in Section 2.7.8.

(N) **Water in-fill to marina and waterways**

Water infill of the marina will be undertaken as outlined within this section.

(O) **Protection of existing vegetation**

The following measures are proposed for the protection of existing vegetation during construction:

- vegetation removal will be minimised wherever possible by clearly defining work areas, and through using temporary fencing and tree guards as appropriate.
- silt fences and sediment ponds will be placed as necessary around construction areas on the site to prevent runoff of sediment and nutrient-enriched waters into nearby drainage lines and vegetated areas. The effectiveness of these traps should be closely

monitored during construction, ensuring that treated site run-off meets EPA guidelines.

- any removal of trees and other vegetation from the site for the proposed development will be conducted with minimal disturbance to the soil, to maintain the integrity of soil conditions for remaining vegetation and to reduce the risk of soil and other sediment entering drainage.

  Soil stability can be achieved by:

  - removing trees at the base of their trunks rather than removing their root systems. When required, new shoots should be treated with herbicides recommended by Mid Murray Council
  - a staged removal of weeds and landscaping. This will help reduce the risk of soil becoming exposed to wind and water erosion.

- trees or bushes will be checked for animals before and after felling or pruning. Injured animals should be taken to a local vet, or the local wildlife rescue service should be notified
- removed vegetation will be retained for use as native mulch in areas that are proposed for landscaping. This could include using logs for habitat features and seed-bearing species for brush-matting.

(P) Groundwater monitoring

Ongoing monitoring and assessment of changes to the groundwater environment will be undertaken. The proponent will implement a Groundwater Management Plan (GMP) prior, during and after construction and the construction related issues will be incorporated into the environmental management implementation plan (EMIP).

The GMP provides for ongoing monitoring and assessment, which enables determination of the actual effects of the construction of the project on the groundwater. The GMP will specify monitoring requirements to identify spatial and temporal changes to the groundwater system as a result of the development.

The GMP will include:

- details of further investigations, including additional investigation into the behaviour of the marina interface
- management of dewatering activities, including:
  - managing dewatering disposal
  - developing a dewatering trial
  - managing effects from dewatering
- monitoring for disposal of water generated during dewatering activities
- monitoring of water quality in the waterways to assess groundwater outflow to the river environment
- monitoring of impact of reclaimed water irrigation as part of the irrigation monitoring plan.

(Q) **Protection of people, property and structures**

(i) **Public safety during construction**

The Construction Environmental Management Plan (CEMP) is discussed in Section 12.2. It will provide a number of specific measures for managing public safety during construction, including:

- site access controls including fencing, signage and procedural controls to be used to prevent public access. A separate dedicated access will be provided for construction traffic which will be stabilised to minimise sediment transport onto public roads and any material that is will be removed as soon as practical
- construction traffic will be managed using the Traffic Management Plan, which will be developed to minimise and control interaction with public roads and incorporated into the CEMP. Construction traffic will be limited to designated haul roads within the construction areas of the development and appropriate maintenance of the haul roads will minimize potential effects on the public
- separation between construction and developed areas will be used to minimise interaction between construction and the existing town. In the case of later stages, interaction with the previously completed stages will also be minimised. The separation will provide improved public safety and minimise potential environmental effects, such as construction noise and dust. The staging has been planned to minimise the interaction between stages and each stage is a compact and defined area
- the commissioning of the waterways will be performed to eliminate water surges by filling of the waterways in a controlled manner. The equalisation of water levels prior to opening the new stage will minimise risks to users of the existing waterways
- dredging will be performed in accordance with the marine navigation rules defined by the Harbours and Navigation Act 1993.

(ii) **Public safety during operation**

Hazardous material storage

The storage of hazardous, flammable or explosive materials on boats is regulated by appropriate sections of the Environment Protection Act, Dangerous Substances Act and Harbours and Navigation Act where relevant. The individual boat owner will be responsible for the safe storage of hazardous, flammable or explosive materials and where appropriate this will be enforced by the Community Corporation Manager and Marina Manager.

Flammable or hazardous materials will be stored in bunded areas to prevent any spillage from reaching the waterways, as will any workshop facilities. Any bunded area will be required to meet with EPA guideline 080/04. In addition the bund floor and walls must be constructed of suitable materials and must be of sufficient strength and integrity to ensure that it does not fail in ordinary use.

It is preferable that the bunded area has a covered roof to prevent the ingress of rainwater. If this is not the case then a suitable drainage system must be incorporated such that any contaminated liquids can be removed and disposed of safely.

Management of public risk

The refuelling operations proposed within the development are considered in risk terms to be an *extreme risk* exposure, potentially resulting in fire, explosion or toxic spill. In the event of an extreme risk exposure, immediate action is required to manage the risk. Areas designated for refuelling activities will be designed to ensure that adequate protection for spillage, such as emergency spill kits and bunding, which will confine any spills. Further the storage of any fuels will be in storage tanks that meet the requirements of AS 1940 “Storage and Handling of Flammable and Combustible Liquids” and the Petroleum Products Regulations Act 1995. Furthermore, to effectively manage fuel storage refuelling, licence conditions and operating rules will be strictly enforced.

The risks of explosions or spills will be assessed in accordance with AS 4360 – “Risk management” and each of the potential events will be classified to determine the appropriate risk status.

The refuelling operations within the commercial area will be considered to be an “extreme risk” exposure, potentially resulting in fire, explosion or toxic spill. In the event of an extreme risk exposure, immediate action is required to manage the risk.

Any workshop activities and operations within privately owned premises are considered to have a *high risk* exposure. In all instances these activities will be carried out in workshop areas that incorporate safety measures in the event of an accident. Therefore in the case of an explosion or fire the damage will be confined locally to the site on which the premises are situated, in accordance with the Building Code of Australia (BCA). To provide containment to the site, the BCA requires that any workshop buildings have adequate separation and construction type and fire protection installed. Furthermore, the Marina Manger will implement emergency procedures which will involve other emergency services to assist in minimising the potential impact on the facility.

Activities and operations within the public areas and commercial zone such as the hard stand and water’s edge area have been assessed as a *moderate risk* exposure. These activities include the disposal of waste oil and liquids, cleaning and washing of vessels and the like. As these areas will be clearly designated and adequate infrastructure for the containment and storage and disposal of the waste is provided, it is considered that this can be adequately managed and enforced by the Marina Manager as part of daily operations.

The storage of hazardous chemicals has been assessed as having a *low risk*. Storage of hazardous chemicals such as solvents, degreasers, paints/thinners and the like will meet the appropriate sections of the Environment Protection Act, Dangerous Substances Act and Harbours and Navigation Act where relevant. The individual property owner will be responsible for the safe storage of hazardous chemicals and where appropriate this will be enforced by the Marina Manager.

12.3 OPERATIONAL ENVIRONMENTAL MANAGEMENT & MONITORING PLANS (EMMP)

12.3.1 Wetland management plan

The Baseby linear riverine wetland, as indicated previously, has been classified as having a moderate to high conservation status. As with all of the linear wetlands along the Lower Murray, there are risks and impacts – hydrological modification, weeds, stock access, water pollution etc. With the proposed development additional risks can be identified – increased public access, feral animals (dogs, cats), increased weeds (garden escapes), etc. The protection of this area is a significant factor in the design of the marina project, as outlined earlier.

To ensure that it remains protected, it is important that a Wetland Management Plan be prepared at an early stage. Without a plan in place, over time there could be a gradual deterioration in the condition of the wetland area, its conservation value and its amenity/passive recreational value.

An earlier Wetland Management Plan has already been prepared (see EMS, 2005), which addressed the protection of the Baseby linear wetland and proposed constructed wetland. The principles of the previous plan have been incorporated within the current EIS. The plan will be modified to address any design changes in the marina and comments received in response to the EIS as part of the consultation process.

(A) Baseby Linear Wetland

The actions that will be undertaken as part of the Wetland Management Plan for the protection of the Baseby linear wetland are summarised in the following Sections.

(i) Control of public access

The layout of the marina waterways provides a water barrier, with only one bridge crossing, which largely prevents uncontrolled pedestrian access. Additional actions to protect the Baseby linear wetland are:

- the erection of signage advising of access restrictions and that the area is protected
- the strategic placement in the vegetation/landscaping plan of prickly species and/or those which develop thickets, eg Lignum, to also discourage access
- the provision of a dedicated pathway through both the constructed ephemeral wetland and a part of the linear wetland. The location of the pathway and boardwalks will be defined as part of a detailed landscape plan for the anabranch channel and new ephemeral wetland. It is also intended to consult with the Dept of Water Land and Biodiversity Conservation for final design.

Fencing (also feral animal proof) will be used to prevent access, as required, for example, along the base of the levee adjacent the access road, refer Section 2.10 and Figure 2.40).

(ii) Control of stock access

All along the river, damage by stock is a significant issue. The removal of stock from the Baseby Irrigation Area is an important positive.

Fencing along the boundary with the southern neighbour will prevent access to stock from the south (refer Section 2.10). Importantly, access from adjacent properties will also be prevented along the linear wetland by fencing through the shallow wetland areas. This may be undertaken when the wetland is dry in this location.

(iii) **Feral animal control**

Actions will include:

- in consultation with the local control authority, instigating a feral animal control programme, particularly for foxes, rabbits and cats
- advising residents of the need to control cats and dogs and the control requirements of Council will be included in management agreements and contracts
- as indicated above, although there is a water barrier, the use of feral animal proof fences (refer Section 2.10) to complete as much as possible the isolation of the riverine and new constructed wetlands
- the ongoing monitoring of the area as part of a Wetlands Management Plan will include monitoring of feral animals.

