ASSESSMENT REPORT

For the Environmental Impact Statement

For the
‘MANNUM WATERS’ MARINA AND
RESIDENTIAL DEVELOPMENT Proposal

Logo Minister for Urban
Development & Planning

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For the

‘Mannum Waters’ Marina and Residential Development Proposal

Planning SA

Primary Industries and Resources SA

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CONTENTS

1 INTRODUCTION

1.1 SUMMARY

This Assessment Report (AR), prepared by the Minister for Urban Development & Planning, assesses the environmental, social and economic impacts of a proposal by Tallwood Pty Ltd to develop a marina and residential development near Mannum. The proposed development is located to the immediate south of the existing township of Mannum, which is located on the River Murray approximately 84 kms east of Adelaide in South Australia. The population of Mannum is approximately 2000 people.

Should it be approved, the development is proposed to be undertaken in several stages over a 16 year period. The development will include a marina basin (primarily for houseboats) with associated boating facilities and residential allotments (many with waterfrontage).

This AR is intended to be a "stand alone" document, but the detailed information on which it is based is contained in the proponent's Environmental Impact Statement (EIS) dated May 2007, submissions on the EIS, and responses to submissions in the proponent's Response document dated November 2007. This AR also relies on information, comments and advice provided by relevant South Australian Government agencies and additional information (including minor modifications to the proposal) provided by the proponent in letters dated 1 February and 18 February 2008 appended to this AR (Appendix 1).

1.2 BACKGROUND

The proponent is Tallwood Pty Ltd, a company that includes interests from the Hickinbotham Group (residential development), Weber Frankiw & Associates (surveying), DCJM P/L (civil engineering), Senwill Civil (civil contracting) and Rushworth & Co. (financial management).

The proponent's objectives for the proposed development are to:

- Develop an off-river marina for use mainly by houseboats
- Provide residential development sites in a desirable riverine location, including affordable housing opportunities
- Adopt environmentally sustainable practices, such as water and energy efficiency measures, in order to minimise the ecological footprint of the development
- Provide a new, improved Waste Water Treatment Plant for both the development and the Mannum Township that is no longer located on the floodplain
- Protect water quality of the River Murray, primarily through pollutant control measures
- Re-establish floodplain ecosystems, through the development of a constructed anabranch/wetland and revegetation using native species
- Protect and improve the habitat values of existing riverine ecosystems
- Preserve sites of Aboriginal Heritage and promote the cultural history of the area
- Provide opportunities for expansion and upgrading of the Mannum Golf Course

The assessment process is detailed in the next section of this AR.

1.3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROCEDURES

Environmental Impact Assessment (EIA) is a process of identifying the potential social, environmental and economic impacts of a proposal and of identifying appropriate measures that may be taken to minimise any impacts. The main purpose of EIA is to inform decision-makers of the likely effects of a proposal before any decisions are made. EIA also allows the community to make submissions on a proposal. The specific EIA procedures for Major Developments or Projects in South Australia are outlined in Sections 46 to Section 48 of the *Development Act 1993* (the Act).

Pursuant to Section 46(1) of the Act, the proposed 'Mannum Waters' Marina and Residential Development (the 'Mannum Marina') was declared a Major Development on 31 March 2005 by the Minister for Urban Development & Planning. This declaration resulted from the Minister forming the opinion that the proposed development was of major environmental, social or economic importance and that a declaration was appropriate or necessary for the proper assessment of the proposal.

Following the declaration, a development application was lodged with Planning SA on 28 June 2005. The proposed development described in the application falls within the ambit of the Minister's declaration and was therefore subject to the Major Developments and Projects assessment provisions of the Act referred to above (i.e. the EIA process).

The proponent's development application was subsequently referred to the former Major Developments Panel (Panel) to determine the level of assessment that should apply to the proposed development and to set the Guidelines for an Environmental Impact Statement (EIS), Public Environmental Report (PER) or a Development Report (DR). In order to make this determination, the Panel prepared and released an Issues Paper for public comment in September 2005, in accordance with legislative processes that operated at the time. The Issues Paper formed the basis for the formulation of the Guidelines, which also considered any public or Government Agency comments on the Issues Paper.

After considering the significant issues for the proposal, the Panel determined that an EIS was the required level of assessment for the proposed Mannum Marina and set the Guidelines, which were publicly released in 7 December 2005. Pursuant to Section 46B of the Act, the proponent must comply with the Panel's Guidelines when preparing the EIS.

The proponent prepared an EIS which was submitted to the Minister in May 2007. The EIS was placed on public exhibition from 6 June 2007 to 18 July 2007, during which time submissions were invited from the public, and relevant Government Agencies. Following the public exhibition period, the proponent lodged a Response to submissions on the EIS with the Minister on 9 November 2007, which contained some variations to the proposal. The proponent's Response document was released on 14 November 2007. Pursuant to Section 48B of the Act, the Minister may permit a proponent to vary an application and any associated documents provided the relevant proposed development remains within the ambit of the EIS. The variations are considered to be within the ambit of the EIS.

Pursuant to Section 46B(9) of the Act, the Minister, in preparing this AR, has taken into account the proponent's EIS, public and Government Agency submissions; the proponent's Response to these submissions, and other matters that the Minister considered appropriate.

This AR provides advice to the Governor, who is the final decision-maker on the proposed development. Pursuant to Section 48(5) of the Act, when making a decision on the proposed development, the Governor must have regard to the provisions of the appropriate Development Plan and Regulations (so far as they are relevant), the Building Rules (if relevant), the Planning Strategy, the objects, general environmental duty and relevant environment protection policies under the *Environment Protection Act 1993* (if the development involves a prescribed activity of environmental significance), the proponent's EIS/Response (and additional information provided) and the Minister's AR and any other matters considered relevant by the Governor. Pursuant to Section 48(7) of the Act, the Governor may also specify any conditions that should be complied with if a development authorisation is granted.

2 THE PROPOSED DEVELOPMENT

2.1 THE SITE

The site of the proposed marina and residential development is land located immediately south of Mannum on the River Murray. The proposal is to be located on the floodplain and valley slopes of the River Murray in the Mid Murray region of South Australia. The floodplain is an abandoned dairy flat that once comprised irrigated pasture and is separated from the river by a levee bank. The modified floodplain lies below the level of the river and acts as an evaporation pan by drawing moisture from the underlying watertable. Surface levels average around -0.2m AHD (-0.65 at the lowest levels) or an average of 0.95 – 1.4m below normal river (pool) level. The floodplain and higher ground is now only used for sheep and cattle grazing. A small portion of the higher ground (around 3 hectares) has recently been used for irrigated pasture. Associated with the agricultural use of the site is a dwelling and rural buildings (including packing shed). The Mannum Waste Water Treatment Plant (WWTP) occupies the north eastern corner of the site. Several houseboats are currently moored along the river bank. A healthy wetland system stretches along the eastern boundary of the site, between the levee and the river bank.

The floodplain and hinterland have been used for primary production and substantially modified from their natural form. The topography of the floodplain has been altered, through levelling and the construction of a levee bank, which has altered the hydrological regime. The majority of native vegetation has been removed and, due to the abandonment of flooding irrigation, salt tolerant native vegetation and weed species dominate the site. The riverbank and wetlands (the 'Baseby Linear Wetland Complex') between the levee and river are healthy and biologically diverse, making them significant from a biodiversity and conservation perspective. The Mannum WWTP is located on the floodplain and, whilst protected by embankments, is at risk during periods of very high river levels (such as the 1974 and 1956 flood levels).

2.2 THE LOCALITY

Mannum is a large river town that acts as a service centre for the Mid Murray region and is a major tourism and recreation destination, especially as a base for a commercial houseboat industry. Mannum is also a key location for the extraction of metropolitan Adelaide's water supply, via the Mannum – Adelaide pipeline.

See Fig 1 for locality plan.

2.3 THE SUBJECT LAND

The proposal is located on land that is a mix of freehold title held by the proponent and Crown Land held by the State Government (leasehold floodplain land and the river bank). A small part of the site is Crown Land occupied by SA Water for the Mannum WWTP. The development is proposed by Tallwood Pty Ltd, which would need to negotiate the purchase of additional land with the State Government, if the proposal is approved. The total area of the proposed site is 172.40 ha.

2.4 NATURE OF THE PROPOSAL

The residential marina proposal seeks to develop a multi-use recreational/commercial marina with a marina basin and moorings for houseboats, large vessels and smaller recreational craft. The proposal seeks to provide a high level of services for boat owners and housing opportunities with a high level of amenity, whilst protecting and enhancing the river environment. The design aims to minimise the

INSERT FIGURE 1: LOCATION PLAN

ecological footprint of the development by adopting sustainability measures, especially for stormwater management and water and energy conservation.

The EIS (Section 2.1.4) states that the proponent is committed to ensuring that the design and construction of the development would create a new benchmark for residential marinas and will incorporate best practices where appropriate. In particular, goals have been set for protection of the river and associated wetlands, protection of Aboriginal Heritage areas, water sensitive urban design, water/energy conservation and comprehensive management and monitoring. The building process would be controlled through a House Owners Charter and design guidelines that would adopt best practice/ecologically sustainable development measures that would be incorporated into Development Plan policies for the site.

Landscaping would use species that complement the river environment, with native species being preferred, and would be integrated with water sensitive urban design measures (such as gross pollutant traps, vegetated swales and retention basins). A riparian zone, using native riverine species, would be established as a buffer along the edge of all watercourses. An anabranch and wetland system would be re-created on the floodplain and extensive revegetation would be undertaken using locally indigenous species.

The site also provides a logical extension of the Mannum township boundary, as it adjoins the urban fringe. It would also be integrated with the adjoining Mannum Golf Course, which could be upgraded and extended to 18 holes. Golf course related housing opportunities could also be developed in the future. Subject to appropriate rezoning investigations, the provision of services could also enable the township to expand inland (ie west of Belvedere Road), such as for country living type allotments, which could reduce development pressure for linear development along the river.

2.4.1 Overview of the Proposed Development

The residential marina proposal comprises the following:

- A marina basin on the floodplain, with separate moorings for 156 houseboats and other large vessels, covering an area of 11.51 ha (8.28 ha water body & 3.23 ha of road reserves). Houseboat moorings for both casual/visitor berthing and permanent mooring (including provision for living on board and associated vehicle parking). All berths provided with a full range of services, including water, power, waste disposal and vehicle access for servicing. In particular, the marina would incorporate waste disposal connections to the vacuum sewer for both effluent and grey water.

- A residential sub-division of 569 allotments, comprising 161 waterfront (including 30 villa), with provision for private moorings (but not for the berthing of houseboats), and 408 standard allotments. Additional information provided by the proponent (refer to Appendix 1) indicates that the overall number of standard allotment has now been increased, in order to meet a requirement that 15% of allotments be for affordable housing. A total of 600 allotments are now proposed, with 36 allocated for affordable housing (ie. for 90 dwellings). Affordable housing allotments would have an average area of 425m^2 (minimum size of 350m^2), whilst all other allotments would range in area from 300 – 1600m^2. All allotments and roads would be constructed to be above the 1956 flood level. The residential area covers some 70.58 ha comprising 44.63 ha of allotments and 26.95 ha of waterways/road reserves. The design of the sub-division would include open space, landscaping, revegetation areas, walking and cycling trails, protection of Aboriginal Heritage sites and sustainable stormwater management, harvesting and use (especially rainwater tanks for domestic use).

- The existing Mannum Waste Water Treatment Plant (WWTP) and lagoons would be removed from the floodplain and replaced by a new upgraded/expanded plant and reclaimed water storage dam, located away from the main development site and existing urban areas.

- A Commercial Area to provide facilities for tourists and for the servicing of houseboats and other craft, including a general store, boat chandlery, public toilets, café, tavern/restaurant and tourism accommodation. A marina office and opportunities for commercial houseboat hiring operator offices would also be provided. Additional information provided by the proponent (refer to Appendix 1) indicates that the Commercial Area has now been increased from 0.68 ha to 1.2 ha to accommodate a boat lift facility.

- A boating facility, including a refuelling station, boat ramp (and associated wash down and car parking), hard stand and boat maintenance area. Additional information provided by the proponent (refer to Appendix 1) now replaces the proposed slip-way with a boat lift facility in order to conserve space and to have less of a visual impact.

- Aboriginal heritage and environmental interpretive centre.

- The retention and protection of existing wetlands of conservation significance between the river bank and levee bank. A large anabranch/wetland system would be re-created on the floodplain for water quality, habitat and amenity purposes.

- An extension and augmentation of town water and power supplies to service the development.

- An upgrading of the existing unsealed road to the development site and a network of new roads within the development area.