(iv) **Protecting water quality**

As indicated previously in Section 11.2.1, the retirement of the irrigation area removes a significant pollution source from the river and wetlands. The intended removal of the wastewater treatment lagoons from the floodplain, adjacent the river and wetlands, as part of the development, is a major positive action. The prevention of water pollution has been an important design and management issue for the proposed development. Key measures included are as follows:

- the treatment of urban stormwater runoff through swales, small detention basins prior to any outflow into the marina basin. The construction of an approximate 6 ha wetland, which will receive all the marina and waterways through flows, will protect the riverine wetland water quality. It is important to note that water sensitive urban design measures are being included in the design, which will regulate stormwater volumes
- all fuelling areas will be bunded, but even so a spill contingency plan will be prepared (refer Section 12.3.3)
- pump out facilities for toilet waste and grey water will be provided for moorings. To date facilities for grey water are not available for boats, which is a significant water quality concern for the river.

Overall with these measures, the removal of the wastewater treatment lagoons, the removal of stock and the retirement of the irrigation area, the net result should be a significant improvement of water quality.

(v) **Specific actions for the four management units**

- Ephemeral Wetlands (Management Unit 1)

  Actions specific to this zone are:

  - the rehabilitation of the wetland basin near the boat mooring area, to reinstate more natural inundation patterns
  - preventing boat access to the permanent water wetland area, north of the boat mooring area, both to protect the wetland and the Aboriginal canoe trees

- maintaining the existing patterns of inundation and drying, that is, ensuring that there is no modification of the current ability of river water to inundate the wetlands
- continued facilitation of the natural regeneration of *Eucalyptus camaldulensis* (River Red Gum)
- removal and ongoing control of *Cyperus eragrostis* (Drain Flat-sedge), *Paspalum distichum* (Water Couch) and *Pennisetum clandestinum* (Kikuyu) followed by revegetation with shorter emergent aquatic macrophytes
- control and revegetation of the beds of *Phyla canescens* (Lippia).

- Riparian Woodlands and Shrublands (Management Unit 2)

  Actions specific to this zone are:

  - removal and ongoing control of *Lycium ferocissimum* (Boxthorn) followed by revegetation with *Muehlenbeckia florulenta* (Lignum) and native chenopod shrubs
  - removal and control of the potential environmental weeds *Casuarina cunninghamiana* (River Oak), *Eucalyptus spp*. (Western Australian Eucalypts) and *Schinus areira* (Pepper-tree)
  - control and revegetation of the beds of *Phyla canescens* (Lippia).

- River Murray Frontage (Management Unit 3)

  Actions specific to this zone are:

  - the existing boat mooring area will be the site of the main entrance into the proposed marina. Because this is a modified area, this in itself should not be an issue. As this work is completed the remaining car parking/mooring area will be rehabilitated, by planting with native species
  - the area of open river bank to the south of the boat mooring area will be extensively planted with native species
  - at the northern extremity of the study area, adjacent to Mannum, there will a second opening to the proposed marina basin, which has a high proportion of weed species. Following construction the embankments will be rehabilitated with native species
  - staged removal and control of the environmental weed *Salix babylonica* (Willow) and its understorey weeds followed by revegetation with *Eucalyptus camaldulensis* (River Red Gum), *Muehlenbeckia florulenta* (Lignum) and their understorey aquatic macrophytes
  - removal and ongoing control of *Lycium ferocissimum* (Boxthorn) followed by revegetation with *Muehlenbeckia florulenta* (Lignum) and native chenopod shrubs.

- Inland Levee Bank (Management Unit 4)

  Actions specific to this zone are:

  - removal and ongoing control of *Lycium ferocissimum* (Boxthorn) followed by reduction of height and revegetation with native chenopod shrubs

- control of rabbits and their warrens
- removal of the potential environmental weed *Nicotiana glauca* (Tree Tobacco).

(vi) **Monitoring**

The following will be included in an ongoing monitoring programme.

- Water quality monitoring

  A water quality monitoring programme will be required for the proposed development, including the anabranch channel, the new constructed wetlands and waterways as previously discussed in Section 2.3.10. .

- Annual inspection of infrastructure

  This will include the annual inspection of:

  - inlets to the marina basin for any erosion, with remedial action taken as necessary
  - all fences and signage, with repairs/replacements undertaken as necessary
  - paths or boardwalks for deterioration damage, with repairs undertaken as necessary.

- Ecosystem Response

  Ecosystem response or biological monitoring will involve:

  - establishing adequate baseline data, against which the results of future monitoring can be compared. This will involve fauna and flora surveys over a 12 month period, to account for seasonal variables.
  - ongoing monitoring to determine the effectiveness of the various management actions outlined above, e.g. weed occurrence and control
  - ongoing monitoring to detect at an early stage any changes that may be occurring, which may be due to the development, so that remedial action can be initiated.

Elements of the monitoring are outlined below:

- Establishing baseline data

  This will involve undertaking surveys for flora and fauna (mammals, reptiles, birds, amphibians, fish and aquatic macroinvertebrates) over a 12 month period, to coincide with the seasons, starting in mid-2007. The existing work will be used to design the further work. For the first few years after the construction of the marina development, surveys will be undertaken at least annually and preferably semi-annually.

  Survey protocols will, as appropriate, be in accordance with Tucker (2004). Transects. However, a difficulty of the wetland area is that large areas are covered by dense impenetrable thickets, which provide both habitat and protection, but making access and random sampling, say using quadrats, difficult. An additional methodology that could be usefully employed both in the establishment of a baseline and future comparative monitoring, is the use of established transects. The transect method is recommended to provide medium term monitoring of the holistic condition of the Baseby wetland. It is the Rapid Appraisal of Riparian Condition method developed by Jansen et al. (2003). The method places transects across the riparian zone and then rapidly assesses a range of riparian condition indicators. The rapid assessment is summarised in a condition score out of 50. By repeating this assessment over time any trends in riparian condition can be detected, with appropriate intervention to follow.

The baseline surveys will also:

- confirm and define all photopoints (with field markers).
- establish permanent quadrats locations at photopoints.
- provide a more detailed definition of vegetation, e.g. delineate the occurrence of various aquatic plant species.

- Monitoring of weeds and their control

  Weed control, particularly for weeds such as Boxthorn, will be given a high priority in order to prevent further spread. The success of this programme will require regular monitoring with the detection of any new growth acted on as soon as possible. This would also minimise ongoing costs of eradication.

- Red Gum Health

  The previous discussion of *Eucalyptus camaldulensis* (River Red Gum) health under each Management Unit concluded that the population of Baseby Wetland was in a very healthy state, scoring the highest possible value (5) on Tucker's scale.

  Tucker's tree health assessment scale can be applied to trees encountered during the application of parts 1-4 of the monitoring program listed above and compared with the starting score of 5. Any decline in health should trigger intervention.

- Reporting

  It is anticipated that a report on all monitoring will be produced annually.

(B) Channels and constructed wetlands

The success of the anabranch channel and constructed wetland, both with respect to the eventual development of a diverse fauna and flora and amenity, depends upon:

- the civil engineering design features
- the landscaping plan, its implementation and initial maintenance (lasting several years), and
- long term management and monitoring.

These are individually addressed below.

(i) Civil engineering design features

As indicated previously, the civil design concept is in part being developed to meet the requirements of the vegetation to be established, both riparian and aquatic. This includes the ability to vary the water levels in the ponds annually and seasonally, by varying the volumes diverted from the anabranch channel, and to simulate a flooding event in Ponds A to mimic natural flooding events, which is necessary for the maintenance of the riparian species.

With regard to long-term management, features to note are:

- there is only one diversion point, which feeds all of the ponds. Therefore water levels in all ponds can be observed and recorded at the same time. Gauge boards will be placed in each pond for the regular recording of water levels and adjustment as necessary. Having only one diversion/distribution point will simplify water level management.
- there is only one outlet structure from Pond A to Pond B. It is intended that these locations are easily accessible. They will only need to be opened and closed approximately once every three years.
- the screen controlling the entry of larger carp needs to be regularly cleaned and inspected for damage. Having only one location simplifies this task.

(ii) **Landscaping plan**

A detailed landscaping plan will be prepared as the detailed civil design is finalised. In summary, the intent will be:

- to create along the anabranch channel and Ponds A similar riparian and wetland communities that currently exist within the riverine wetland area
- to select a suite of native species for planting endemic to the region from those currently in the area
- to collect propagules from the existing riverine communities (with approvals as necessary).

Important considerations are as follows:

- for each specific area, a planting schedule will be prepared, which is likely to extend over a number of years. This will identify species, planting densities, period of planting, species in first, second, third year etc. Some species may not be introduced into the terrestrial or riparian zones, for example, until there is a closed canopy/sufficient shading for their particular needs
- initial weed control/eradication will be necessary
- initial and ongoing rabbit control will be necessary
- maintenance will be required for the first few years, including for example:
    - watering of terrestrial plantings in summer
    - weed control (critical) within terrestrial and riparian zones
    - the removal of invasive aquatic species such as Typha dominogensis from the ponds while other preferred species are becoming established
    - replacement of any losses with the same or other suitable species.

Access is important during the establishment period for maintenance. As plantings such as Lignum develop thickets access will become increasingly difficult. Staging the construction of the anabranch channel and ponds will help.

Initially, after its construction in Stage 1, the anabranch channel will be accessible along its whole length from both sides. However, when Ponds A are developed this will make access (vehicular) more difficult on the southern side. Similarly, when Ponds B are developed access is increasingly more difficult. It is to be remembered that the intent is restrict public access to some areas by not providing a pathway through these areas and by developing dense thickets of prickly species. Once this is achieved, the need for regular access for maintenance should be greatly reduced.

(iii) **Long term management and monitoring**

Tucker (2004) outlines in some detail the rationale and protocols for monitoring, data collation and interpretation, to assist in the management of wetlands. As appropriate, these will be adopted as standard procedures. The adoption of standard procedures will ensure consistency with time. Adopting the same procedures as used elsewhere will enable comparisons to be made with other areas. At this stage, it is anticipated that the long-term management and monitoring will require the following:

- the shallow groundwater will be continuously monitored to determine salinity and watertable level. Shallow piezometers will be established for this purpose. Their number and locations will be determined during the investigations to be undertaken as part of the detailed design of the groundwater interception system
- the design of this system and monitoring, for a period of years after installation, will be undertaken by a qualified hydrogeologist
- the preparation of a water level management schedule, which specifies the objectives for each year over a two, three and ten year cycle, enabling longer wetting and drying cycles and flood event simulation
- water diversions from the anabranch channel will be metered. Although this is required for reporting on the use of ELMA water, it is also important to continually review the usage of water. Observations of the condition of the riparian vegetation and aquatic communities will also be made. While efforts will be made to use water efficiently, the ecological needs are paramount
- annual inspections will be undertaken of all infrastructure, including, pipes, culverts, paths, boardwalks, signage and repairs undertaken as required. The diversion structure will be inspected prior to the commencement of flows each year and the carp screen inspected monthly during the periods when diversion is occurring
- regular surveys and inspections will be undertaken to record:
    - flora condition, including the assessment of tree health, the occurrence of new species by natural causes, particularly those with a conservation status
    - the occurrence of weed infestation
    - terrestrial fauna (birds, reptiles, amphibians)
    - the occurrence of feral species.

  While during the establishment phase the objective will be to monitor the success of the planting programme, in the longer term they will be to:

    - document the establishment of the biological communities and changes in biodiversity
    - identify the need for intervention (weed eradication, additional planting)

- the need for feral animal control (e.g. destruction of rabbit warrens).

  This work will be undertaken by qualified personnel (botanist, zoologist etc.).

- regular surveys will be undertaken of the wetland ponds, to determine:
  - condition of aquatic flora, emergent and submerged;
  - macroinvertebrate species present and diversity;
  - amphibians present;
  - fish species present and if and when carp eradication is required (during dry periods)

  This work will be undertaken by qualified personnel (botanist, zoologist etc.).

- As part of the above surveys photopoints will be established for future reference.
- Water quality monitoring will be undertaken in the anabranch channel and wetland ponds, as follows:
  - anabranch channel

    As the outlet for the marina basin, monitoring on a regular monthly basis, determined in consultation with State Government agencies, will be for:
    - conductivity/salinity
    - pH
    - dissolved oxygen
    - suspended solids/turbidity
    - nutrients
    - heavy metals (Cu, Pb, Zn)
    - hydrocarbons
    - algal blooms (i.e. chlorophyll A and B)

    The most appropriate location would be near the outlet to the river.

    The objective will be to characterise the quality of water being returned to the river. It is to be noted that this will be part of a broader programme of monitoring water quality in the marina basin (including sediments) and inflow quality into the waterways from the river.
  - wetland ponds

    Monitoring of water quality in wetland ponds will include:
    - turbidity
    - pH
    - temperature
    - salinity
    - dissolved oxygen

The objective will be to examine seasonal variations in these parameters. Fixed monitoring points will be used using markers. For dissolved oxygen diurnal rhythms will be examined, particularly in the summer and during the initial period of inundation following a dry phase.

Water quality monitoring is likely to be a condition of approval for the overall project. The collection of samples and field measurements will be undertaken by qualified personnel, with samples analysed at a NATA certified laboratory. Sample containers will be provided by the laboratory, with sampling, sample handling and delivery in accordance with standard procedures.

Annual reviews of all data collected will be undertaken and a summary report prepared.

As outlined in Tucker (2004), the key is adaptive management. By continuous monitoring and evaluation of data the response of the wetland to management can be determined and management improvements made if necessary. Also important is the provision of early warning of developing problems, which require intervention, before significant damage occurs. This could, for example, include an increase in salinity, or the occurrence of invasive weeds.

12.3.2 Infrastructure and waterway maintenance

(A) Infrastructure

Infrastructure maintenance will involve:

- Listing all items requiring regular inspection and periodic maintenance and the development and consolidation of all maintenance schedules and manuals into one progamme. Items will include:
  - water transfer pumps
  - wetland diversion weirs and culverts
  - field monitoring stations
  - boardwalks
  - bridges
  - marina bulkheads
  - moorings
  - reserves (irrigation etc.)
  - fences (particularly feral proof fencing) and gates
  - signage.

(B) Waterways

The marina basin and waterways will require regular policing and management, including:

(i) Floating rubbish and debris

To ensure against litter being generated by the users of the marina, a waste collection system will be employed with receptacles for waste provided in convenient locations within the commercial zone including adjacent the wharf and boat ramp facilities. The receptacles will have self-closing lids to prevent escape of rubbish, manage odours and to exclude rainwater, rodents and scavengers.

It is inevitable that the floating debris can enter the marina, however the area immediately inside the marina entrance provides an area for the debris to settle out where it can be removed as part of a management plan to ensure water quality of the waterways is not compromised.

(ii) Vessel speed control

Within the marina boating speed will be restricted to a maximum of 4 knots. This will also reduce the resuspension of bottom sediments which would otherwise result in increases in turbidity. For safety, all boat owners are expected to comply with the international boating code which outlines navigational requirements and other safety aspects, in accordance with the marine navigation rules.

Leisure activities such as jet skiing and waterskiing within the internal waterways will not be permitted, with the exception of transporting the vessel from its berth to the open river. These circumstances will require users to adhere to speed restrictions, which will reduce the level of noise.

(iii) Waterway levels and maintenance

Water levels will be subject to levels within the River Murray. No further control is proposed within the Mannum Waters development

Measures to minimise and contain pollutants from entering the waterways from the development are discussed in Sections 2.3 (Houseboats) and 2.7.2 (Stormwater).

The intention of the monitoring will be to ensure that standards of management are maintained, detect at an early stage any developing problem and through adaptive management ensure continuing protection.

(iv) Maintenance dredging

The marina and channel have been designed to minimise the need for maintenance dredging, and as it does not allow sediment and silt movement through the mouth of the marina, thereby avoids sediment build-up in the channel where it might affect safe navigability of the channel. Also, the marina is deeper than it needs to be for houseboats. As a result, maintenance dredging of the navigable channel is expected to be very infrequent, and at this stage is assumed to be of the order of once every 15 to 25 years.

Where required, it is proposed to use a conventional cutter suction dredge to excavate sediment from the channel and pump it to a disposal site. The use of a cutter suction dredge will result in minimal turbidity increases in the waterways. As dredging will largely be restricted to the main waterways and marina basin there will be minimal disturbance to any aquatic vegetation.

All material excavated by the dredging activities will be placed on land and there is no disposal to river proposed. The material will be pumped to sedimentation basins, with any overflow directed into the new vegetated areas and not allowed to reach any drainage. The dried material obtained from the basin will be to create mounding in the new vegetation areas.

The environmental management of this operation will be undertaken in accordance with the Dredging Management Plan, which will have been developed in consultation with the EPA prior to the commencement of excavation.

12.3.3 Spill contingency plan

Provisions will be included in the House Owner's Charter, Marina Owner's Charter and commercial area obligations in regard to practices to avoid pollutants.

The design of the sewerage system incorporates preventative measures to manage any potential sewage spills or leaks. The design and construction will be performed in accordance with the current specifications and guidelines of the relevant water authority i.e. SA Water. These measures include utilisation of vacuum sewers in low lying areas, locating the sewer mains within the road reserve to assist in containing possible sewage leaks or spills and avoiding the construction of sewer mains beneath the waterways, in order to minimise serviceability and maintenance issues. Alarms, emergency generators and emergency storages will be incorporated in all pumping station as required by SA Water to protect against potential spills.

The use of hazardous chemicals or materials within the commercial area will be subject to approval from the Marina Manager and the EPA where required. Bunding of areas where the use of chemicals is allowed will ensure that any accidental spills will be contained.

Emergency response procedures will be incorporated in the spill Contingency Plan for the development. These procedures will provide information regarding contacting the relevant emergency services personnel and information regarding the methodology and equipment for containment and disposal of spills or sewage leaks.

A waste oil depository will be located in a convenient location adjacent the commercial areas to provide appropriate facilities for the disposal of waste oil.

As part of the Emergency Response measures described above, the following procedures will be incorporated into the Spill Contingency Plan:

- the Marina Manager should be the first point of contact. Information will be provided in conspicuous locations to advise the public of the contact details of emergency services personnel and the Marina Manager
- the method of containment will depend largely on the location of the spill and the type of substance. Wherever possible the containment of the spill to the land is a priority. Therefore, all entry points to the stormwater drainage systems shall be sealed to prevent spill from spreading. A floating boom would be installed at the main entrance to the marina and control mechanisms provided at each of the bridges, water transfer stations and inlet and outlet culverts
- emergency spill kits will be located at the commercial wharf area and in other areas as deemed appropriate.

- the Marina Manager will record all details of the spill or leak including the time of the spill, location and any information regarding the type of substance and an estimate quantity
- upon notification, the Marina Manager shall contact the necessary emergency service personnel. Further in the case of a large oil spill the State Oil Spill Commander will be contacted to coordinate any additional resources to assist in the containment and clean up operation
- in the case of hazardous materials including fuel, oil, and sewage spills the EPA shall be notified. The containment of the spill is of the utmost importance.
- the clean up and disposal of the spill will be carried out by an appropriately licensed Contractor. In the case of a sewage spill the Marina Manager shall contact SA Water for the maintenance and operation of the wastewater treatment system.

12.3.4 Terrestrial weed control

Weed control measures during construction are outlined in Section 12.2.5. These measures will continue to apply throughout the operational life of the project where appropriate. In addition, spread of pest plants from the developed area into areas of native vegetation will be minimised through:

- restricting access to native vegetation areas
- maintaining weed control in the buffer areas between residential allotments and the riparian zone
- monitoring the edges of native vegetation areas and responding with appropriate management if new infestations occur
- informing residents of the importance of weed control through appropriate signage or printed material.