The proponent's Response to public submissions (Section 4) states that, in response to discussions with State government agencies, the following minor changes have been made to the proposal:

- the provision of a 50m wide Crown land zone along the river bank
- the relocation of stormwater retention ponds above the 1956 flood level
- adjustments to the layout of roads and waterways to avoid removal of existing trees
- additional car parking associated with the marina
- provision of a shower, toilet and laundry block for marina users
- provision of an area for boat maintenance, including a slip-way (now replaced with a boat lift) and hard stand area

Additional information provided by the proponent (Appendix 1) shows that the proposed layout plan has undergone several refinements compared with that presented in the EIS and Response documents. The minor modifications comprise:

- a separate mooring area within the marina for customer access to hire boats (ie. to act as a staging area)

- enlarged commercial area to provide additional space for a boat ramp, slip-way (now boat lift), boat maintenance area and conference centre

- relocation of casual houseboat moorings to a position near the entrance channel (ie. opposite the commercial area) for safer boating movements

- new pedestrian bridge from the commercial area to the opposite bank for access to the casual moorings and for pedestrian access to Mannum (via River Lane)

- three new roundabouts on the main access road
- further alterations to road and waterway alignments for the retention of existing trees
- reconfiguration of the constructed anabranch/wetland system

It is considered that the proposed changes are only minor and would improve the proposal.

See Figure 2 for the final development concept plan and Figure 3 for an enlarged layout plan of the Commercial Area.

In addition, following negotiations with the State Government, the proponent has agreed to a requirement that 15% of the residential development would comprise affordable housing, in accordance with the State Government Affordable Housing Policy. Figure 4 provides an indication of where affordable housing allotments could be located within the land division.

2.4.2 Proposed Design and Sustainability Measures

The proposal has been designed with the philosophy of protecting the environmental and resource values of the River Murray, especially water quality. The provision of a best practice marina facility would cater for the needs of the houseboat industry, whilst encouraging the mooring of boats off-river to reduce the impacts of houseboats on the river bank and river water quality. In addition, the proposal aims to establish a high standard of residential design and amenity, whilst encouraging ways of minimising the 'ecological footprint' of the development.

Stormwater would be managed using Water Sensitive Urban Design measures to avoid polluted discharges reaching the River Murray, with stormwater reused wherever practical. Reclaimed water from the Waste Water Treatment Plant would be used to irrigate the adjoining golf course and open space/revegetation areas (ie that lie beyond the required 100 metre buffer distance from the river). The plant would also be capable of treating effluent and grey water from houseboats, including those permanently occupied.

Other sustainable features of the proposal include the retention and protection of existing wetlands of conservation significance between the river bank and levee bank and the re-creation of a large wetland system on the disused dairy flats on the floodplain.

2.4.3 Infrastructure Requirements

The EIS states that all required infrastructure services (including power, water, and telecommunications) could be established on the site of the proposed development, either as new facilities or by connection to existing services. A new Waste Water Treatment Plant to service the proposed development and the Mannum township would be established off site.

2.5 CONSTRUCTION STAGING AND OPERATION MANAGEMENT

The EIS (Table 11.5) states that the proposed development would involve a capital investment of around $24.4 million, constructed in more than seven stages over approximately 16 years, depending on commercial uptake.

- Stage 1 would include the majority of the marina basin, waterways, constructed anabranch/wetland system, major service infrastructure and the formation of allotments for the commercial area and some of the waterfront residential blocks. It is expected that these components would be completed within three years of commencement.

- Stage 2 would proceed on completion of Stage 1 and would include the remaining waterfront allotments and the remainder of the wetland area.
- Stages 3 to 6 are likely to include development of high ground allotments (ie. adjacent the proposed golf course extension, which is not part of this proposal).
- Stage 7 and subsequent stages would see development of the remaining standard allotments on the high ground

The EIS (Section 2.1.2 and Figures 2.5 – 2.8) shows how the staging would progress.

The filling of the marina basin with river water could also be staged in response to river levels and water availability. Rather than filling the whole of the basin, only a portion could be filled, based on demand for marina berths. This could defer some of the complete cost of filling the basin, especially if water restrictions required the proponent to purchase additional water allocations to achieve the volume of water needed. A small allocation would also be needed to compensate for annual evaporative losses. This approach would help reduce overall demand on the water resource during drought conditions, especially when water restriction are in place.

The Response (Figure 2) shows how the staged filling of the development could progress.

INSERT FIGURE 2 - Final Conceptual Layout Plan

INSERT FIGURE 3 – Commercial Area Conceptual Layout Plan

INSERT FIGURE 4 – Affordable Housing Conceptual Layout Plan

3 EXISTING ENVIRONMENT

3.1 PHYSICAL SETTING

The EIS (Section 3.1.2) provides a description of the physical setting of the proposal. Topographically, the proposed site includes areas of low lying floodplain (abandoned irrigated river flats) and riparian/wetland zones between the levee bank and the river, with the high land at the western end of the site being relatively bare. Scattered River Box Woodland vegetation, with a modified understory, occurs along the gully in the north-western corner.

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

The mean annual rainfall for Mannum over the last 30 years is approximately 304 mm. It falls mostly in the winter months from May to October. February is the driest month, with a mean rainfall of 13.9 mm. Mean annual temperature at Murray Bridge is 16.1^0C at 9.00 am and 23^0C at 3.00 pm. Daily mean maxima are 28.8^0C for January and 16.2^0C for July. Daily mean minima are 14.5^0C for January and 5.4^0C for July. 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. The EIS (Section 6) contains tables describing temperature, rainfall and relative humidity.

Generally, winds are quite variable in the area, with summer months bringing winds from a southerly direction, and winter from the north. 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 strongest winds recorded (ie. above 30km/hr) were from the south-west and west during the winter. During periods of low river flows, consistent winds from a southerly direction can substantially influence the flow and level of the river. Wind induced currents can reverse the flow of the river and the level of water on one side of the river can be up to a 1m difference to the other side in extreme circumstances.

3.3 GEOLOGY AND HYDROGEOLOGY

Concerns were raised in Government agency submissions that the EIS did not include a comprehensive investigation of potential soil and groundwater contamination for the entire site. In particular, the pollutant risks from the Mannum WWTP and the nearby Council landfill were not adequately addressed. Since the release of the Response document, the proponent has undertaken further investigations into the hydrogeology of the site. In particular, a series of groundwater wells have been installed for collecting soil and groundwater data. The main aim of the investigation was to determine whether saline groundwater could potentially be discharged to the River Murray as a result of the proposal. The Hydrogeological Report is included as Appendix 2. The results would then be used to generate a groundwater model, prior to construction commencing, to confirm that groundwater contamination or salinity risks for the River Murray are low and manageable.

3.3.1 Geology

The geological and hydrological setting of the proposed development is adequately discussed in the EIS (Sections 6.3 and 6.4).

There are three formations within the area, the Murray Group Limestones beneath the highland, and the Coonambidgal Formation (comprising clays and silts) and Monoman Formation (comprising sands) beneath the river floodplain. 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).

Two geotechnical investigations were undertaken by the proponent on the site in 2003 and 2006. Selective boreholes were drilled, three in the initial investigation in 2003 and eight in 2006. The results of these investigations are included in the EIS (Appendix D). Seven near-surface soil samples and one deeper natural soil sample from seven borehole locations were analysed to assess the concentration of compounds.

No Acid Sulphate Soils were detected and it was considered that the clay soils were not expected to develop Acid Sulphate conditions.

3.3.2 Hydrogeology

The hydrogeological conditions on a regional scale and within the site were generally described in the EIS (Section 6.4).

Groundwater is located in three systems; the Murray Group Limestone regional unconfined aquifer beneath the highland, the Coonambidgal Formation unconfined aquifer beneath the floodplain, and underlying this, the confined Monoman Formation.

Preliminary excavations undertaken by the proponent suggest that construction work should not lead to the groundwater table being intersected. The EIS (Section 6.5.3) concluded that groundwater is generally at a depth greater than 1m below the floodplain (ie. -1.6 to -2.1m AHD). The level would fluctuate in accordance with the level of the river.

The Environment Protection Authority (EPA) submission noted a lack of adequate groundwater assessment. Subsequently, the proponent has undertaken additional hydrogeological investigations, which are further discussed below.

Unconfined Aquifer

Under the highland, the water table is contained within the Murray Group Limestone which flows in a south-easterly direction towards the floodplain. 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. The EIS (Section 6.4.1) states that groundwater salinities in the upgradient limestone aquifer are high, ranging from 8,000 mg/L to over 20,000 mg/L. Under the floodplain, salinities are significantly lower due to past draining of excess irrigation water down to the water table and some subsurface inflow from the River Murray, which lies at a higher level than the floodplain watertable. Typical salinities under similar irrigated riverine tracts range from 2000 to 4000 mg/L.

Confined Aquifer

The sands of the Monoman Formation have been interpreted to 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 the EIS (Figure 6.2). Its potentiometric surface (pressure surface) will also be sloping towards the River Murray.

The proponent suggests that 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. This would be dependent on the thickness of the low permeability Coonambidgal Formation separating the river from the Monoman Formation.

Groundwater Flow

The EIS (Section 6.4.3) states that groundwater flow rates beneath the floodplain are very low because of the low hydraulic gradients and low hydraulic conductivity of the Coonambidgal Formation, which is typically > 0.1 m/day. However, the Department of Water, Land & Biodiversity Conservation (DWLBC) raised a concern that further on-site investigations would be required to confirm that the marina and waterways would not be affected by regional saline groundwater or contaminated groundwater from the nearby Mannum landfill. Following negotiations with government agencies, the proponent decided to undertake additional studies to obtain further physical information regarding groundwater conditions at and adjacent to the proposed site, including the installation of 14 groundwater monitoring wells into the shallow water aquifers (12 in the Coonambidgal Formation and 2 in the deeper Murray Group Limestone). Additional wells are proposed to be drilled into the Murray Group Limestone in the vicinity of the Council landfill on the NW corner of the site.

The further investigations (Appendix 2) confirmed the findings of the EIS that saline groundwater is not discharged from the site into the River Murray. There was some evidence of leakage from the WWTP lagoons that had resulted in the formation of a groundwater mound and lower groundwater salinities. Based on groundwater elevations, it was considered that the waterways would be above the groundwater level, with the exception of the ends of the north-western and south-western reaches of the residential waterways, which could intercept regional groundwater in the limestone aquifer. The proponent is considering an engineering solution, comprising of a low permeability clay liner, together with maintaining a permanent head of water pressure to prevent saline groundwater intrusion into the waterways.

The EIS (Section 11.2.4) indicates that the depth of marina basin and waterways would be at a higher elevation than the groundwater level, which would result in the water table rising slightly. However, due to low hydraulic gradients there would be little effect on local groundwater flows from the River Murray.

Groundwater/River Interface

The EIS indicates that the proposed marina basin and waterways would be cut into the underlying Coonambidgal Formation resulting in a transfer of flow from the marina into the groundwater table. This will result in the groundwater table rising, however the effects are expected to be local, with little modification to the local groundwater flows from the River Murray.

Groundwater Use

Regional groundwater is generally too saline for domestic or agricultural use. Thus, there are no existing users of groundwater in the locality, as most users access River Murray water supplies.

The Response (Section 5.1) indicates that desalinated groundwater could be used as an option for filling the marina basin and waterways, as an alternative to using River Murray water. However, this is unlikely to be pursued due to the high cost of desalination and problems with disposal of highly saline brine waste.

3.3.3 Regional Salinity

Salinity is a major issue within the whole river system. The EIS (Section 5.2.4) states that salt loads reaching the river have increased by 500 t/day as a result of irrigation, according to information given by the proponent. 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. Regional salinity maps produced by the DWLBC indicate that, whilst the floodplain is not within a High Salinity Impact Zone, the surrounding high ground is (ie. due to the geology being Murray Group Limestones).

Additional hydrogeological investigations (Appendix 2) found that regional saline groundwater does not discharge from the site into the River Murray. Groundwater level data indicates that the floodplain forms a groundwater sink, with groundwater discharging from both the regional aquifer to the north and the River Murray from the south. Evaporation is considered to be the primary driver for the occurrence of the groundwater sink. The raising of the floodplain watertable around the marina and waterways would redirect regional inflows to the remaining areas of low-lying floodplain to the south-west of the site.

3.4 EXISTING RIVER ENVIRONMENT

The EIS (Section 5.2.4) provides a general overview of the water related aspects associated with the River Murray, including flows, levels, flooding, quality and usage. Additional information is provided in the Response (Section 5.2). Whilst the proponent has not undertaken any water quality testing of the river adjacent the site, existing monitoring data sets have been used to describe the current situation. A greater focus has been placed on measures to ensure that the quality of discharges to the river would be to an acceptable (or even better) standard than river water quality. The EIS (Section 5.2.4) states that the site currently has a low discharge of pollutants to the river, especially as past irrigated dairying practices ceased around 15 years ago. It is uncertain whether the Mannum WWTP may be leaking nutrients due to seepage from the base of unlined lagoons. Further groundwater monitoring would investigate any potential risk.