New developments can potentially impact on adjacent habitat areas as a result of weeds (garden escapes) and also human intrusion, feral animals (cats and dogs) etc.

In this instance the “edge effect” will be minimised by the above measures and:

- the separation of the development area from the riverine habitats by the large constructed wetland and revegetation zone. These will provide a substantial buffer
- the wetland management plan, which will address existing weed threats as well as monitoring of any new invasions.

12.3.5 Waste management

(A) Solid waste from boats

A waste collection system will be employed with receptacles for waste provided in convenient locations. The receptacles will have self-closing lids to prevent escape of rubbish, manage odours and to exclude rainwater, rodents and scavengers.

Users of the facility will be encouraged to segregate the rubbish to enable the recyclable materials to be separated at the point of disposal. This will be achieved by providing clearly marked bins and signs identifying types of materials that may be deposited in each recycling container.

All collection of rubbish will be carried out by the Mid Murray Council and shall be treated or disposed of at an appropriately licensed facility.

(B) Commercial area waste

The measures outlined in Table 12.3 would be applied for waste management within the commercial area.

Table 12.3 – Commercial area waste management measures

Waste type	Management measure
General store / chandlery / retail and entertainment	A dedicated bunded waste disposal area would be provided for waste collection bins, for removal by a licensed waste disposal contractor.
General wastes	General wastes would be stored in the on-site bunded waste area for removal by licensed contractor.

(C) Household waste

The existing arrangements will continue and be extended according to the growth of the area. Waste disposal for the new residents will be undertaken by Mid Murray Council.

12.3.6 Refuelling facilities

The refuelling facilities will be designed to best practice guidelines as detailed in Protecting Our Coastal Waters, Doing It Better, Refuelling Guidelines (Transport SA 2003) and Code of Practice for Vessels in Inland Waters (EPA 2003). In addition, the Marina Owner's Charter will include refuelling restrictions, prohibiting the hand refuelling of vessels from individual drums, cans or containers anywhere in the waterways.

Any commercial premises storing flammable or potentially explosive materials will be required to install appropriate fire safety measures such as automatic sprinklers and will also require the storage of materials in a secure area, which is appropriately bunded. The storage facilities will need to meet the requirements of AS 1940 "The Storage and Handling of Flammable and Combustible Liquids".

The Marina Manager must ensure safe navigation and use of the refuelling facility in accordance with the provisions of the Harbours and Navigation Act, 1993.

12.3.7 Pump out facilities

It is proposed that a sewage pump out facility will be installed which meets the "Best Practice Guidelines for Waste Reception Facilities at Ports, Marinas and Boat Harbours in Australia and New Zealand" (ANZECC 1997).

A pump out point will be provided at a service point within the commercial area. All reception points and storage containers will be clearly identified to provide information on the correct use and the types of wastes that are accepted.

The connection fittings for the waste facilities will be standardised (ISO) connections with a quick coupling to ensure compatibility with vessel waste systems designed in accordance with the appropriate Australian Standard: Pleasure boats - toilet waste collection, holding and transfer systems (AS 3542 1996). The pump out facility will be connected to the sewage treatment and disposal system, and wastewater from vessels will be treated in the same manner as sewerage from land based activities.

12.4 EMMP MANAGEMENT AND REPORTING

Monitoring, reporting and auditing of the operational EMMP will be undertaken. In order to ensure the environmental management plans are effectively controlling the potential risks, monitoring and reporting of the outcomes is incorporated.

Further, this allows ongoing assessment and modification of the plans in order to improve the outcomes sought. Independent auditing of the management, monitoring and reporting process will be undertaken to further enhance the degree of certainty associated with the operation of the plans.

13 Management maintenance and monitoring agreements

13.1 MMM AGREEMENTS

It is proposed that an agreement between the proponent and Mid Murray Council will be established for the control of the project during and after construction to ensure:

- informed decision making
- coordination of the preparation of the PAR for the development site
- that the project is undertaken in an orderly, economic and efficient manner
- the long term maintenance and care of the facilities.

To that end, a Project Control Group (PCG) will be established as a vehicle for managing the development of the primary infrastructure for the project and its management thereafter. This body will provide a regular forum for representatives of the proponent and Mid Murray Council to meet together with any relevant infrastructure development consultants and contractors to review, discuss and exchange ideas in relation to any or all aspects of the development.

The representatives from Mid Murray Council will report to Council the outcomes and progress of the development as recorded at the PCG. The arrangements require:

- monthly meetings
- reports on the progress of the infrastructure development including the proposals for the infrastructure development which will be presented to the Project Control Group
- the PCG to facilitate approvals and agreements in relation to the infrastructure development

Further, the proponent as the Development Manager of the project will:

- provide all necessary management and other services required to implement the development of the infrastructure
- conduct all operations in a proper, efficient, economical and safe manner
- prepare and submit to the Project Control Group regular reports on the progress of the implementation of the infrastructure development
- prepare and submit for execution to the necessary authorities all documents required to divide the development area into allotments and marina berths

- ensure compliance with all applicable laws and regulations and lawful directions of any Authority and in particular implement the infrastructure development in accordance with the Act and all other planning and development legislation
- do all other things necessary to implement the infrastructure development
- plan and submit to the Project Control Group for consideration proposals as to the stages and sections of the development area to be developed
- supervise direct and control all site work and installation of services
- call tenders where necessary
- ensure appropriate Contractor’s Risks, Public Liability and Workers Compensation insurances and make payment of all required Work Cover levies
- take all reasonable steps to minimise any industrial or other disputes that could affect the development
- execute all such acts deeds documents and things as may be necessary or incidental in expeditiously completing the infrastructure development.

13.2 LEGISLATIVE CONTROLS

The development of the land by the creation of allotments and provision of infrastructure will be controlled primarily by the *Development Act 1993* and the Regulations thereto, which by definition includes the Development Plan. This includes the building of sheds, dwellings and commercial infrastructure, as well as the use of land and buildings. Further, the Environment Protection Act, Regulations and related Policies will control development in terms of the licensing and operation of prescribed activities. Activities may also require licences and approvals from various other authorities including EPA, DWLBC, DAARE, PIRSA, Liquor Licensing Court, DH and SA Water . In addition to these normal control mechanisms, it is appropriate and common in integrated development schemes such as marinas to incorporate additional measures to manage and control activities as discussed in Section 13.1 above. These measures provide confidence in terms of the expectations and use of the area and thus provide additional protection of the interests of users and landowners.

All titled property will have an encumbrance registered on the title which sets out the various requirements or obligations for the development form, land use, occupation and activities appropriate to the property. There will also be a Marina Owner’s Charter that applies to the use and development of the marina and waterways. Enforcement of these agreements and rules will be the responsibility of the proponent and the Mid Murray Council though the Community Corporation Manager and Marina Manager.

In terms of building development, the following factors are intended to be incorporated within the development plan policies established through the PAR process:

- requirements for applications
- approval process
- land use
- design character

- siting of development
- building height
- building setbacks
- building materials and finishes
- water and energy efficiency measures
- outbuildings
- plant and equipment
- landscaping
- fencing
- privacy
- stormwater management;
- pollution control
- definitions
- maintenance
- construction management
- land use relationships.

Council by-laws, the Community Corporation Scheme Description together with the Marina Owner's Charter agreements and the marina rules provide control and guidance for various activities on and adjacent the waterways including:

- the use and berthing of vessels
- vessel types
- vessel speed
- maintenance and related activities
- fishing areas
- swimming areas
- maintenance of facilities and vessels within the water
- activities on landings and berths
- wharf access and use
- refuelling
- parking controls

Where appropriate, the Development Plan will reflect aspects of the agreements relating to the development and use of land, thereby reinforcing the intent of those agreements and desire for development that satisfies the character, form and function expectations of the development.

The proposed agreements and guidelines will provide confidence to users that a high quality and consistency of development will be established and assurance that a sustainable environment and an attractive and desirable amenity will prevail in the long term.

13.3 SAFE NAVIGATION LEGISLATION

Public safety will be controlled by a consistent approach to the application of rules, by-laws and regulations. These include normal Department of Transport, Energy and Infrastructure (DTEI) boating safety requirements, Mid Murray District Council requirements (enacted via Council by-laws). The Marina Manager will be charged and where appropriate delegated responsibilities to assist policing of activities on and around the waterways.

Measures to ensure safe navigation include:

- within the waterways boating speed will be restricted to a maximum of 4 knots. All boat owners are expected to comply with the DTEI Maritime and Boating rules.
- Navigational markers will be erected from the channel in the River Murray into the main basin area which will define the main navigation areas. Signs will also be posted indicating a standard 4 knot speed limit.

13.4 CONTROLLED ACTIVITIES WITHIN MARINA

Controlled activities to ensure public safety on and around the waterways include the following:

- swimming and wading activities will be prohibited within the marina and the dredged entrance channel to the marina. Warning signs will be erected in conspicuous locations. Council will have the power under the Local Government Act to police this and fine offenders to actively discourage this practice.
- fishing activities will be allowed in areas signposted for such activities. Fishing using handheld fishing lines from privately owned water front properties will be allowed, however restricted to the owners of the area. No fishing activities will be permitted in the main berthing areas of the marina
- no structures other than approved structures for the berthing of boats will be constructed in the waterways
- the safe use of Personal Water Craft (PWC) such as jet skis will be governed as prescribed by Transport SA
- non-powered vessels less than 3.0 metres (canoes and kayaks) will be allowed in the recreational areas of the waterways but will be prohibited from the private wharf and berths areas
- public areas will be under the control of Mid Murray Council. As such Council will manage any safety issues relating to the operation and management of the facility
- the commercial areas will be privately owned under a Torrens title arrangement. As such public safety will be managed under the arrangements made by the private title owner.