3.4.1 River Flows

The River Murray is in its sixth consecutive year of drought, with the floodplains in the lower Murray under extreme environmental stress. 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).

The natural creek catchment surrounding the proposed development site is made up of an area of 3,100 ha. The river flats make up an area of 86 ha and receive an annual rainfall average of 261.53ML. Essentially all of this rainfall is evaporated from the floodplain before reaching the River Murray.

It has now been a decade since many floodplains and wetlands along the lower reaches of the Murray last experienced a beneficial flood. The last significant flood at Mannum was in 1995, with flows peaking at 55,900 ML/day 80 km upstream at Blanchetown.

River Levels

Water levels in the river above Blanchetown (ie Lock 1) are regulated by a series of locks and weirs. Barrages near the Murray Mouth are used to regulate river pool levels at Mannum to a level of 0.75m AHD. Whilst river levels can be kept relatively constant due to such manipulation, during extreme drought conditions the river level is dictated by flows. The current drought conditions have had a significant impact on river levels and flows, consequently the river level is (at the time of writing this AR) around 0.20m AHD. The height and flow of the river has become more variable under the influence of wind conditions. River levels and the direction of flows now vary on a daily and weekly basis. This aspect has not been recognised in the EIS.

Recent very low flows and reduced upstream storage capacity has resulted in the river level at Mannum being at a record minimum (ie since river regulation). However, this has not resulted in the river becoming un-navigable for houseboats. Some parts of the river have become difficult for large boats to negotiate, due to greater exposure of sandbars and snags, and berthing along the river bank can be difficult due to shallow water.

3.4.2 River Water Quality

Water quality is a major issue in the River Murray, because of the need to maintain its essential environmental values, aquatic ecosystems, recreation, agricultural and domestic water supply; particularly the supply to Metropolitan Adelaide.

The *River Murray and Lower Lakes Catchment Risk Assessment for Water Quality* (EPA, 2007) report states that total heavy metals are generally low in the Mannum area, although turbidity levels are slightly elevated. The study identified the main hazards in proximity to the proposed site, with the highest frequency hazards being stormwater discharges, flood-irrigated dairying area discharges, wastewater infrastructure, septic tanks, wetlands and fuel stores. Most of these risks would also be associated with the proposal.

The EPA study identified bacteria (*E. coli*) and nutrients as the main factors that affect water quality in this stretch of the river, mainly due to irrigated dairy farms. It should be noted that such dairying practices are now undergoing a reform program to improve the quality of such discharges to the river. Saline groundwater inputs, heavy metal and pesticide levels are generally low. The Mannum WWTP was identified as a high nutrient and organic matter risk, as it is located below the 1956 flood level.

Marinas and mooring areas (such as along River Lane in Mannum) were identified as a moderate risk, due to greywater and, to a lesser extent, blackwater discharges. Houseboat effluent pump-out stations were also identified as a moderate risk due to the potential for accidental spills. Road run-off and marinas (especially those with slip-ways) pose a moderate heavy metal risk. However, the risk to benthic (bottom dwelling) aquatic biota from particulate forms of heavy metals is unknown. The Mannum landfill also poses a moderate heavy metal risk. Pesticide risks were assessed as low, although wash-off from slip-ways could contain anti foulant compounds. Most pesticide levels were below detection limits and did not pose a risk, even from urban run-off. Mannum stormwater and houseboat discharges were identified as moderate – high pathogen and organic matter risks to the Mannum raw water offtake, due to their close proximity. There is a high hydrocarbon risk from refuelling facilities in Mannum.

The EIS (Section 5.2.4) provides an adequate discussion on the range of factors that affect water quality, based upon existing literature (EPA, 2002 and Sinclair Knight Merz, 1999). The Response (Section 5.2.1) identified the Mannum WWTP lagoons as a potential source of groundwater pollution that would be removed as part of the proposal. SA Water has clarified that this is incorrect, as regular monitoring has shown that heavy metal levels are not a cause of contamination. The proponent has recognised that the statements made in the Response were premature and should be disregarded, pending groundwater assessment results (refer to Appendix 1).

Water Quality Improvement Initiatives

There are a number of initiatives in place and/or being implemented by government and the community, often under the guidance of the South Australian Murray Darling Basin Natural Resources Management (SA MDB NRM) Board and Local Area Planning (LAP) Groups, to improve River Murray water quality. Many of these initiatives are outlined in the EPA (2007) report, as well as in the EIS. Section 11 of the EIS outlines the proponent's mitigation measures for potential impacts.

3.4.3 River Water Usage

The River Murray is the most important water source for South Australia. As described in the EIS (Section 5.2.5), river water is also used largely for irrigation purposes, particularly for dairying and horticulture. With drought conditions affecting the water levels in the Murray, a cap was placed on diversion in South Australia in 2000.

3.5 TERRESTRIAL AND RIVERINE ECOLOGY

The EIS (Section 7) provides a detailed description of the terrestrial and riverine ecosystems that occur on the site and along the river bank. In particular, a good level of survey data was collected for the Baseby Linear Riverine Wetland complex (the Baseby Wetland), which will provide an essential baseline for monitoring any impacts. The baseline should also be used for measuring proposed habitat improvements of the proposal on this important riparian zone (such as through better management and rehabilitation works). An overview of regional ecological features, particularly wetland habitat, is also provided. Suitable survey and data collection methodologies have been employed to adequately describe the native vegetation and fauna community types present.

The *Biodiversity Plan for the South Australian Murray Darling Basin* (Kahrimanis et al, 2001) describes the region as supporting a wide variety of habitats, with an extremely diverse biota. Whilst 59% of native vegetation remains in the entire basin, only 16% occurs in the agricultural portion, whilst 43% occurs in the rangeland region due to differing land uses. The proposed site lies within the River Corridor Regional Ecological Area that includes the entire River Murray valley (river, floodplains and wetlands) from the Victorian border to Wellington. The Plan states that, despite its biodiversity and economic significance to the State, there is a significant lack of documented and mapped biological information for the river corridor.

The water dependent communities that occur along the floodplain are all highly affected by river regulation and salinity and are thus threatened, particularly if water flow is inadequate and does not provide for environmental needs. In addition, many species are now considered threatened at a Regional, State or National level due to broad scale native vegetation clearance (mainly for agriculture), fragmentation, selective clearance (often due to development), grazing and edge effects (such as weed invasion). Although the River Corridor has been significantly altered since European settlement, it is still a botanically rich and complex area that sustains a wide range of biodiversity.

3.6 EXISTING INFRASTRUCTURE

Stormwater

Apart from the culvert structure connecting the main creek beneath Belvedere Road, no other stormwater infrastructure exists on the site. Drainage follows natural gullies and creeks to the abandoned dairy flats. There is no natural drainage outlet from the development area to the river due to the presence of levee banks.

Waste Water Treatment Plant

The existing lagoons of the Mannum Waste Water Treatment Plant (WWTP) occupy an area of approximately 4 hectares. An overflow structure permits flow from the lagoons to the river in emergencies. Sludge drying beds are also present. An existing pumping station, which extracts water from both the river and the reclaimed water storage lagoons, delivers water for irrigation to the nearby 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.

Water, Electricity and Gas Supplies

There is no mains water supply to the development site. The EIS (Section 2.7.4) states that potable water would be provided by an extension of the existing SA Water supply lines in Mannum. Typical water supply connections would be provided to each allotment and marina mooring, including fire hydrants. The existing town water supply would be augmented in accordance with recommendations provided by SA Water.

An irrigation water licence for 170 megalitres (Ml)/annum is owned by the current property owner (Mr. Reschke) and would be made available for purchase by the proponent (if the project proceeds). This licence would need to be supplemented by securing an additional water licence (and water allocation) to ensure the water balance required to fill and maintain the marina and waterways is met.

An overhead power line traverses the site, via easements providing power to the Mannum WWTP, the Reschke land, the disused dairy and neighbouring property to the south. It is proposed to replace the existing line with an underground service that will maintain supply to the adjacent properties, as required.

There are no gas services to the site.

Telecommunications

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

Buildings and Irrigation Infrastructure

No existing buildings, other than the Reschke's residence, will be retained in the development.

Private irrigation systems have operated on the high ground and within the gully of the main creek. The systems are no longer in use and will be decommissioned if the development proceeds. Extensive drainage channels traverse the site that were established as part of the flood irrigation schemes along the lower River Murray in the past.

Roads

The are no existing roads within the site, with the only access being an unsealed road to the Reschke's residence and the boat ramp and houseboat moorings on the river bank ('Reschke's Landing').

Belvedere Road, which is unsealed, borders the inland (western) boundary of the site and would be the main access road from Mannum. The road also connects with the Mannum – Murray Bridge Road.

Embankments and Levee Banks

Constructed embankments surround the Mannum WWTP lagoons. They will not form part of the new development and would be removed if the proposal proceeds.

A levee bank exists along the length of the river side boundary of the site, from the Mannum WWTP to the southern boundary and beyond, that isolates the dairy flats from the River.

3.7 SURROUNDING LAND USES

The current land uses directly north of the site are the Mannum Golf Course and the Cemetery. North-west of the site is the Council landfill and rural land used for grazing. North of the site is the township of Mannum and the Mannum WWTP (lagoons, associated buildings and infrastructure). The Baseby 'shacks' along River Lane are located to the northeast and currently form one of the urban boundaries of the township of Mannum. Bounding the site to the east is the River Murray, with houseboat moorings

located sporadically on the river embankment the length of the site. A formal mooring area, including a concrete revetment constructed along the bank, and boat ramp ('Reschke's Landing') has also been established in the past.

The majority of the site has already been cleared of native vegetation to provide pastures for dairy farming. The land is no longer used for dairying and irrigation purposes. As indicated in the EIS some salt tolerant native vegetation has recolonised the abandoned dairy flats. The soil has a high salt content and is infested with weeds, especially African Boxthorn. The current owners of the land reside on the property on the higher ground away from the river. There are five existing houseboat berths and an existing houseboat shed.

3.8 EXISTING SOCIAL ENVIRONMENT

Aboriginal History and Culture

The EIS (Chapter 10) contains a thorough investigation of Aboriginal Heritage sites on the land. The proposal lies within the Peramangk Country and there are no current Native Title claims or Indigenous Land Use Agreements over the land.

The River Murray was an intensively occupied area for Aboriginal people and has significant meaning for the Permanagk people and their descendants. Investigations undertaken for the EIS have revealed a number of sites of significance, including middens and scarred trees.

The proponent has undertaken consultation with the Mannum Aboriginal Community Association Incorporated (MACAI).

Aboriginal Affairs and Reconciliation (a Division of the Department of Premier & Cabinet) has indicated it is satisfied with the level of investigations undertaken into this aspect of the proposal.

Short European History of Mannum

The EIS (Section 8.2) outlines the important strategic role that Mannum held in the development of the river trade commencing in the 1850's. Paddle steamer trade from the port of Goolwa to New South Wales and Queensland during the latter half of the 1800's sustained the development of the town.

Mannum was also a centre for the growing agricultural activity in the region, which connected with the important river trade opportunities.

Today Mannum is an important service centre for the surrounding district. The town is seen as an attractive retirement destination as it has a relaxed lifestyle, while not being too remote from Adelaide for other desirable services. Mannum has an important tourism focus and is an easy day trip destination as well as providing access to the river for boating and house boat holidays.

Recreation and Tourism

Recreation at Mannum is focussed on the river and the boating, skiing and other water based activities that it provides. As outlined in the EIS (Section 8.4), the town also has a wide range of land based facilities for football, netball and many other sporting activities.

3.9 SOCIAL DEMOGRAPHICS

Demography

The social characteristics of the Mannum township and surrounding areas are adequately described in the EIS (Section 8.5) using Census data from the Australian Bureau of Statistics (1981-2001 Census period).

The investigations undertaken for the EIS indicate that the population of Mannum in 2001 was 2,160. The population has fluctuated over the last 20 years, with a recent increase in numbers resulting from an influx of retirees, after a decline in population during the period 1986-1996 that was related to changes in local industry and farming. However, Census data for 2006 show that the current population is around 2,000 people (ie. a population decline of 1.84% since 2001).

The number of people over 65 in Mannum is significantly higher than the figure for the whole of the State, whilst the population of those in the categories aged 44 and under is lower. The growth of the elderly population is attributed to a number of factors, including the availability of existing health, community and commercial services and its proximity to metropolitan Adelaide.

Other notable characteristics of the current Mannum population are its high proportion of people born in Australia and the number of households occupied by either couples or singles without children or dependents, which is significantly lower than the State average and reflects Mannum's growing popularity as a retirement destination. Mannum's population mobility has also been relatively stable in recent times although there has been some movement attributed to an influx of retirees from rural areas to the town and people departing the area due to a decline in agricultural employment.

Social Services

Health services currently available in Mannum include the Mannum District Hospital, which serves the town and surrounding areas. The hospital incorporates a range of inpatient and outpatient services and is reported to have the capacity to be expanded if required.

In terms of education, Mannum is currently served by the "Community College" which provides educational services to students from Reception to Year 12. The college shares facilities with the broader community (eg meeting spaces, oval and library) and is also used by the University of the Third Age, which provides education to the elderly population. Tertiary education is not currently available in Mannum, with TAFE facilities available in Mt Barker and Murray Bridge.

Other services available in Mannum include Police, Country Fire Service and the Murray Bridge Passenger Service that provides limited bus transport between Mannum and Murray Bridge. In terms of telecommunications, Mannum has good mobile telephone coverage, but a limited broadband internet service at present.

3.10 EXISTING ECONOMY

The EIS (Section 9) provides an overview of Mannum's role and importance to the economy of the Murraylands Region. Mannum's local economy is primarily dependent upon recreation and tourism, especially holiday home (shack) owners and the houseboat industry. Mannum is also strategically placed as a main service centre for the surrounding area (mainly for primary production related industries), especially due to its retail and medical services.

4 CONFORMITY WITH LEGISLATION AND POLICIES

Section 48(5) of the *Development Act, 1993,* requires that, before the Governor considers a proposal that has been declared a Major Development, the Governor must have regard to, amongst other things, the provisions of the appropriate Development Plan and the Regulations (so far as they are relevant) and the Planning Strategy. Other matters considered relevant by the Governor can also be taken into account.

The Crown Solicitor has advised that in respect of applications being assessed as Major Developments under the Act, the appropriate Development Plan and Planning Strategy are those current at the time of the decision, as Section 53 of the *Development Act, 1993*, does not apply to the Major Development provisions of the Act.

4.1 DEVELOPMENT PLAN

The relevant Development Plan is the *Mid Murray Development Plan - Consolidated – 13 December 2007*. The subject land is located within the River Murray Zone and the *Conservation Policy Area*, *Floodplain Policy Area* and *Primary Production Policy Area,* as prescribed in Map MiMu/62 and MapMiMu/36 of the Development Plan.

The River Murray Zone supports tourism and recreation confined to designated areas and can be undertaken in a limited capacity in the *Primary Production Policy Area*. Residential development is also limited within the subject policy area.

Land division where additional allotments are created is non-complying in both the *Conservation Policy Area* and *Floodplain Policy Area* and unacceptable when associated with urban residential development in the *Primary Production Policy Area*. Marinas are also non-complying in the *Conservation Policy Area* and *Floodplain Policy Area* and further to that the Development Plan indicates that marinas should only be in environmentally acceptable areas.

Mid Murray Development Plan Zone Provisions

Council Wide (CW)
River Murray Zone (RMZ)
Principle of Development Control (PDC)

Land Use

CW Objective 45: *Encouragement of the District's tourism industry.*
CW Objective 46: *Tourist development located with regard to the character of an area or locality and natural features.*
CW PDC 161 *Tourism development should be located so that its scale and external appearance does not have an adverse visual impact upon either the rural or township character (whatever the case may be) and should not:*
(a) generate excessive volumes of traffic;
(b) require large or extensive numbers of advertising signs;
(c) create excessive noise or such other disturbances which could cause a nuisance to nearby residents; and
(d) result in the uneconomic extension of public services and facilities.
CWPDC 162 *Tourism development should be located in such a way as to maximise the retention of existing native vegetation and ensure the bed and banks of watercourses are protected from inappropriate development and management practices.*
RMZ Objective 20: *Limited residential development.*
Residential use limited to: Shack Settlements and River Settlements, where required to support

tourism and recreation ventures in designated areas; and on a restricted basis in Primary Production Policy Area. No residential development is anticipated in the Conservation Policy Area or the Flood Plain Policy Area.

RMZ Objective 14: *Use of land for tourism and recreation confined to designated areas and undertaken in a limited form in the Primary Production Policy Area.*

Tourism and Recreation uses, many of which will be river related, should be confined to the Tourism and Recreation Policy Area and undertaken to enhance the riverine environment and minimize environmental impact, and where undertaken in the Primary Production Policy Area, not impair the prospects of horticulture development. Clustering substantial structures will ensure large tracts of the River retain their attractive natural character.

Flood Plain Policy Area PDC 1 *Development should not be undertaken unless it is consistent with the Desired Future Character and Acceptable Uses of the Zone and Flood Plain Policy Area.*

Flood Plain Policy Area PDPC 12 *Development or use of land for tourism should complement or interpret the:*

(a) natural environment of the region;
(b) primary production in the area; or
(c) local cultural heritage.

Primary Production Policy Area PDC 31: *Development or use of land for Tourism development should complement or interpret the:*

(a) natural environment of the Murray Valley;
(b) primary production; or
(c) local cultural heritage.

The proposed development takes advantage of the natural features of the river locality and its immediacy to the township of Mannum. The proposal facilitates the opportunity for the establishment of tourist accommodation, associated ventures and recreational activities. The extensive planted areas proposed throughout the site and the 40 hectares of constructed anabranch/wetland maintain the visual amenity, adding to the natural features and river character of the locality.

As a result of this development, the Zone would be occupied by a mix of uses. The predominant use being residential, marina moorings and facilities, commercial area (general store/café, interpretative centre), tourist accommodation and public recreational areas. The proposal limits residential development to the north and western side of the site and seeks to retain existing riverine and riparian vegetation on the River Murray side.

Land Division

CW Objective 10: *Division of land for purposes appropriate to the location and intended use of the land.*

CW PDC 10 *When land is divided:*

(a) any reserves or easements necessary for the provision of public utility services should be provided;
(b) stormwater should be capable of being managed in a manner which does not have an adverse impact on natural drainage systems, exceeds the capacity of downstream drainage systems or results in or exacerbates the flooding of property;
(c) in areas of significant fire risk, alternative access routes should be provided for allotments;
(d) a water supply sufficient for the purpose for which the allotment is to be used should be made available to each allotment;
(e) provision should be made for the collection, treatment and the disposal of waste water, sewage, and other effluent on each allotment without risk to health;
(f) roads or thoroughfares should be provided, where necessary, for safe and convenient access to the carriageway of an existing or proposed road or thoroughfare;
(g) proposed roads should be of a gradient to connect safely and conveniently with an existing road or thoroughfare; and

(h) allotment boundaries should be located where interference with native vegetation and natural drainage lines will be minimal.

***CW PDC11** The size, shape and layout of allotments should be determined with regard to physical characteristics and the intended use of the land.*

***Flood Plain Policy Area Objective 22:** Allotments suited to their proposed use.*

***Flood Plain Policy Area PDC 33:** Land should not be divided if the size, shape and location of, and the slope and nature of the land contained in each allotment resulting from the division is inconsistent with the Acceptable Uses and land use policies for the Flood Plain Policy Area.*

The scale of the proposed development is more extensive than that envisaged in the Development Plan. The proposed land division will comprise of 161 waterfront allotments, 403 standard allotments and 36 affordable housing allotments. However, the proposed development has addressed the relevant requirements encompassing the division of land and reinforces the township of Mannum as a major urban and population centre.

The proposed residential layout has been located with regard to the physical characteristics of the site, predominantly located on the higher ground. Waterfront allotments have been restricted to the edge of the floodplain and the valley slope.

Character /Built Form

***CW Objective 15:** Amenity of localities not impaired by the appearance of land, buildings and structures including landscape.*

***CW Objective 31:** A range of attractive living environments and housing types.*

***CW PDC 43:** Buildings and structures should be sited unobtrusively and be of a character and design which will blend naturally with the landscape.*

***CW PDC 35:** Development should not be undertaken unless:*

(a) it conforms with the desired future character of an Area; and

(b) it is sited so as to protect scenic views from public roads or reserves, and is not located on visually-significant ridgelines.

***RMZ Objective 2:** Development which recognises the variety in the land types and corresponding character difference.*

***Conservation Policy Area PDC 5:** Development should be designed and sited to respect and maintain the landscape character of an area which is of:*

(a) historical (including archaeological) significance;

(b) scientific interest;

(c) scenic value or natural beauty; or

(d) other heritage significance.

***Conservation Policy Area PDC 11:** The visual obtrusiveness of buildings and structures should be minimised through:*

(a) their design and siting;

(b) the use of screen landscaping.

***Flood Plain Policy Area Objective 2:** Buildings and structures strictly limited, but where undertaken, compatible with the environmental qualities, built form, character of the surrounding area and landscape and designed not to impede the flow of flood waters.*

***Flood Plain Policy Area PDC 4:** Development should be designed and sited to respect and maintain the landscape character of an area which is of:*

(a) historical (including archaeological) significance;

(b) scientific interest;

(c) scenic value or natural beauty; or

(d) other heritage significance.

***Primary Production Policy Area Objective 5:** Maintenance and enhancement of the landscape character.*

***Primary Production Policy Area PDC 4:** Development should be designed and sited to respect and maintain the landscape character of an area which is of:*

(a) historical (including archaeological) significance;
(b) scientific interest;
(c) scenic value or natural beauty; or
(d) other heritage significance.

The proposal will have some impact on the scenic amenity of the river by introducing a substantial area of new urban development in a location where there are relatively few structures. However given that part of the land currently includes an existing waste water treatment plant (and associated evaporation ponds) and abandoned dairy flats, the impact would be minimal. The proposal seeks to provide significant revegetation and constructed wetlands and would preserve the existing riverine environment. This would form a considerable habitat area which will complement the riverine area and act as a buffer, improving the amenity of the locality. A substantive dwelling and associated sheds will be retained but are absorbed within the residential component.

The proposed draft House Owners Charter (ie. that would be attached as an Encumbrance on the land) addresses the standard objectives and principles relating to waterfront residential development. The proposed Design Guidelines are an appropriate mechanism for incorporating environmental and sustainability requirements. The Council would need to take into consideration the urban design issues when assessing individual dwelling applications under the Mid Murray Development Plan in the future (if the proposal is approved). The concept designs for the waterfront dwellings show that visual amenity and diversity are strong considerations, having appropriate scale and proposing a pleasant living environment.

The residential component is located on the higher part of the site in the north and north-western corner, with more immediacy and connectivity to the existing urban fringe of the Mannum township. All residential and commercial allotments would be constructed above the 1956 flood level. Having further regard to the character of the area, the proposed development accommodates the type of recreational and tourist development that is synonymous with River Murray activities.

The EIS has acknowledged the significance of Aboriginal Heritage areas and the River Murray environment, with particular emphasis on the wetland and conservation area satisfying the relevant provisions.

The proposal would re-use onsite stormwater as a way of reducing mains water demand. Gross pollutant traps, stormwater retention basins and other Water Sensitive Urban Design (WSUD) measures, plus the constructed anabranch/wetland system, would be provided as means of treating run-off water quality prior to its discharge into the marina.

Traffic Movement

CW Objective 11: *Safe and efficient movement of people and goods by road.*
CW PDC 15 *Development liable to generate traffic volumes which cannot safely and conveniently be accommodated on the existing or proposed road system should not be undertaken.*
Flood Plain Policy Area PDC 31 *Sites should be provided with a safe and convenient means of access which:*
(a) avoids unreasonable interference with the flow of traffic on adjoining roads;
(b) accommodates all types and the volume of traffic likely to be generated by the development or land use; and
(c) is located and designed to minimise any adverse impact on the occupants and visitors.

The increase in traffic created by the proposed development should not adversely affect the township area. This is due to the number of dwellings and houseboats that would be used as holiday places. Therefore, the traffic volume would be marginally lower than if the occupants resided at all dwellings and mooring sites on a full time basis.

The EIS (Traffic Report) indicates that modifications would need to occur to connect existing road networks with the proposed access roads into and out of the site. In addition, access and movements to and around the site would be undertaken in a safe and efficient manner. The proposal is considered to satisfy the relevant traffic provisions.

At this stage the proposal is for the conceptual land division only and the principles for on-site car parking would be finalised at the detailed design stage. It is intended that the full length of the access road (Belvedere Road) would be sealed.

Access

RMZ Objective 13: *Human and stock access controlled.*
Human and stock access to the River Murray managed to minimise the adverse impact of uncontrolled access on the stability of the bank and vegetation growth.
RMZ Objective 15: *The waterway and parts of the foreshore of the River Murray maintained as a public resource.*
RMZ Objective 17: *Riverfront land kept free from development.*
Only development that has a demonstrated essential relationship with the River Murray should be located on land adjacent to the River. Other development should be set well back from the bank of the River Murray. Development which would intensify the use of riverside land should provide public access to the foreshore.
Flood Plain Policy Area PDC 13 *Development should not occur on the waterfront unless:*
(a) the use is dependent on waterfront access for its operation eg boat mooring; and
(b) it will enhance public access.

The proposed development allows for both public and private use of the river.