13.5 MARINA BERTHS

The marina berths and the marina waterways would be subject to conditions of use that would be reflected in the Scheme Description and By Laws under the Plan of Community Division. The Community Corporation Manager and Marina Manager would be responsible for the enforcement of the conditions of use.

The draft points to be incorporated into the Scheme Description and By Laws are included in Appendix C.

14 Legislation and planning context

14.1 DEVELOPMENT ACT 1993

The *Development Act 1993* makes provision for both the:

- orderly development of the State
- assessment of proposals that have the potential to adversely impact on the environmental, social and economic climate at the local, regional or State levels.

The Act is divided into two sections as follows:

- Planning schemes
  - Division 1—The Planning Strategy
  - Division 2—Development Plans.

The Planning provisions of the Act set out an overarching strategy for development in the State (the Planning Strategy), and make provision for development plans for each geographic region of the State (the Development Plans).

The Strategy is a vision of the development of the State in an orderly manner, whereas the Plans are specific to geographic regions, and contain a greater level of detail as to what is permissible within the context of the plan.

The strategic and development plan policies of relevance to the development are outlined in Section 14.2 below.

14.1.1 Assessment provisions

The assessment provisions of the Act set out the circumstances under which a proposed development is submitted for assessment against a range of planning and environmental criteria, and the assessment methods to be used under specified circumstances. For example, assessment under ‘Crown Development’ provisions differs from that under the ‘Major Development’ provisions.

In general, there are three levels of Major Development assessment that can be applied to a propos:

- Development Report (DR)
- Public Environmental Report (PER)
- Environmental Impact Statement (EIS).

The EIS is the highest level of assessment.

It has been determined by the State Government that the Mannum Waters proposal will be assessed under the Major Development provisions, and that the level of assessment will be an EIS.

The Guidelines for the EIS are discussed in Section 14.3, which demonstrates how this EIS addresses the guidelines. A copy of the Guidelines is contained at Appendix A.

14.2 PLANNING STRATEGY AND DEVELOPMENT PLAN

14.2.1 State Strategic Plan

The Premier of South Australia launched South Australia's Strategic Plan (SASP) in March 2004 which has been updated in January 2007. The Plan has a ten year horizon and is directed at the whole of the State, with a focus on creating opportunity for all of its people. There are six interrelated objectives:

- Objective 1 – Growing prosperity: sustained economic growth resulting in rising living standards with all South Australians sharing in the benefits through more and better job opportunities and accessible, high quality services.
- Objective 2 – Improving well-being: being healthier and fitter, having less crime and feeling safer and with a particular emphasis on preventative measures, including education programs.
- Objective 3 – Attaining sustainability: South Australia must be world-renowned for being clean, green and sustainable. This will boost community well-being, safeguard future generations and contribute to the State's prosperity. The focus will be on protecting our biodiversity, securing sustainable water and energy supplies, and minimising waste.
- Objective 4 – Fostering creativity: innovation and creativity provide South Australia's future capital for growth and expansion.
- Objective 5 – Building communities: enhancing peace, pride and prosperity and building social capital to attract new migrants, visitors and investors, who bring skills, resources and economic life.
- Objective 6 – Expanding opportunity: 'strong, healthy democracies are built on inclusive societies where all citizens, irrespective of circumstances, have the means and opportunity to participate in the civic, cultural, social and economic life of their communities.'

Areas where the proposed development will facilitate elements of the SASP's targets are:

- T1.1 – Economic growth. The project will provide a significant economic stimulus to Mannum (refer Section 11.4.4)
- T1.10, T1.11 – Employment opportunities (refer Section 11.4.4)
- T1.15 – Tourism opportunities (refer Section 11.4.4)
- T1.21 – Infrastructure augmentation (refer Section 11.4.4)
- T1.22 – Opportunity for population growth (refer Section 11.4.1)
- T1.26 – Opportunities for Aboriginal employment (refer Section 10.5)

- T2.3 – Recreational opportunities (refer Section 11.4.9, 11.4.10)
- T2.12 – Opportunities for improving the work-lie balance (refer Section 11.4.12)
- T3.1 – Improve and increase habitats (refer Section 11.3.2)
- T3.2 – Improve soils in the existing river flats (refer Sections 11.3.3 and 11.3.4)
- T3.5 – Offsetting carbon emissions with plantings (refer Section 11.5)
- T3.7 – Ecological footprint is enhanced with development on degraded land (refer Section 4.1)
- T3.9 – Adoption of water saving techniques and reuse of reclaimed water (refer Section 11.4.7)
- T3.10 – Assist river flows by return of surplus water allocations (refer Section 11.2.2)
- T3.11 – Limit saline groundwater flows to the River Murray (refer Section 11.2.4)
- T3.14 – Promote and encourage energy efficient dwellings (refer Section 11.4.7)
- T4.4 – Assist in understanding Aboriginal culture through preservation and interpretation (refer Sections 10.5 and 10.6)
- T5.9 – Increase regional population (refer Section 11.4.1)
- T6.1 – Assist in improving Aboriginal wellbeing by involvement in the construction and operational phases (refer Sections 10.5 and 10.6)

14.2.2 Planning Strategy for Regional South Australia

In its report *Planning Strategy for Regional South Australia, January 200, Planning SA, Department of Transport and Urban Planning*, the Government has stated the following:

> The South Australian Government supports the development of regional areas of the State through sound and responsive planning that encourages and facilitates development based upon land use that balances development and conservation.
>
> The Planning Strategy sets out the State Government's vision for development. It indicates directions for future growth and development to the community, the private sector and local government. The Government also applies it to its own development activities.
>
> The Government is committed to understanding the needs and priorities of people in regional South Australia. Future prosperity is dependent largely on the economic, environmental, cultural and social wellbeing of regional communities.
>
> Regional communities exert an influence far beyond their size and population. Much of the primary produce, minerals and petroleum from these regions is exported, contributing about two thirds of the State's exports and a significant proportion of its manufacturing and services wealth.

(A) Strategies specific to Murraylands planning and development area

Within the regional planning report, strategies have been identified specific to the Murraylands area. Mannum lies in this area and the relationship of the strategies to the proposed development of Mannum Waters include (the numbers are references taken from the Regional Strategy):

- 10. Further develop and market the area's tourist attractions including:

- e. recreation and boating opportunities

- 11. Develop new tourism ventures and products.
  - a. Promote river bank development around Murray Bridge and Mannum in keeping with the character of the area.
  - d. Promote nature-based developments that address the river, wetlands or conservation parks.
  - f. Improve facilities for houseboats and leisure boats along the river including, mooring and refuelling facilities.
- 13. Protect and enhance biodiversity and essential ecological processes.
- 14. Recognise the importance of a healthy River Murray to the economic, social and cultural prosperity of the communities along the length of the river.
- 15. Protect and restore key habitat features in the river, riparian zone, flood plain and estuary to enhance ecological processes.
- 16. Protect and restore healthy riverine and estuarine environments and high value floodplain and wetlands of national and international importance.
  - b. Improve the biodiversity value and long-term viability of wetlands.
  - c. Avoid the development of flood prone land to safeguard development and minimize environmental impacts.
  - d. Minimise disturbance to the shape of the bank and riparian native vegetation in any development of river front land.
- 17. Prevent the extinction of native species from the riverine system.
- 19. Promote ecologically sustainable development and rehabilitate degraded areas on the River Murray flood plain.
- 20. Remove evaporation basins from the flood plain.
- 21. Control drainage and run-off to protect water quality and environmental health.
- 27. Manage salinity to minimise impacts on ecological processes and productivity levels.
  - a. Investigate options to use planning tools to prevent further irrigation development in areas of high salinity impact risk, linked with water allocation and catchment management plans.
- 29. Minimise the impact of potential pollutants such as sediment and pesticides within riverine environments.
- 30. Maximise sustainable use of regional water supplies by managing demand and providing opportunities to supply future needs.
- 32. Promote measures that will protect and enhance the area’s native vegetation and associated fauna.
- 33. Develop community-based conservation strategies to maintain the ecosystem in a multiple-use framework.

- 35. Develop vegetation rehabilitation programs on degraded land to lower the water table and process wastes.
- 36. Protect and enhance natural areas, scenic routes and landscapes from unsightly development by minimising its visual impact.
  - a. Develop urban areas adjoining the River in a manner that protects the natural character of the River while accommodating sensitively designed and located urban activities and tourist and recreation facilities.
  - c. Protect and enhance the River environments and ecosystems and ensure development does not change the natural dynamics of these areas
- 38. Plan, manage and service the expanding permanent, holiday and tourist populations at the many river towns and settlements including Mannum, Swan Reach, Blanchetown and Morgan, with Murray Bridge as the area's principal town.
- 39. Ensure land-use policies encourage a diverse range of housing types to meet the changing needs of the community, including accommodation in town or business areas where appropriate.
- 40. Encourage increased private sector investment in housing in regional areas along with appropriate management structures, infrastructure and supply of land.

14.2.3 Development Plan for the Mid Murray Council

The subject area relating to the Mannum Waters development is contained within the Development Plan for Mid Murray Council which was consolidated in March 2005. The Development Plan is structured to include Council-wide policies and specific zones. The preferred location south of Mannum township adjoins the designated urban area of Mannum and is located entirely within the River Murray Zone.

(A) Development Plan objectives

There are a number of Objectives stated in the Plan which are supported by the proposed development. They include:

- Objective 1: Orderly development with the economic extension of services and facilities in accordance with Structure Plan for the District.
- Objective 2: Townships, Service Centres and Settlements contained within defined outer boundaries.
- Objective 3: Mannum reinforced as the major urban and population centre.
- Objective 5: Re-development of localities which have a bad or unsatisfactory layout, or unhealthy or obsolete development.
- Objective 6: Land liable to flooding from the River Murray, either kept free of development which could be damaged or which would impede floodwaters, or designed and located to minimise property damage or impede flood waters.
- Objective 7: Development safe from natural or man-made hazards and to be compatible with land capability.