Control of public access would minimise physical disturbance of the existing wetland areas. The conceptual layout plan in the EIS shows that access to the river has been provided in a practical and sensitive manner, having regard to the existing and proposed vegetated and wetland areas. The Response document indicates that a 50 metre strip of land would be retained as Crown land adjacent to the river's edge, as requested by the Department for Environment and Heritage.

Stock access is not a requirement for this proposal.

Infrastructure

CW Objective 14: *New development serviced with adequate public infrastructure commensurate with projected demands at the cost of the proponent.*
CWPDC 25 *Development should only be undertaken where demands placed on essential services such as water supply, common effluent drains or electricity can be met by existing facilities or expansion.*
Primary Production Policy Area Objective 18: *Economic provision of infrastructure in an environmentally sensitive manner.*
Primary Production Policy Area Objective 19: *Development provided with an adequate level of appropriate services and infrastructure without excessive cost to the community*
Flood Plain Policy Area Objective 15: *Economic provision of infrastructure in an environmentally sensitive manner.*
Flood Plain Policy Area Objective 16: *Development provided with an adequate level of appropriate services and infrastructure without excessive cost to the community.*
Flood Plain Policy Area PDC 30 *Infrastructure required for development should:*
(a) be able to be economically provided;
(b) be of a sufficient standard, design and capacity to accommodate the proposed development;
(c) not have a detrimental impact on the environmental qualities and amenity of the area;
(d) not necessitate the removal of native vegetation;

(e) not increase the level of risk to public health;
(f) be provided at full cost to the developer without public subsidisation now or in the future;
(g) not compromise the level of service to other existing users; and
(h) not be at the risk of damage by flood waters.

The EIS indicates that the provision of infrastructure is to be staged. The water supply and power supply would be upgraded to meet the capacity envisaged by the proposed development. The existing Mannum WWTP site would be decommissioned and a new wastewater treatment facility established that would service the proposed development, as well as the township of Mannum. This facility has the potential to improve services to the site and surrounding area from an environmental and community perspective, as well as removing a hazard from the flood plain. The new plant would be built away from the flood plain (at the cost of the proponent) in accordance with relevant legislative requirements.

In terms of other infrastructure, the proposed development would also utilise existing services and information provided by utilities provider (ETSA Utilities), which has indicated that there is sufficient power capacity. The site would also be augmented with reclaimed water storage as required. Gas is not located within the immediate vicinity so the use of solar hot water would also be encouraged.

Flooding/Hazards

CW 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.*
CW Objective 7: *Development safe from natural or man-made hazards and to be compatible with land capability.*
Conservation Policy Area PDC 8: *Structures apart from purpose built flood control levees, including fencing, and the filling of land, should:*
(a) not impede the flow of floodwaters or change the pattern of movement of floodwaters; and
(b) when feasible mitigate any existing impediments to floodwaters,
(c) unless they are to permit the manipulation of water to replicate environmental flows or for other environmental purposes - such as carp eradication.
Flood Plain Policy Area Objective 3: *Maintenance of natural hydrological systems and environmental flows.*

The EIS indicates that the SA Water wastewater lagoon and over flow structures would be removed from their current location in the floodplain, minimising a potential pollution risk.

In regard to flood management, the EIS indicates that all new development would be located above the 1956 flood level. The residential component would be located to the north and north-west of the site, the majority of which is higher ground. The dwellings proposed are conceptual only at this stage, but it should be noted that the garaging and storage areas sit below the flood level. The impact of flooding on the garaging and storage areas would be dependent on the design of the buildings and any other impediments to the flow of floodwaters.

The EIS indicates that suitable plantings are proposed as an erosion preventative measure. A series of earthen embankments (levees) are proposed to be provided around the waterways, marina and wetland area to contain water and prevent flooding into the neighboring dairy flats to the south. A levee is also proposed to be constructed on the southern boundary to divert floodwater back into the river, which would protect downstream properties.

The EIS indicates that a Construction Environmental Management Plan (CEMP), an Operational and Environmental Management and Maintenance Plan would be implemented to provide adequate safeguards and mitigation during the construction stage to prevent potential major environmental effects. Potential effects are water, dust, noise and habitat pollution as well as soil erosion.

The Response indicates that stormwater wetland areas have been relocated and provided with flood gates at discharge outlets to prevent stormwater flooding entering into the wetland areas, consistent with the 1956 flood level requirements.

The proposed development also includes revegetation, conservation and wetland schemes that further improve the site. Generally the proposed land use is compatible with the land capability. The EIS concludes that all of the effects identified are manageable and there are no significant effects considered unacceptable.

Conservation/Revegetation

CW Objective 36: *Conservation, preservation or enhancement of scenically attractive areas, including land adjoining water or scenic routes.*
CW Objective 38: *Preservation of natural vegetation of historic, local or particular visual significance.*
CW PDC 109 *Important natural resources including watercourses and water catchment areas, scenic areas and significant flora and fauna should be conserved and protected from development which would affect them adversely.*
RMZ Objective 4: *Protection and improvement of the riverine landscape.*
Measures should be taken to protect and enhance the riverine landscape by maintaining riparian vegetation communities along the river bank and adjacent land, rehabilitating degraded sites and stabilising and revegetating riverbank appropriate species
RMZ Objective 6: *Protection and improvement of wetlands.*
Wetlands are natural resources which have ecological, recreational, economic, flood storage and nutrient and pollutant filtering values which should be protected.
Land use and management decisions affecting wetlands should:
(a) conserve wetland ecosystems and their environmental resources;
(b) provide for a hydrological regime appropriate for the maintenance or restoration of the wetland;
(c) consider the potential impact of the surrounding land uses and incorporate measures such as a vegetated buffer which may mitigate any adverse effects; and
(d) control inappropriate human and animal access.
Conservation Policy Area PDC 1 *All revegetation and screen plantings should be of locally occurring native species, preferably using seed sourced from the region.*
Conservation Policy Area Objective 1: *Retention of native vegetation, wildlife habitat, features of cultural heritage significance and natural beauty.*
Conservation Policy Area Objective 2: *Environmental water allocations to imitate natural flow regimes and the protection of wetlands of conservation significance.*
Conservation Policy Area PDC 4 *Development should not degrade the wildlife value, scenic beauty or scientific or cultural value of land or waters in the policy area.*
Conservation Policy Area PDC 6 *Trees and other vegetation, including native flora and bushland remnants which are of:*
(a) special visual, historical or scientific significance or interest or heritage value;
(b) existing or possible future value in the screening of a building or unsightly views;
(c) existing or possible future value in the prevention of soil erosion; or
(d) value as a habitat or feeding area for native fauna;
(e) should be conserved and their value and function not compromised by development.
Flood Plain Policy Area Objective 7: *Retention and maintenance of wetlands and existing native vegetation for its conservation, biodiversity, and habitat value and environmental management function.*
Primary Production Policy Area Objective 4: *Retention and maintenance of wetlands and existing native vegetation for its conservation, biodiversity, and habitat value and environmental management function.*

The site is comprised of flood plain, river bank (native vegetation and wetland) river channel, former irrigated river flats and high ground vegetation. The floodplain was extensively modified for dairy farming. Whilst the proposal would result in intensification of development on a site where it is currently

minimal, measures would be incorporated that would assist in the protection of the existing adjacent wetlands and water quality in the river and waterways. Retirement of the irrigation area would also help reduce salinity on the floodplain.

Nonetheless the EIS indicates that an inherent design consideration for the layout of the overall proposal is to retain the existing wetland and riverine environment for its biodiversity/habitat and visual/scenic features. Therefore, some of the key environmental issues identified relate to protecting the adjacent wetland areas and water quality in the river and waterways. Furthermore, the EIS describes environmental management measures that would be implemented to conserve the environment and the benefits that would occur as a result of those measures. The benefits would include retaining existing vegetation, riparian and wetland areas, as well as rehabilitation of modified or disturbed areas (preventing further salinisation) and the maintenance of existing hydrological patterns to create a substantial habitat area.

The EIS indicates that a planting protocol would be established for the development, as well as an Environmental Management and Maintenance Plan. Currently there is a significant amount of the pest plant Boxthorn, which the proponent is gradually removing.

The Response document indicates that minor adjustments have been made to the proposed layout of the residential road reserves and waterways to ensure that all native River Box trees are retained.

The EIS indicates that every effort will be made to avoid the removal of trees and that additional trees would be planted as part of the revegetation process.

The intent of the proposed development is to ensure that measures would be implemented that aim to protect, preserve and improve the riverine landscape. The proposal seeks to enhance what already exists and to maintain as much of the natural environment where possible, meeting the majority of the principles and objectives for conservation within the zone and policy areas.

Heritage

CW Objective 39: *Conservation of land, buildings, structures and other items of significant historical, social and architectural or other Aboriginal or European heritage significance.*
RMZ Objective 9: *Conservation of Aboriginal sites, items and areas which are of archaeological, cultural, mythological or anthropological significance.*
The River Murray has a rich Aboriginal history which should be conserved, interpreted and promoted.
Conservation Policy Area Objective 3: *Provision of appropriate environmental and heritage interpretive facilities.*

The EIS has identified six areas of significance and three Scarred Trees which will be preserved with the agreement of the respective Aboriginal custodians at Mannum, without compromising those sites. The EIS also indicates that an Interpretative Centre would be established within the proposed commercial area to interpret and promote Aboriginal heritage. Indigenous heritage places or objects are to be protected during the construction process. Thus, the proposal is consistent with the Development Plan Provisions.

Open Space/Recreation

CW Objective 32: *Residential environments with a safe, convenient and legible network of all weather paths for pedestrians and cyclists.*
CW Objective 43: *Creation of passive and active recreation areas*
CW Objective 44: *Provision of open spaces.*
CW PDC 33 *Linkages between significant regional recreational and conservation features should be established or enhanced.*
RMZ(Conservation Policy Area) PDC 7: *Development or use of land for recreation should provide services such as access roads, signage, car parks, fire pits, campsites, drinking water, lawns and rubbish and toilet facilities commensurate with the intended intensity of use.*

Flood Plain Policy Area Objective 13: *A range of recreation activities compatible with the local character of the River Murray.*
Flood Plain Policy Area Objective 14: *Development and use of land for recreation which does not contribute to increased health and safety risks for the users of the River Murray.*

The proposed development has more than 50 percent public open space which is more than adequate. The open space takes the form of revegetated areas and constructed wetlands, some of which will have restricted access to preserve habitats, as well as specific recreational and public open space. The proposal encourages the extension of the existing Mannum Golf Course. Further negotiation between the Golf Course, Council and the proponent would need to take place to make this a possibility.

Economic

CW Objective 1: *Orderly development with the economic extension of services and facilities in accordance with Structure Plan for the District Map MiMu/1 (Overlay 2).*
CW Objective 3: *Mannum reinforced as the major urban and population centre.*
CW Objective 8: *Maintenance and promotion of a diverse local economy*
RMZ Objective 10: *Use of land for Primary Production as the prime economic use in the zone.*
Primary production is the leading economic land use in the Zone which should be given primacy in land use decisions providing however it is undertaken in a way which does not adversely affect the Valley's natural environment.

The proposal creates an opportunity for orderly urban development, with a mix of dry land and waterfront allotments, plus marina and waterways within a river environment. The proximity of the proposals location to the township of Mannum would result in residents utilizing the services and facilities of the town, reinforcing it as a major urban centre along the River Murray. The site is located on the edge of Mannum and would be considered an extension of the existing township.

The socio economic assessment in the EIS indicates that the facility would result in a population increase of 45% for Mannum. Employment opportunities would be created through the construction stage and the ongoing operation of the proposed marina, commercial facilities and servicing of the development as a whole (including tourism and recreational activities). The proposed development could potentially have flow on effects at a regional level by adding to an existing diverse local economy through river related recreational and tourist activities. The proposed development reinforces the township of Mannum as the major urban and population centre for the area.

The 'River Valley's' natural environment would improve from its current state, given the adoption of measures to revegetate, rehabilitate, maintain and protect the riverine environment, as opposed to further agricultural use of the land. The proposed development is dependent on the scenic aspects of the river to reinforce its potential and as such, it could be argued it supports the economic extension of services and facilities in accordance with the relevant structure plan.

Retail/Commercial

CWPDC 46 *Retail and business development should:*
(a) integrate facilities;
(b) allow for the multiple use of facilities and the sharing of utility spaces; and
(c) allow for the staging of development.

The commercial component would be associated with the day to day living needs of the immediate community and the proposed boating, tourist and recreational facilities.

The proposal would be staged, with priority on ensuring that the environmental aspects are completed prior to the commencement of the commercial component and the occupation of the residential areas.