- Objective 13: Free flow of traffic on roads by minimising interference from adjoining development.
- Objective 14: New development serviced with adequate public infrastructure commensurate with projected demands at the cost of the proponent.
- Objective 15: Amenity of localities not impaired by the appearance of land, buildings and structures including landscape.
- Objective 16: Shopping, administrative, cultural, community, entertainment, educational, religious and recreational facilities located in designated centres or country townships.
- Objective 30: A range of attractive living environments and housing types.
- Objective 31: Residential environments with a safe, convenient and legible network of all weather paths for pedestrians and cyclists.
- Objective 35: Conservation, preservation or enhancement of scenically attractive areas, including land adjoining water or scenic routes.
- Objective 36: Preservation and replanting of roadside vegetation.
- Objective 37: Preservation of natural vegetation of historic, local or particular visual significance.
- Objective 38: Conservation of land, buildings, structures and other items of significant historical, social and architectural or other Aboriginal or European heritage significance.
- Objective 39: Retention of environmentally significant areas of native vegetation.
- Objective 40: Water resources protected from excessive usage and pollution.
- Objective 41: Conservation of energy.
- Objective 42: Creation of passive and active recreation areas.
- Objective 43: Provision of open spaces.
- Objective 44: Encouragement of the District's tourism industry.
- Objective 45: Tourist development located with regard to the character of an area or locality and natural features.
- Objective 46: Tourism development, lookouts and tourist signage designed to complement the character of an area or locality.
- Objective 50: Protection of life and property from the effects of flooding.
- Objective 51: Prevention of development which could lead to a potential hazard in the event of a major flood.
- Objective 54: Minimise the threat and impact of bushfires on life and property while protecting the natural and rural character.
- Objective 55: Direct development away from sites and areas with an unacceptably high level of bushfire hazard.

- Objective 56: Ensure new development and land users are adequately protected from the impact of bushfires.
- Objective 57: Ensure new development, together with associated bushfire management measures, can be accommodated with minimal clearance of or impact on native vegetation.

It can be seen that the proposed development at Mannum Waters meets these objectives.

(B) Mannum

Mannum township is identified as a Major Centre which is at the highest level in the Council's centre hierarchy, viz:

- major centre
- country township
- service centre.

(C) River Murray Zone

The River Murray Zone is structured into six Policy Areas, viz:

- Conservation
- Flood Plain
- Primary Production
- Recreation and Tourism
- Shack Settlement
- River Settlement.

Other than the riverbank/levy bank, the subject locality, where it is located below the 1956 flood level, is within the Flood Plain Policy Area, whilst the land above that line is within the Primary Production Policy Area. The Crown Land along the riverfront (refer Figure 3.3) is within a Conservation Policy Area.

The River Murray Zone provides for marina and tourist development through designation of the Recreation and Tourism Policy Area, which has the purpose of accommodating:

- marinas;
- offices, shops and dwellings (for management) associated with tourism development;
- tourist accommodation including camp sites, caravan parks, hostels, bank houses, guest houses and farm-stay;
- infrastructure to support desired uses, and
- water based recreation.

No land is defined as a Tourism and Recreation Policy Area within reasonable proximity of Mannum. The closest upstream location is 7 km, and there are no such locations downstream for a distance of 20 km or so in that part of the Council area before the transition to Rural City of Murray Bridge.

The current arrangement and structure of development policies suggest that there is mismatch between the concept of orderly provision of services and facilities via designated centres, i.e. designation of Mannum as a Major Centre**,** and the identification of tourism and recreation opportunities along the River. This supports identification of the preferred location as a Recreation and Tourism Policy Area to address a mismatch that has been known for some time, however without the opportunity or resources to undertake detailed planning, environmental and engineering investigations have not previously been available.

The Development Plan needs to conform to the Planning Strategy and it is notable that from the foregoing analysis there are fundamental areas of disparity between the Strategy and Development Plan as indicated below in Table 14.1

Table 14.1 – Disparity between Development Plan and Planning Strategy

Development Plan	Existing Use/Issues	Conforms with Planning Strategy	Potential for Conformity via Development Proposal
Primary Production Policy Area	Low Productivity	No	Strong through: discontinuing primary production; revegetation and cultural management plan
	Degraded	No	
	Culturally Significant	No	
Floodplain Policy Area	Degraded river flats formerly used for flood irrigation	No	Strong: Based on removal of barriers that affect flood flows (wastewater lagoons) and which constitute a risk to river contamination. Providing a form of development that facilitates flood flows and raises development and infrastructure above flood flows.
	Sewerage Treatment and Disposal	No	
	Structures on Flood Plain that restrict flood flows	No	
Conservation Policy Area	5 Berth marina	No	Strong: Based on removal of current development interests; rehabilitation and limits on public access.
	Access Licence	No	
	Grazing Licence	No	

The foregoing assessment indicates both that the development policy is inconsistent with the Planning Strategy and that there are a range of potential environmental improvements through development of the locality for a marina and housing development

As discussed in Chapter 2, the preferred design is shown in Figure 2.3 and includes residential, commercial and marina developments.

The prevailing planning/land use control regime does not facilitate the development of a marina and housing development in its present form on the basis that:

- land allocated for primary production (highlands) is proposed for residential, cultural purposes and revegetation;
- land identified as flood prone, and used in part for sewage treatment and disposal, is proposed for recreation (boating, water edge recreation), and residential development, and
- conservation areas, currently used in part for marina purposes and grazing, are proposed essentially for conservation purposes, apart from openings into the river channel for boat access and water transfer.

It will therefore be necessary to amend the Development Plan to address these uses and set in place appropriate zoning, objectives and principles of development control. An amendment to the Development Plan could be affected through either:

- redesignation of the locality within the River Murray Zone framework as a Recreation and Tourism Policy Area, but with modifications to allow marina and residential development
- expansion of Mannum's urban zones.

In cases where a developer wishes to undertake an activity in a defined area that is not compatible with the Plan, it may require a Plan Amendment Report (PAR). The PAR sets out any incompatibilities between what is proposed and what is allowed, and puts forward reasons why the area's Development Plan needs to be amended in order to allow the development.

Conflicts between what is proposed and what is allowed generally stem from the 'zoning' of the area in question. Areas are allocated a zoning which reflects their use, thus there are zones classified as 'residential', others classified as 'industrial' and so on. One purpose of the Plan is to ensure that incompatible land uses do not come into conflict (e.g. an industrial zone next to a residential zone). A PAR is required if the proposed land use is not specifically listed in the Plan as an 'allowed' use.

In the case of Mannum Waters, the area is zoned 'River Murray', where residential development is not generally allowed, thus a PAR will be required. It should be noted that proposals that are declared Major developments are not specifically assessed against the Development Plan, but are subject to a higher level of assessment. Whilst the proposal may be approved by the Governor, any buildings would be the subject of decision-making under the standard development assessment process. Thus, new Zones and policies would need to be established via the PAR process.

14.2.4 Strategic Infrastructure Plan for South Australia

In addition to the State and Regional Plans, the Government of South Australia released an infrastructure plan for South Australia in 2005. This plan outlines what South Australians now need to do to build new infrastructure, overhaul and update existing infrastructure and avoid bottlenecks so that the State is left in good order for future generations. The regional component of the plan provides a framework for infrastructure investment throughout the entire State, with emphasis placed on each region of South Australia.

The major undertakings that are mentioned in the Plan have an impact on Murray Bridge and the region which will in turn impact on the opportunities for the town of Mannum, in particular:

(A) **Energy**

- Establish a business case for extending the gas distribution network to Murray Bridge.

(B) **Health**

- Redevelop Murray Bridge Hospital.
- Provide more aged care facilities and services (residential and community aged care) to meet the needs of an ageing population.
- Construct new ambulance station at Murray Bridge.
- Continue to upgrade hospital facilities to support the co-located delivery of primary health care services including general practice, allied health, mental health and Aboriginal health programs.

(C) **Water**

- Identify and resolve infrastructure implications for the development of areas that have high productive potential and provide the lowest ecological impact for the River Murray.

(D) **Transport:**

- Consider the general aviation potential of Murray Bridge.
- Complete River Murray Ferry refurbishment program.

(E) **Community services and housing**

- Consider options to provide affordable housing to seasonal workers in the required areas.

(F) **Education and training**

- Rejuvenate local schools to support improved utilisation and integration of services.
- Undertake planned capital works at Mannum schools.
- Expand capacity of child care facilities.
- Ensure that future infrastructure requirements of TAFE support the expected growth in the primary and allied industries.

The proposed development at Mannum Waters is not the answer to all the strategic plans considered by the State; however it is definitely in keeping with the strategy.

14.3 RIVER MURRAY ACT 2003

14.3.1 General description

This description is taken from the *River Murray Act 2003*, Users' First Guide (DLWBC 2003). The River Murray Act is a two-part legislative package. It comprises the Act itself and the Schedule to the Act, which amends 22 other South Australian Acts.

The main features of the River Murray Act are:

- a new 'duty of care' – a duty not to harm the river through one's actions. The duty is enforceable through River Murray Protection Orders and associated instruments
- various powers of the Minister to undertake activities and carry out works and measures
- the ability for the Minister to register management agreements with landowners, assisting projects like wetlands management on private land and other conservation efforts
- the establishment of a new Joint House Standing Committee of the South Australian Parliament - the Natural Resources Parliamentary Committee. The Committee is composed of sitting Members of both Houses of Parliament
- a regulation making power that will enable the future regulation or prohibition of any identified activity deemed to harm the river
- the ability of the Minister to impose conditions on activity authorisations, through the operation of the new 'referral' mechanism. The referral mechanism requires:
  - the referral of certain applications for statutory authorisations (for example, licences or permits) made under other Acts to the Minister for the River Murray
  - the referral of certain statutory planning instruments (for example, council Development Plans as well as other natural resources management instruments such as native vegetation guidelines and district soil plans) to the Minister for the River Murray.