Stormwater

CW PDC 27 *Stormwater discharge points should be located and constructed so as to prevent soil erosion.*
CW PDC 31 *Stormwater systems should be located and designed to minimise the hydraulic impact of discharges on streams by mitigating peak flows and providing erosion protection at entry points.*
RMZ PDC 16 *Site drainage should:*
(a) include, where practicable, on-site stormwater detention, retention and use, including the collection and storing of water from roofs and communal car parks in appropriate devices;
(b) provide on-site infiltration where practicable, having regard to:
(i) the availability of unbuilt upon or unsealed areas;
(ii) the ability of soils to absorb water;
(iii) the ability of building footings on and adjacent to the site to withstand the likely effects of retained water; and
(iv) potential adverse impacts on the level and quality of groundwater;
(c) allow convenient access to all components of the drainage system for maintenance purposes;
(d) not cause damage or nuisance flows on site or to adjoining properties; and
(e) not cause contamination of surface water.
RMZ PDC 17 *Storm drainage should have the capacity to safely convey major stormwater flows.*
RMZ PDC 18 *Local storm drainage system should:*
(a) contain and retain creeks and vegetation;
(b) incorporate, where practicable, non-flood-sensitive uses;
(c) incorporate detention and retention basis where required;
(d) enhance residential amenity; and
(e) be integrated with open space systems and provide recreational opportunities
Flood Plain Policy Area Objective 4: *Surface run-off designed to protect property and life and environmental quality.*
Primary Production Policy Area Objective 2: *Maintenance of natural hydrological systems and environmental flows.*
Primary Production Policy Area Objective 3: *Surface run-off designed to protect property and life and environmental quality.*
Flood Plain Policy Area PDC 2 *No adverse impact on natural hydrological systems and environmental flows by ensuring the quality of water leaving the site is of a physical, chemical and biological condition equivalent to or better than pre-development flow characteristics conditions.*

The proposal includes on-site stormwater detention with self cleaning processes enabling the water to be returned to the waterways in an improved state. Part of that self cleaning system would use Gross Pollutant Traps, retention ponds, planted swales and other WSUD techniques where possible. In addition the EIS indicates a wastewater treatment plant and storage system would be established to re-use treated water on site. A management and monitoring plan would ensure that the underlying groundwater and any surface water quality are not unduly impacted by the development.

Sustainability

RMZ Objective 1: Ecologically sustainable development.
Outcomes from sustainable development in the Murray Valley will be:
(a) Maintenance of Water Quality;
(b) Conservation of valuable natural environments;
(d) Growth of tourist and recreation opportunities; and
(e) Sympathetic development of facilities related to primary production, tourism and recreation.

Forms of development which support these outcomes include:

Environment:
(a) conservation of wetland habitats and management of the natural environment to allow regeneration, breeding and spawning of native species;

(b) recognition of the visual qualities of the valley slopes and their contribution to the zone's overall character; and
(c) recognition of the variety in function and character of the upper reaches of the River compared to the lower end of the River.
Recreation and Tourism:
(a) restrictions on waterfront development for a distance of 50 metres from the water's edge to prevent erosion, maintain native vegetation, retain the river's visual characteristics and the character of the historic public waterfront;
(c) designation of specific locations for marina developments and pre-conditions for their development.
***Related Development**:*
(a) limitations on development on the flood plain as defined by the level of the 1956 flood on the basis of protecting property from damage;
(c) restrictions on residential development in primary production areas to ensure land management practices are not fettered by interface limitations;
***RMZ Objective 3:** Protection and improvement of water quality.*
The use or management of riverine land which reduces pollution caused by salts, sediments, nutrients and other pollutants entering the River Murray and otherwise improves the quality of water in the River Murray.

The intent of the proposed development is to be compatible with an improved land capability of the floodplain beyond its current state of abandoned dairy flats and waste water treatment lagoons. In this regard, the EIS provides measures and specific management plans that take into consideration the potential flooding and erosion issues, plus the protection, conservation and enhancement of the riverine environment, so that it is maintained and not degraded. The EIS also provides further measures that deal with stormwater and water quality within the site and the impact the proposed residential and marina components would have on them. Hence, the intention to limit and locate the residential component away from the river and along the edge of the internal canals, plus containing the houseboats within a marina, allow for better environmental controls.

The land and water management practices proposed in the EIS support ecologically sustainable development. Furthermore the establishment of a large anabranch/wetland system and revegetation of the site would benefit the biodiversity of the area.

The EIS indicates that climate change and flood levels have been considered when designing the proposed marina development.

Land Degradation

***RMZ Objective 5:** Prevention of land degradation.*
Development which avoids degradation processes such as erosion, destruction of riparian vegetation, pollution of ground or surface water, groundwater accession, salinity and soil acidity and adverse effects on the quality of terrestrial and aquatic habitats
***RMZ Objective 7:** Minimum disturbance to the shape of the bank and riparian native vegetation in any development of river front land.*
Riparian landform and vegetation, including the trunks of dead trees, provide important fish and fauna habitat.
***Flood Plain Policy Area PDC 5** Development should not have an adverse impact on the natural, physical, chemical or biological quality and characteristics of soil resources.*
***Flood Plain Policy Area PDC 6** Development should minimise the loss of soil from a site through soil erosion or siltation both:*
(a) during the construction phase; and
(b) following commencement of an activity.
***Primary Production Policy Area Objective 6:** Protection and maintenance of:*
(a) the physical, chemical and biological quality of soil resources;

(b) the quantity of soil resources;
(c) the natural processes of sediment transfer.
***Primary Production Policy Area PDC: 5** Development should not have an adverse impact on the natural, physical, chemical or biological quality and characteristics of soil resources.*

There would be some disturbance to the existing bank of the river, but the impacts appear to be minimal. Erosion of the bank has occurred due to houseboat moorings, but a key objective of the proposal is to contain the houseboats within the site away from the rivers edge, which would prevent this type of erosion from occurring and would allow riparian vegetation to improve.

The proposed development to a large extent is dependent on the scenic and visual amenity of the site. Therefore, the proponent seeks to conserve and maintain the river front land (riparian and wetland areas) within the site.

The soil on the flood plain has a high salt content due to previous floodplain modifications associated with irrigated dairying.

Water

***Conservation Policy Area PDC 2** Development should take place in a manner which will not compromise the utilisation, conservation or quality of water resources or capacity for natural systems to restore or maintain water quality.*
***Primary Production Policy Area PDC: 2** No adverse impact on natural hydrological systems and environmental flows.*

The EIS indicates that the natural hydrological systems and environmental flows would not be substantially impacted upon within the site and that the water quality would improve as a result of the remedial actions that will be put in place. All improvements would be subject to the requirements of Government Agencies, including the preparation of an Environmental Plan for Wastewater and an Irrigation Management Plan (ie. in accordance with EPA Guidelines). The prevention of ground water and surface water contamination and the implementation spill contingency plans/response strategies would ensure that no wastewater would reach any water course. All flows from the residential waterways and marina basin would pass through a constructed anabranch/wetland system to receive natural treatment, before returning to the river.

In terms of water flows and water turnover, Water Transfer Stations would pump the water within the marina and waterways every 10 days to prevent stagnation and maintain the natural hydrological systems and environmental flows. It appears that river water would be pumped to the head of the north-western canal to maintain water circulation, especially for that waterway. Overall the proposed development meets the provisions for the conservation and quality of water resources.

Marina

***RMZ Objective 18:** Moorings for vessels with overnight accommodation only in designated locations.*
Mooring of vessels with overnight accommodation should be confined to the Recreation and Tourism Policy Areas, Designated Tie-up areas, or identified urban areas.
***RMZ Objective 22:** River structures restricted and adequately designed.*
River Structures restricted in number and constructed to design standards to withstand floodwater and not detract from the aesthetic quality of the riverine environment.
Structures for recreation use, boat ramps, jetties and mooring boats, should only be constructed where the depth of water is inadequate to access the River. Where practical, structures should be shared amongst a number of users to maintain equity in access to the River and minimise obstruction to the River channel.
***RMZ PDC 1:** All river structures including jetties, boat ramps, landings and pumping structures should be consequential on an authorised use of land.*

RMZ PDC 2: *All river structures should be constructed to withstand flood waters, increased River flow rates and collision impact through day-to-day use.*
RMZ PDC 3 *All river structures should be located where they do not cause a hazard to safe navigation or unsafe conditions.*
RMZ PDC 4 *All river structures should be of an appropriate human scale and designed through the use of materials and detailing to contribute to the riverine and natural character.*
RMZ PDC 8 *Fuel storage including mobile trailers should be located in a designated area off the 1956 flood plain and designed to prevent the run-off of spilled fuel.*
RMZ PDC 9 *The separation distance between moored vessels measured at the pontoon or hull of the vessel should be 2.0 metres.*
RMZ PDC 12 *Moorings for vessels should not be located within:*
(a) 100 metres of either side of a ferry crossing; or
(b) 150 metres of a lock; or
(c) 400 metres of the pumping stations at Swan Reach or Morgan.
Flood Plain Policy Area PDC 18 *River Structures are appropriate in the zone.*

The marina is a main feature of this development and would provide serviced moorings for up to 156 houseboats. All river structures (including moorings) should be constructed and located addressing the relevant design techniques within the River Murray Zone. Use of the marina and waterways would be governed by a Marina Owners Charter (ie. an Encumbrance on the land) and the requirements of an EPA marina licence.

The marina would provide vacuum sewer connection point at all moorings for vessels to discharge their wastewater. Currently, it is not compulsory to treat grey water via such a system. The EIS indicates that this would be put in place prior to the occupation of the marina, ensuring that greywater is discharged into the vacuum sewer. The EPA *Draft Code of Practice for Vessel and Facility Management: Marine and Inland Waters (2007)* would also be adopted.

The location of the marina is satisfactory and the design seems reasonable, given that river structures would be appropriate in the subject policy area. Details for the moorings, whilst conceptual at this stage, address the issue of flooding. The configuration of the marina layout is compatible with the site, existing riverfront and wetlands and is appropriately placed at the edge of the township of Mannum.

A facility would be provided for refuelling, which would be bunded to EPA requirements. The EIS notes that the design of the waterways is such that any spillage would be isolated, allowing for adequate clean-up.

Waste

RMZ PDC 11 *There should be no land-based disposal of effluent collected from moored vessels within the flood plain as defined by 1956 flood levels.*
RMZ PDC 14 *Household effluent should be treated on site in a septic tank system designed to handle the household sewage and sullage load.*
RMZ PDC15 *Wastewater produced in the Flood Plain Policy Area, Recreation and Tourism Policy Area and Shack Settlement Policy Area should be disposed into a sewage treatment system or septic tank effluent disposal scheme providing there is no land based disposal in the Flood Plain Policy Area.*
Flood Plain Policy Area Objective 19: *No adverse impacts from the treatment of wastes.*
Effective on-site treatment and management of solid and liquid wastes to prevent environmental nuisance and harmful or adverse impacts on the public, worker health, water quality of the River Murray or the amenity of a locality.
Flood Plain Policy Area PDC 22 *Untreated waste should not be spread or discharged to land or water either on-site or elsewhere.*
Flood Plain Policy Area PDC 23 *On-site waste treatment and the spreading or discharging of treated waste on-site should not occur.*

Preliminary discussions have been held with the Mid-Murray Council and it is envisaged that the residential component, marina and public areas would be serviced by the Council's existing waste management service.

The EIS indicates that currently there is no safe disposal of greywater and sewage effluent on the site as there are insufficient moorings and no pump out facilities along the river. All residences, commercial buildings and public toilets within the proposed development would be connected to a sewer system. Houseboats would be required to have appropriate greywater storage or treatment (ie. in addition to standard blackwater storage) for connection to the sewer system. Safe disposal measures for grey water and sewage are considered to be appropriate and are consistent with the Development Plan provisions.

Conclusion

An assessment against the Council Wide Principles and Objectives of the Mid Murray Development Plan indicates that the proposal is generally compatible in regards to the proposed tourist, recreational and, to a lesser degree, residential uses. The proposed development is within a defined area and as such there are some incompatibilities with the types of envisaged land uses within the River Murray Zone and as such, this assessment concludes that the proposed development is at variance with the polices within the Zone. Nonetheless, the proposal appears to be orderly development despite the variance. It appears reasonable to locate a tourist/ recreational marina and residential development adjacent to an existing town and close to existing facilities and infrastructure. The proposed development further reinforces the significance of Mannum as a tourist destination and major town centre along the River Murray. A significant area of land identified in the Conservation Policy Area is to be maintained and enhanced. The Aboriginal heritage areas identified in the EIS are to be preserved. The construction and ongoing tourist and recreational facilities associated with the marina are likely to create an economic flow on effect that will benefit the immediate and broader locality.

The residential component will have minimal impact, although the relevant policy areas don't envisage the type of density proposed and the placement of residential uses, where primary production is encouraged as the prime economic use. Nonetheless, the proposed designs for the waterfront dwellings, whilst conceptual, are interesting and of a high standard. The residential buildings are above the 1956 flood level as per Development Plan requirements. The stormwater, sewerage and traffic aspects meet the general provisions.