14.3.2 Objects of the Act

The following Objects are listed (as numbered) within the act. Comments are attached with regard to the relationship of the proposed development with each of the objects.

(a) to ensure that all reasonable and practicable measures are taken to protect, restore and enhance the River Murray in recognition of its critical importance to the South Australian community and its unique value from environmental, economic and social perspectives and to give special acknowledgement to the need to ensure that the use and management of the River Murray sustains the physical, economic and social well being of the people of the State and facilitates the economic development of the State.

(b) to provide mechanisms to ensure that any development or activities that may affect the River Murray are undertaken in a way that provides the greatest benefit to, or protection of, the River Murray while at the same time providing for the economic, social and physical well being of the community; and

(c) to provide mechanisms so that development and activities that are unacceptable in view of their adverse effects on the River Murray are prevented from proceeding, regulated or brought to an end; and

(d) to promote the principles of ecologically sustainable development in relation to the use and management of the River Murray; and

(e) to ensure that proper weight is given to the significance and well being of the River Murray when legislative plans and strategies are being developed or implemented; and

(f) to respect the interests and aspirations of indigenous peoples with an association with the River Murray and to give due recognition to the ability of those indigenous people to make a significant contribution to the promotion of the principles of ecologically sustainable development in relation to the use and management of the River Murray; and

(g) to respect the interests and views of other people within the community with an association with the River Murray and to give due recognition to the ability of those people to make a significant contribution to the promotion of the principles of ecologically sustainable development in relation to the use and management of the River Murray; and

(h) otherwise to ensure the future health, and to recognise the importance, of the River Murray.

The proposal meets these objects by:

- protecting the existing riverine wetlands and controlling human access, removing grazing and isolating the riverine wetlands from feral and domestic animals
- improving water quality by providing off-river moorings for houseboats with facilities for removing all waste, treatment of the stormwater run-off through detention ponds and treatment of the water returning to the river from the marina and waterways through a constructed anabranch and wetland
- improving the water balance by effective use of run-off, management of proposed wetlands, effective management of ELMA water entitlement and the use of reclaimed water
- rehabilitating the degrade river flats and removing of the wastewater treatment lagoons from the flood plain
- providing for the preservation of Aboriginal cultural heritage areas and making opportunities for the Aboriginal community's involvement in interpretive facilities
- providing an ecologically sustainable development with socio-economic benefits for the river town community of Mannum
- extending and protecting wildlife habitats.

14.3.3 Objectives of the Act

Several objectives have been identified which are concerned with the river's health, its environmental flow, its water quality and its relationship to the human dimension. Table 14.2 reviews the development proposal in relation to the objectives of the Act.

Table 14.2 – Development proposal's conformity with the objectives of the River Murray Act

Objective	Conformity
The river health objectives	
(a) the key habitat features in the River Murray system are to be maintained, protected and restored in order to enhance ecological processes	Yes
(b) the environments constituted by the River Murray system, with particular reference to high-value floodplains and wetlands of national and international importance, are to be protected and restored	Yes
(c) the extinction of native species of animal and vegetation associated with the River Murray system is to be prevented	Yes
(d) barriers to the migration of native species of animal within the River Murray system are to be avoided or overcome	Yes
The environmental flow objectives	
(a) ecologically significant elements of the natural flow regime of the River Murray system are to be reinstated and maintained	Assisted
(b) the Murray mouth should be kept open in order to maintain navigation and the passage of fish in the area, and to enhance the health of the River Murray system and estuarine conditions in the Coorong	Not applicable
(c) significant improvements are to be made in the connectivity between and within the environments constituted by the River Murray system	Yes
The water quality objectives	
(a) water quality within the River Murray system should be improved to a level that sustains the ecological processes, environmental values and productive capacity of the system	Assisted
(b) the impact of salinity on the ecological processes and productive capacity of the River Murray system is to be minimised	Assisted
(c) nutrient levels within the River Murray system are to be managed so as to prevent or reduce the occurrence of algal blooms, and to minimise other impacts from nutrients on the ecological processes, environmental values and productive capacity of the system	Yes
(d) the impact of potential pollutants, such as sediment and pesticides, on the environments constituted by the River Murray system is to be minimised	Yes
The human dimension	
(a) a responsive and adaptable approach to the management of the River Murray system is to be implemented taking into account ecological outcomes, community interests and new information that may become available from time to time	Yes
(b) the community's knowledge and understanding of the River Murray system is to be gathered, considered and disseminated in order to promote the health and proper management of the system	Assisted
(c) the interests of the community are to be taken into account by recognising indigenous and other cultural, and historical, relationships with the River Murray and its surrounding areas, and by ensuring appropriate participation in processes associated with the management of the River Murray system	Yes
(d) the importance of a healthy river to the economic, social and cultural prosperity of communities along the length of the river, and the community more generally, is to be recognised.	Yes

14.3.4 General duty of care under the Act

The following paragraphs are quoted from the River Murray Act and specify the requirements of the General Duty of Care:

(1) A person must take all reasonable measures to prevent or minimise any harm to theRiver Murray through his or her activities.

(2) For the purposes of subsection (1)

(a) harm includes

(i) a risk of harm, and future harm; and

(ii) anything declared by regulation to be harm to the River Murray; and

(b) harm need not be permanent but must be more than transient or tenuous in nature; and

(c) in determining what measures are required to be taken, regard must be had, amongst other things, to—

(i) the nature of the harm; and

(ii) the sensitivity of the environment that may be affected and the potential impact of the harm environmentally, socially and economically; and

(iii) the practicality and financial implications of any alternative action, and the current state of technical and scientific knowledge; and

(iv) any degrees of risk that may be involved; and

(v) the significance of the River Murray to the State and to the environment and economy of the State; and

(vi) insofar as is reasonably practicable and relevant, any assessment of potential harm to the River Murray as a result of the relevant activity undertaken before a statutory authorisation (if any) was granted under a related operational Act, and the extent to which any such harm was intended to be prevented or minimised through the attachment of conditions to a statutory authorisation (if any) under a related operational Act.

(3) A person will be taken not to be in breach of subsection (1) if the person is acting in circumstances prescribed by the regulations.

(4) A person who breaches the duty created by subsection (1) is not, on account of the breach alone, guilty of an offence but

(a) compliance with the duty may be enforced by the issuing of a protection order under Part 8; and

(b) a reparation order or reparation authorisation may be issued under Part 8 in respect of the breach of the duty.

The proponent is aware of the general Duty of Care as set out within the Act. As a consequence considerable attention has been given to the concept designs to ensure conformity with the strategies for the River Murray. In every aspect of the development, attention has been given to sustaining or improving river water quality, the wildlife habitats and the general amenity of the river. These provisions are discussed in the EIS, in particular within Sections:

- 2.2.2 – Urban design
- 2.3.9 – Water use and transfer
- 2.3.10 – Water quality monitoring
- 2.5.3 – Walking and cycling trails
- 2.7.2 – Stormwater
- 2.7.3 – Wastewater
- 2.8 – Constructed anabranch channel and wetland
- 2.9 – Urban landscape design and revegetation
- 10.5 – Aboriginal cultural heritage areas protocols for design, construction and operation.

Potential impacts directly related to the River Murray and the mitigation measures to be undertaken are discussed in the following Sections of this EIS:

- 11.2 – Physical environment
- 11.3 – Biological environment
- 11.5 – Climate change
- 12.2 – Construction Environmental Management Plan
- 12.3 – Operational Environmental Management & Monitoring Plan
- 13.1 – Management Maintenance & Monitoring Agreements
- Water quality considerations are discussed in Section 11.2.2

The Schedule to the Act amends a number of other Acts including the so-called ‘related operational Acts’. The related operational Acts are primarily those Acts whose administration has the potential to have a significant impact on the river – Acts for town planning and development, for harbours and navigation, for mining and petroleum activities, for the management of national parks, the protection of native vegetation, management of water resources and pollution control. A list of such Acts is shown in Table 14.3.

More recently, the State brought together a number of related operational Acts under an Integrated Natural Resources Management Plan (a part of the Natural Resources Management Act 2004). The relationship between the River Murray Act and the NRM Plan is explained in the Schedule to the Plan.

Between them, the River Murray Act and the Natural Resources Management Act (and Plan) seek to provide an integrated way of protecting the River Murray from adverse environmental, social and economic impacts. In the context of Mannum Waters, this protection is largely related to protection of water quality in the river. Activities and processes on land and in the marina need to have as their end point the objective of maintaining or improving water quality in the river. To achieve this, the environment through which water flows to the river must itself be 'healthy', and practices that might threaten the health of this environment need to be managed.

Ultimately, compliance with the Act is achieved through:

- characterisation of the existing environment
- identification of potential impacts of the proposed land use (including the construction phase)
- identification of practices that might threaten the environment
- development of strategies that:
    - eliminate the potential impacts or threats
    - mitigate residual impacts or threats.

Table 14.3 – Related operational Acts

Act and Date	Act and Date
Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986	Mining Act 1971
Aquaculture Act 2001	Murray-Darling Basin Act 1993
Coast Protection Act 1972	National Parks and Wildlife Act 1972
Crown Lands Act 1929	Native Vegetation Act 1991
Development Act 1993	Opal Mining Act 1995
Environment Protection Act 1993	Parliamentary Committees Act 1991
Fisheries Act 1982	Parliamentary Remuneration Act 1990
Harbors and Navigation Act 1993	Petroleum Act 2000
Heritage Act 1993	Soil Conservation and Land Care Act 1989
Historic Shipwrecks Act 1981	South Eastern Water Conservation and Drainage Act 1992
Irrigation Act 1994	Water Resources Act 1997

In designing Mannum Waters, the proponent has sought to follow these steps and has documented its findings in this EIS. The principal features of the development that address these issues include:

- removing houseboats from the river, thus:
    - providing sewage pump-out facilities
    - providing solid and putrescible waste disposal facilities
    - reducing the impacts of casual mooring on the banks of the river (e.g. erosion, litter, etc.)

- removing the existing sewage treatment facility and providing a new facility, thus:
  - removing the sewage lagoons from the flood plain and placing the new facility above the 1956 flood level
  - rehabilitating the sewage treatment plant site
- managing stormwater run-off from the site, thus:
  - improving the quality of the water discharged into the river
  - trapping gross pollutants
- provision of a constructed wetland that will:
  - treat all water from the marina and waterways
  - increase the biodiversity of the flood plain area
  - increase the amenity of Mannum Waters by providing an attractive walking trail
- restoration of the site by:
  - removal of weed species
  - planting of native species
  - preservation (where possible) of existing natural features
- preservation of Aboriginal cultural areas by:
  - preserving the areas to provide public open space.

14.4 NATIONAL RESOURCES MANAGEMENT ACT

The South Australian Government's *National Resources Management Act 2004* provides for an integrated and transparent system to ensure sustainable use of the State's resources. The act is currently under review for completion in June 2007.

Under the Act a *State National Resources Management (NRM) Plan* was established in 2006. Certain policies and strategies were outlined to assist managers in making effective and efficient decisions in the protection of the South Australia's natural systems. The plan identifies four goals: They are:

- Goal 1 – Landscape scale management that maintains healthy natural systems and is adaptive to climate change
- Goal 2 – Prosperous communities and industries using and managing natural resources within ecologically sustainable limits
- Goal 3 – Communities, governments and industries with the capability, commitment and connections to manage natural resources in an integrated way
- Goal 4 – Integrated management of biological threats to minimise risks to natural systems, communities and industry

The goals are linked to South Australia's Strategic Plan.

As well several Appendices within the NRM Plan provide guidelines for various management principles. The proponent acknowledges the guidelines and their assistance in the development of the project. The relevant Appendices area:

- Appendix A: Ecosystems: Guidelines
- Appendix B: Water allocation and management: Guidelines
- Appendix C: Coasts, Estuaries and Marine Environment: Guidelines
- Appendix D: Principles for Riparian and Floodplain Management: Guidelines
- Appendix E: Principles for Wetland Management: Guidelines
- Appendix G: Extracts from the *Natural Resources Management Act 2004*

Appendix G identifies key objectives of the NRM Act. Table 14.4 identifies those objectives and the proposal's conformity with the Act.

Table 14.4 – The development proposal's conformity with the objectives of the National Resources Management Act

Objective	**Conformity**
(a) recognises and protects the intrinsic values of natural resources	Yes
(b) seeks to protect biological diversity and, insofar as is reasonably practicable, to support and encourage the restoration or rehabilitation of ecological systems and processes that have been lost or degraded	Yes
(c) provides for the protection and management of catchments and the sustainable use of land and water resources and, insofar as is reasonably practicable, seeks to enhance and restore or rehabilitate land and water resources that have been degraded	Yes
(d) seeks to support sustainable primary and other economic production systems with particular reference to the value of agriculture and mining activities to the economy of the State	Not applicable
(e) provides for the prevention or control of impacts caused by pest species of animals and plants that may have an adverse effect on the environment, primary production or the community	Yes
(f) promotes educational initiatives and provides support mechanisms to increase the capacity of people to be involved in the management of natural resources.	Yes

Mannum Waters lies within the area administered by the SA Murray-Darling Basin NRM region

14.5 ENVIRONMENT PROTECTION ACT

The *Environment Protection Act 1993* provides for the protection of the environment. Its objectives include the promotion of ecologically sustainable development to ensure that all reasonable and practicable measures are taken to protect, restore and enhance the quality of the environment.

A general environment duty is imposed on all persons not to undertake activities on land that pollute or might pollute the environment unless all reasonable and practicable measures are taken to prevent or minimise any resulting environmental harm.

Prescribed activities of environment significance require an environmental authorisation, such as for dredging and the operation at a marina with 50 or more berths.

14.6 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is a Commonwealth Act that seeks to identify and protect matters of national environmental significance. The Act identifies seven matters of national environmental significance:

- World Heritage properties
- National Heritage places
- Wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining).

The Commonwealth Department of Environment and Heritage (DEH) provides a web-based tool for assessing specific sites to determine if matters of national environmental significance are likely to be present in an area where development is proposed. The results of the use of this tool in the Mannum Waters area has shown that there are no relevant matters at or adjacent to the site (refer Table 7.4).

If the DEH database indicates that a matter of national environmental significance may occur in the proposed development area, Tallwood is obliged to investigate the potential impacts of the proposed development to determine if the impact is 'significant'. If a self-assessment indicates that impacts may be significant, Tallwood is obliged to refer the proposed development to the Federal Minister. An assessment of the development against the provisions of the act for reserves and national heritage properties etc. is contained in Table 7.4

With regard to fauna and flora species, status under Australian and state legislation is summarised as follows:

- **FLORA**
  - **Australia:**
    - No flora species of conservation significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (*EPBC Act*) were found.
    - No threatened ecological communities within the local areas listed under the *EPBC Act*.
  - **South Australia:**

- No species protected under the schedules of the National Parks and Wildlife Act 1972 (SA) (as at January 2005) (*NPW Act*) were recorded on site.

- **Murray Botanical Region:**

  - Within the Murray botanical region, following Lang & Kraehenbuehl (2002), three species classified as uncommon and three classified as rare were found in the linear wetlands. This is an area to be protected.

- **FAUNA**

  - **Australia:**

    - No fauna species of conservation significance under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (*EPBC Act*) were found.

  - **South Australia:**

    - No species protected under the schedules of the National Parks and Wildlife Act 1972 (SA) (as at January 2005) (*NPW Act*) were recorded on site.

  - **Migratory agreements:**

    - No birds recorded are protected under the Japan Australia Migratory Birds Agreement (JAMBA) or the China Australia Migratory Birds Agreement (CAMBA).

14.7 OTHER RELEVANT LEGISLATION AND PLANNING STRATEGIES

14.7.1 Aboriginal Heritage Act

The *Aboriginal Heritage Act 1988* provides for the protection and preservation of the Aboriginal Heritage (As Amended 4 May 2002). It repeals the Aboriginal Historical Relics Preservation Act 1965 and the Aboriginal Heritage Act 1979. It amends the *Mining Act 1971*, the *Planning Act 1982* and the *South Australian Heritage Act 1978*.

Following surveys of the site, conducted with representatives of the indigenous people of the area, cultural heritage sites were documented and mapped.

The design of Mannum Waters takes into account the location and extent of these sites, and incorporates a number of open spaces over these sites. As such, approvals under the Act will not be required.

As detailed in Section 10.3 above, there are no Native Title claims over the land.

14.7.2 Native Vegetation Act

The *Native Vegetation Act 1991* (and accompanying Regulations, 2003) provides incentives and assistance to land owners in relation to the preservation and enhancement of native vegetation and to control the clearance of native vegetation.

Any clearance of native vegetation is subject to approval by the Native Vegetation Council (NVC) under the Act, which specifies the need to demonstrate a 'significant environmental benefit' (SEB) accruing from removal of native vegetation.

The substantive area to be developed is currently salinising samphire (approximately 50 ha), established after the use of the area for dairying. Weeds currently occupy approximately 50% of some areas, and some species such as boxthorn are spreading. The loss of the vegetation is offset by the construction of the wetland system (42 ha) and revegetation areas (23 ha).

Along the riverfront, the area is in good condition and the Baseby Linear Riverine Wetlands have high conservation value. This area is to be protected. Through the mechanism of a Wetland Management Plan current threats including feral animals, weeds and stock grazing will be controlled. Disturbed areas (current houseboat moorings) will be rehabilitated. No native trees will be removed at the inlet and outlet to the waterways (refer Section 2.3.5).

A maximum of 4 have been identified as may require removal. This will be clearer during final design when every effort will be made to reduce this number. Nevertheless considerably more replacement trees will be planted (refer Section11.3.2).

Proposals that are declared Major developments are exempted from the need to seek approval from the NVC. However, an SEB that provides adequate compensation for the removal of native vegetation still needs to be approved by the NVC before construction can commence.

14.7.3 Heritage Act 1993

The *Heritage Act 1993* (and Regulations 1993) provides for the conservation of places of heritage value (as Amended 24 November 2003). There are no features of significance under the Act within the development site or its surrounds.

14.7.4 Historic Shipwrecks Act 1981

The *Historic Shipwrecks Act 1981* (and Regulations 1999) relates to the protection of certain shipwrecks and relics of historic significance (As Amended 24 November 2003). No shipwrecks are impacted the development. An existing shipwreck in the River Murray near the site is discussed in Section 5.3.

14.8 APPROVALS AND REQUIREMENTS TO COMPLETE THE DEVELOPMENT

If Major Development approval is granted by the Governor, the following legislative requirements and approvals would need to be initiated:

- clearance of native vegetation in areas for marina access under the *Native Vegetation Act 1991*
- licence for marina facilities under the *Environment Protection Act 1993*
- land division approvals under the *Development Act 1993* for super lots and creation of individual allotments for development purposes
- road closures/realignments pursuant to the *Roads Opening and Closing Act* for various aspects of the development
- Plan Amendment Report pursuant to the *Development Act 1993* to amend zones and policies
- development approvals for various land uses under the *Development Act 1993*

- Trade Waste Disposal Licences under the *Environment Protection Act 1993*

If required, approval to proceed with development according to the *Environment Protection and Biodiversity Conservation Act 1999* would also be needed.

14.9 GUIDELINES PREPARED FOR THE MANNUM WATERS PROPOSAL 2005

The Guidelines prepared for the basis of the Mannum Waters EIS have been addressed within this report. A reconciliation of the Guidelines with the various sections of the EIS is included in Appendix M.