Marinas are non-complying in the *Conservation Policy Area* and the *Floodplain Policy Area*. If approval is granted, a Development Plan Amendment (DPA) process would need to be undertaken to establish complementary zoning and policies commensurate with the approved land uses. In particular, policies would need to support the priority issues relating to housing sustainability and the protection of water quality, the environment and the River Murray in general.

This AR concludes that the proposed development is, on balance, in accordance with the relevant provisions of the appropriate Development Plan. More detail supporting this conclusion is set out in the Main Issues Section of this AR. The relevant section of the Development Plan covering the site would need to be reviewed by Council in order to take proper control of the development of the subject land.

4.2 PLANNING STRATEGY

The appropriate Planning Strategy is the *Planning Strategy for Regional South Australia (Premier of South Australia, January 2003*) which provides broad strategic direction for South Australia.

The site is subject to a range of broad strategies (Economic, Environment & Resources, Water Resources, People, Towns & Housing and Infrastructure) and those specifically relating to the Murraylands.

It is considered that the overall development of a marina is consistent with the general objectives contained in the Planning Strategy. The objectives across the country region encourage economic development, particularly in the tourism sector, that focuses on the natural and cultural assets of the region - in this case the River Murray.

The Planning Strategy for Regional South Australia (2003) acknowledges that tourism in the Murraylands is an expanding industry. The accessibility of the proposal and its relative close proximity to Metropolitan Adelaide facilitate the promotion of regional tourism and recreation on a broader scale. Specific strategies relevant to river resources encourage the location of recreation and boating opportunities and improving those facilities. River-bank development is also appropriate where the character of the area is not compromised. Urban areas (including marinas) can be located in environmentally acceptable areas.

The strategy indicates that urban development should be accommodated within the town boundaries to preserve primary production land and other valuable resources. The proposed development site is located adjacent the Mannum township boundary on land that is no longer used for primary production. The proposal seeks a definite balance between development and conservation and, being a river-based tourist and recreationally orientated development, the river environment needs to be suitably protected. In addition, the Strategy recognises that the water resources need protection and that the provision of adequate infrastructure and protection measures is a key issue for economic development.

The proposal satisfies the strategies for the River Murray through the establishment of a facility that would safeguard the river by mooring houseboats and riverboats off-river in a strictly controlled environment. In addition, the strategies would be met through the preservation of existing wetland and riverine habitats, the rehabilitation and restoration of a degraded floodplain, protection of the water quality of the river and the protection of the Aboriginal heritage sites (ie. middens and scar trees).

The residential component would provide a range of housing opportunities and private sector investment not provided at that scale in the Murraylands, increasing the town's population with flow-on economic benefits for local businesses, especially in Mannum. The proposal encourages further economic expansion through employment opportunities that would be generated at the construction stage and from the marina and uses associated with tourism and recreation.

In conclusion, this AR considers that the proposal is generally compatible with the relevant objectives of the Planning Strategy.

4.3 BUILDING RULES

This AR does not include a specific assessment of the development against the provisions of the Building Rules under the *Development Act 1993*. If the Governor grants a provisional development authorisation, pursuant to Section 48 of the Act, further assessment and certification of the proposed development against the Building Rules may be set as a reserved matter for further decision-making. However, a development authorisation (equivalent to a development approval under Part 1of the *Development Act 1993*) will only be made by the Governor or her delegate *after* a private certifier or the relevant council for the area in which the development has been proposed, has assessed and certified that any work that constitutes 'building work' under the Act complies with the Building Rules and has supplied this information to the Minister (as required by Regulation 64 of the *Development Regulations 1993*). The Building Rules certification must be consistent with any provisional development authorisation and would ensure safety (including fire safety) and stability of construction.

The design of the marina facility should generally be in accordance with the Australian Standard AS3962 *Guidelines for Design of Marinas* and AS 4997-2005 *Guidelines for the Design of Maritime Structures*. It would be the responsibility of the design engineer to ensure the structural integrity of any structures (e.g. revetment, moorings, jetties, pontoons and navigation aids) are certified to the required standard.

4.4 ENVIRONMENT PROTECTION ACT 1993

The proposed development involves activities of environmental significance (dredging and earthworks drainage, marinas and boating facilities) as defined in Schedule 1 of the *Environment Protection Act, 1993*, as detailed below.

- Earthworks Drainage: the conduct of earthworks operations in the course of which more than 100 kilolitres of wastewater containing suspended solids in a concentration exceeding 25 milligrams per litre is discharged directly or indirectly to marine waters or inland waters

- Marina and Boating Facilities: the conduct of

    - facilities comprising pontoons, jetties, piers or other structures (whether on water or land) designed or used to provide moorings or dry storage for 50 or more powered vessels at any one time, or

    - works for the repair or maintenance of vessels with the capacity to handle five or more vessels at any one time or vessels 12 metres or more in length

- Dredging: removing solid matter from the bed of any marine waters by any digging or suction apparatus, but excluding works carried out for the establishment of a visual aid to navigation and any lawful fishing or recreational activity

When proposals involve activities of major environmental significance the Governor, before making a decision on the development, must have regard to the objects of the *Environment Protection Act 1993*, the general environmental duty and any relevant environment protection policies.

The objects of the *Environment Protection Act 1993* are:

- To promote the principles of ecologically sustainable development

- To ensure that all reasonable and practicable measures are taken to protect, restore and enhance the quality of the environment having regard to the principles of ecologically sustainable development, and to prevent, reduce, minimise and, where practicable, eliminate harm to the environment.

In addition, proper weight should be given to both long and short term economic, environmental, and social and equity considerations in deciding all matters relating to environmental protection, restoration and enhancement. The EPA is required to apply a precautionary approach to the assessment of risk of environmental harm and ensure that all aspects of environmental quality affected by pollution, and waste are considered in decisions relating to the environment.

The following Environment Protection Policies are also applicable:

- Environment Protection (Water Quality) Policy, 2003

- Environment Protection (Waste Management) Policy, 1994

- Environment Protection (Used Packaging Materials) Policy 2007

- Environment Protection (Environmental Noise) Policy 2007

- Environment Protection (Air Quality) Policy, 1994

- Environment Protection (Industrial Noise) Policy, 1994
- Environment Protection (Machine Noise) Policy, 1994

Of particular relevance is the recent release of the EPA *Code of Practice for Vessel and Facility Management: Marina and Inland Waters* (2007). The Code provides guidance for the prevention of pollution that may arise from the construction, use and maintenance of vessels and related facilities. In particular, it outlines suitable environmental management practices and frameworks that should be considered when designing, constructing and operating a marina type development. The EIS (Section 2.3) states that all boats within the marina would be expected to comply with the Code. In addition, the EPA *Guideline: Greywater Management Systems on Vessels* would be adopted for the correct handling of greywater. The EPA *Guideline: Managing Vessel Waste Water for Black and/or Wastewater (2007)* and the EPA *Guideline: Managing Wastewaters On-board Vessels* are also relevant.

The proposal includes facilities to ensure compliance with EPA requirements, including:

- constructed moorings
- effluent and greywater pump-out connections (ie. to a vacuum sewer system)
- bunded fuel pump and storage area
- waste disposal
- spill contingency plans and equipment
- controls for boating related activities, especially cleaning and maintenance.

In addition, there are a range of supporting documents and guidelines that are endorsed, or have been adopted, by the EPA and would have relevance for the proposal, including:

- EPA Guideline: Bunding and Spill Management (2007)
- EPA Guideline: Dredging and Earthworks Drainage (2008)
- National Environmental Protection Measures (NEPM), such as for the Assessment of Site Contamination, Ambient Air Quality, Used Packaging Materials, Air Toxics and Diesel Vehicle Emissions.
- ANZECC (2003) *Waste Reception Facilities in Australian and New Zealand Ports*
- ANZECC (1997) *Best Practice Guidelines for Waste Reception Facilities at Ports, marinas and Boat Harbours in Australian and New Zealand*

In addition, the EPA encourages marina owners to be part of the Clean Marinas Programme developed by the Marina Association of Australia. The programme is a national voluntary accreditation system for developing suitable environmental practices that also rewards marina operators with business benefits.

The EIS also includes a range of measures for controlling pollutants and activities, especially the Water Sensitive Urban Design measures and the use of riparian buffers.

The EPA's comments are provided in Section 5 below and are discussed in Section 6 of this AR.

4.5 OTHER MATTERS

4.5.1 State Strategic Plan

The State Strategic Plan seeks to widen opportunities for all South Australians through the pursuit of the following objectives:

- Growing Prosperity
- Improving Wellbeing
- Attaining Sustainability
- Fostering Creativity and Innovation
- Building Communities
- Expanding Opportunity

It is recognised by the proponent that job and income creation are critical elements of the social agenda for economic regions, as they are intertwined. In terms of "growing prosperity" the priority of the Strategic Plan is sustained economic growth resulting in rising living standards, with all South Australians sharing in the benefits through more and better job opportunities and access to quality services. The proposal would result in upgraded facilities for the mooring of vessels and, in addition, the increased resident base would have a positive impact on support industries and the general economic well-being of the region. There is likely to be increased tourism in the area as a result of the marina facility. On this basis the proposal is consistent with the Strategic Plan aim of "growing prosperity".

The proponent would be providing a new sewage treatment facility for the proposed development to serve the existing township and the whole of the proposed development. In addition, a reliable water supply would be provided through an extension of the existing SA Water supply lines. The proposed establishment of a large wetland and revegetation of the flood plain, riparian. hillside and gully areas would benefit the biodiversity of the area, with increased and improved habitats. The supply of 156 fully serviced marina births would also reduce the impact on the river banks, fitting in under the 'attaining sustainability' objective.

The Strategic Plan also deals with building communities through the maintenance and development of viable regional population levels and reduction of unemployment rates. Both the construction phase and on going maintenance of the development, as well as new businesses and industry, would provide employment opportunities for the region.

'Expanding opportunity' is another objective of the proposal, with opportunities for local Aboriginal groups to possibly have business opportunities through tours, educational facilities linked with the interpretive centre, as well as the opportunity for employment during the construction stages.

The Department for Trade and Economic Development (DTED) indicated support for the proposal, as it would assist in achieving several of the targets of the Plan.

This AR concludes that, the proposal would clearly support the objectives of the State Strategic Plan for South Australia.

4.6 OTHER RELEVANT LEGISLATION

4.6.1 River Murray Act 2003

The *River Murray Act 2003* applies to the River Murray and River Murray Protection Areas. The Act seeks to protect, restore and enhance the River and its natural resources (including water, soil, ecosystems and heritage associated with the River). It also aims to ensure that the River and natural resources are used and managed in a sustainable way. The Act imposes a 'duty of care' on all people to ensure that their actions do not cause harm to the River. It also gives the Minister for the River Murray the power to place conditions on certain applications to undertake activities near the River.

The proposed development was referred to the Minister for the River Murray, via the Department for Water, Land and Biodiversity Conservation (DWLBC). The DWLBC advised that the proposal is considered to be consistent with the Objects and Objectives for a Healthy River Murray, concluding that the overall net impact of this development will have a neutral and/or beneficial effect on the River Murray system. The existing Mannum Waste Water Treatment Plant is to be removed from the flood plain as part of the development and the containment of houseboats into a managed and regulated environment within the marina lessens the detrimental impact on water quality of the River Murray.

Further to the above, any allocation of water regarding the marina needs to be consistent with the laws, plans and agreements set in place through the *Natural Resources Management Act 2004*, the Water Allocation Plan (WAP) for the River Murray Prescribed Watercourse, the Agreement approved under the *Murray-Darling Basin Act 1993* and the National Water Initiative by the Commonwealth Government.

All floor levels for residential and commercial buildings are to be constructed above the 1956 flood level. However, storage areas and garages for the southern waterfront residences would be below this level. Structures below the 1956 flood level would need to be designed and constructed so that they do not impede flood flows.

The EIS recognises the importance of the River Murray to the State and indicates the provision of mechanisms to maintain a duty of care specifically with water quality and maintenance of the riverine environment through conservation of the subject wetlands, revegetated areas and positioning of structures in relation to flood levels.

4.6.2 Natural Resources Management Act 2004

The *Natural Resources Management Act 2004*, the Water Allocation Plan for the River Murray Prescribed Watercourse, the Agreement approved under the *Murray-Darling Basin Act 1993*, and the National Water Initiative provide the legal and policy framework for the allocation of water within the Murray-Darling Basin. Any allocation of water for the filling and evaporative losses of the marina needs to be consistent with these laws, plans and agreements. Similarly, the use of the Environmental Land Management Allocation on the property needs to be consistent with the River Murray Water Allocation Plan (WAP).

The Act governs the licensing of water within South Australia. Specifically, the definition 'to take' includes:

'(a) to take water by pumping or syphoning of water';

'(b) to stop, impede or divert the flow of water over land (whether in a watercourse or not) for the purpose of collecting the water';

'(c) to divert the flow of water in a watercourse from the watercourse'; and

'(d) to release water from a lake.'

Following legal advice that the taking of water by artificial water bodies (including marinas and canal estates) constitutes the 'taking' of water under the *Natural Resources Management Act 2004*, both the Minister for the River Murray and the Minister for Environment and Conservation have jointly endorsed that marinas and canal estates now require a water licence for the filling and topping up for annual evaporative losses of these water bodies. The DWLBC is finalising the basis for determining the volume of water required and licence conditions, which will be set down in an operational policy. The proponent has been informed of this and the DWLBC would continue discussions with the proponent about this matter, if the proposal is approved.

Section 124(3)(a) of the Act indicates that a water licence or authorisation granted under section 128 is required to take water from a prescribed watercourse. Given that the River Murray is a prescribed watercourse, a water licence is required to take water. In addition Section 124 (7) indicates that 'water must not be taken contrary to the provisions of an NRM plan that applies in relation to that water unless the water is taken pursuant to a water licence or an authorisation under section 128'.

Part 3, Division 1 of the Act sets out the requirements in relation to licensing of water. In particular, 146(5) indicates that 'the Minister's decision on an application for a licence that relates to a water resource within the Murray-Darling Basin must take into account the terms or requirements of the Agreement approved under the *Murray-Darling Basin Act 1993*, and any relevant resolution of the Ministerial Council under that Agreement'. Water licences issued under this part of the Act must be endorsed with a water allocation.

The existing 170 ML water licence, proposed to be used to offset annual evaporative losses from the marina, has been endorsed by the DWLBC for the purposes of irrigation and would need to be varied to allow it to be used for the marina or other purposes. Amendment of the Water Allocation Plan for the River Murray Prescribed Watercourse may be required to grant this variation.

Section 152 of the Act sets out the basis of the Minister's decision on the grant or variation of a water licence. The decision as to whether the water allocation should be endorsed on the licence must be consistent with the relevant water allocation plan (in this instance, the Water Allocation Plan for the River Murray Prescribed Watercourse), and any conditions to be attached to the licence must not be seriously at variance with the relevant water allocation plan. In addition, both of these decisions must be made in the public interest, must take into account the terms and requirements of the Agreement approved under the *Murray-Darling Basin Act 1993*, and any resolution of the Ministerial Council under that Agreement, and be consistent with any requirements prescribed by the regulations.

Water Allocation Plan for the River Murray Prescribed Watercourse

The plan does not specifically consider the allocation of water for marinas. The plan makes reference to availability of water for Environmental Land Management Allocations (ELMA) within the Lower Murray Reclaimed Areas Irrigation Management Zone. An ELMA licence (131297) was issued to Tallwood Pty Ltd in June 2007 for use on a specified portion of the land (approximately 20ha) on which the proposed development is to be located. This area has been identified in the EIS as the wetland area, and an allocation of 127 ML of water has been issued by the DWLBC under this licence. The ELMA issued to Tallwood Pty Ltd must be used for the purposes of environmental land management, in particular to assist in minimising the impacts of rising saline groundwater, to comply with the licence conditions and the principles of the Water Allocation Plan.

The Agreement approved under the Murray-Darling Basin Act 1993

In March 2001 the Murray Darling Basin Ministerial Council set a 103.5 GL Cap on annual water diversion for the Lower Murray Swamps irrigation area based on annual irrigation development levels in 1993/1994. Water use cannot exceed the level set by the Cap. Water use on the non-floodplain parts of the site would form part of other cap limits.

The National Water Initiative

The National Water Initiative is a national agreement to reform water resource management within Australia. The agreement signifies a commitment to restoring over-allocated water systems, including the Murray-Darling, to sustainable extraction levels, as well as an expansion of the trade in water. The South Australian Government, as a signatory to this agreement, has a commitment to ensure that all water management is carried out within the framework of the agreement.

Under the NWI, the consumptive use of water requires the user to hold a water access entitlement. Consumptive use is defined as the use of water for private benefit consumptive purposes including irrigation, industry, urban, and stock and domestic use.

The establishment of water markets and trading is designed to facilitate the transfer of water and water rights between different users in systems that are fully allocated. Water markets allow new consumptive uses to obtain water by purchasing or leasing water from existing licence holders, promoting the transfer of water to higher value end uses.

4.6.3 Harbours and Navigation Act 1993

The *Harbors and Navigation Act 1993* applies to coastal and inland waters of the State and has relevance for the proposal in regard to the provision of boating facilities and the management of boating activities (especially navigation, safety and pollution control). The government agency responsible for administering the Act, Department of Transport, Energy and Infrastructure (DTEI), has considerable experience in design for marina and other boating related facilities and would be responsible for auditing certification processes for such structures on behalf of the Governor (or his/her delegate).

The Department for Transport, Energy and Infrastructure considers that the design of the marina facility should generally be in accordance with the Australian Standard AS 3962-2001 *Guidelines for Design of Marinas* and AS 4997-2005 *Guidelines for the Design of Maritime Structures* and it is the responsibility of the design engineer to ensure the structural integrity of any structures (eg revetments, moorings, wharves, pontoons and navigation aids) are certified to the required standard.

The general design of the marina is consistent with these requirements. Further consultation with the DTEI, which administers the *Harbors and Navigation Act 1993,* will need to be undertaken at the detailed design stage.

4.6.4 Public and Environmental Health Act 1987

The proponent would need to comply with the *Public and Environmental Health Act 1987* in regard to the disposal of effluent and the maintenance of suitable water quality within the residential waterways and marina basin to protect public health and amenity. Minimising inputs into the basin and providing good water exchange rates, which are proposed in the Mannum Marina development, are considered the most effective measures for maintaining suitable water quality standards for human use and for reducing the likelihood of problems arising. Consultation with the Department of Health (Waste Water and Control Unit), which administers the *Public and Environmental Health Act 1987,* will be required to ensure suitable standards are adopted for effluent disposal.

4.6.5 Aboriginal Heritage Act 1988

The Department of Premier & Cabinet (Aboriginal Affairs and Reconciliation), which administers the *Aboriginal Heritage Act 1988,* requires that in the event archaeological items are uncovered during earthmoving, it be contacted immediately. The proponent will need to ensure construction contractors are aware of this requirement. Approval would need to be sought to clear or disturb any sites of significance to Aboriginal heritage.

4.6.6 Native Vegetation Act 1991 (and amended Regulations)

Under the Regulations of the *Native Vegetation Management Act 1991* the proponent is exempt from the requirement to obtain approval for vegetation clearance if the proposal has been the subject of an EIS and the comments of the Native Vegetation Council (NVC) on the EIS are included in the relevant Assessment Report. The NVC has been formally consulted and its comments have been considered in the preparation of this report. No statutory approval for vegetation clearance is required from the NVC.

The regulations have been recently amended and, whilst the proponent is still exempt from having to seek separate approval from the NVC to clear or disturb native vegetation, suitable compensation for such clearance needs to be to the satisfaction of the NVC as an adjunct to the Major Development approval.

Under Regulation 5(1)(c) of the Native Vegetation Regulations, native vegetation may, subject to any other Act or law to the contrary, be cleared if-

(i) *the clearance is incidental to a proposed development to which section 48 of the Development Act 1993 (the Major Developments Process) applies; and*

(ii) *an environmental impact statement, public environmental report or development report; and an Assessment Report, relating to the development have been prepared under that Act; and*

(iii) *the Minister responsible for the administration of the Development Act 1993 referred the environmental impact statement, public environmental report or development report to the Native Vegetation Council for comment and report and –*

(a) the Council provided comments which were included (wholly or substantially) in the relevant Assessment Report; or

(b) the Council failed to provide comments within 8 weeks after receiving the Minister's invitation for comment and report; and

(iv) *the Governor has granted his or her consent to the proposed development under section 49 of the Development Act 1993;and*

(v) *the clearance is undertaken in accordance with that consent; and*

(vi) *the clearance is undertaken in accordance with a management plan that has been approved by the Council that results in a significant environmental benefit on the property where the development is being undertaken, or the owner of the land (or a person acting on his or her behalf) has, on application to the Council to proceed with clearing the vegetation in accordance with this provision, made a payment into the Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit in the manner contemplated by section 21(6) of the Act.*

The proponent would need to negotiate with the NVC a suitable form of compensation for the clearance of native vegetation – a 'Significant Environmental Benefit' (SEB).

It is expected that the proposed re-creation of an anabranch/wetland system on the floodplain, extensive revegetation works and protection/enhancement of the Baseby Wetland complex would address the requirements for an SEB, to compensate for the relatively small amount of vegetation clearance needed.

4.6.7 Historic Shipwrecks Act 1981

The *Historic Shipwrecks Act 1981* relates to the protection of certain shipwrecks and relics of historic significance. Two shipwreck locations have been identified near the proposed development site, the Mary Ann and the Saddler.

The register for shipwrecks within South Australia lists the Mary Ann, (built 1852) which is located at the old ferry crossing at Mannum. The Mary Ann is a protected item. The Mary Ann was one of the original paddle steamers on the River Murray and was used for the transportation of animals. The other shipwreck is the "Saddler" (built in 1877), a barge that is located on the opposite side of the River Murray to the town.

The EIS indicates that both shipwrecks are beyond the boundary of the subject site and as such the proposed development will not impact upon them.

4.6.8 Crown Lands Act 1929

The proposed site includes land associated with the Mannum WWTP and the river bank that has been dedicated a reserve, under the *Crown Land Act 1929,* and is owned by the Minister for Environment and Conservation. Any future decision on the possible sale or transfer of ownership of Crown Land (including any on-going land management arrangements) can only be made by the Minister, taking into account the provisions of *Premier & Cabinet Circular 114*.

Government policy requires that a 50 metre wide strip of land adjacent the river's edge be retained as public land. This requirement would need to be satisfied as part of the process for securing land tenure.

In addition, the Minister for Environment and Conservation is also the owner of the river bed. Thus, permission would be required to undertaken any construction works that affect the bank or bed of the river (including any subjacent land), such as excavating the entrance channel.

4.6.9 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act),* came into operation on 16 July 2000. The Act establishes an environmental assessment and approval system based on matters of National Environmental Significance (NES) that is separate and distinct from State systems. The Act requires proponents of actions to which the Act may apply to seek a determination from the Commonwealth Environment Minister regarding whether or not their action is a 'controlled action' and therefore, subject generally to Commonwealth assessment and approval processes. Matters of NES that would relate to the proposal include migratory species and threatened species and ecological communities.

The proponent has conducted a 'self assessment' of the proposal against the Act, using the Department of Environment, Heritage, Water and the Arts web-based search tool, and determined that it does not trigger any of the matters of NES. Thus, referral of the proposal to the Commonwealth for a determination was not deemed necessary by the proponent.

Although, as noted by the SA MDB NRM Board, the EIS identifies that the fauna survey of the Baseby Linear Wetland complex recorded five species of duck that are listed under the Act as migratory. However, the wetlands would not be directly affected by the development and it is proposed to implement measures to actually protect and enhance their habitat value.

5 CONSULTATION

5.1 COMMUNITY

The EIS was placed on public exhibition from Wednesday 6 June 2007 to 18 July 2007. Nine submissions were received from the public (including one late submission). The main issues raised in public submissions include:

- Potential to increase houseboat numbers on the River
- Disposal of effluent and grey water
- The extent of public consultation
- Water use and licensing
- Groundwater interception
- Access to wetlands causing disturbance
- Use of native plants in landscaping
- Inadequate fauna surveys
- Increased runoff and stormwater
- Canal estate affecting local environment
- Water quality issues from dredging
- Adequacy of buffer zones
- Sealing of Belvedere Road
- Impacts on adjacent agriculture needing consideration
- Inadequate onsite parking within the development

5.2 COUNCIL

The Mid Murray Council is fully supportive of the development.

5.3 GOVERNMENT

The key comments provided by Government Agencies are included below:

Murray Darling Basin Commission, Canberra

- The Commission is satisfied that the EIS for Mannum Waters Marina and Residential Development is a professionally competent document which adheres to the legislation and administrative requirements and addresses the main environmental issues of concern.

Department of Further Education, Employment, Science and Technology

- No comment.

Aboriginal Affairs and Reconciliation

- Supports the development and proponent.

Department of Trade and Economic Development (DTED)

- Impacts of development on existing adjacent uses. Possibility of new residents causing conflict with existing dairy farmers adjacent to the marina.

Department of Water Land and Biodiversity Conservation (DWLBC)

- Water allocations and availability of water is an issue.

- The salinity impacts of the proposed development need to be clearly defined. Any actions that may increase salinity within the River Murray need to be fully defined, scoped and the impacts quantified before the development is approved.

- As the river level rises, water flows into the marina, then when the river level drops, water flows out of the marina as backflow. This backflow will regularly be at a rate that cannot be offset by pumping. The backflow will not pass through the treatment wetland and will therefore not be afforded the benefits provided by wetland treatment.

- Spill contingency plans are missing information on timeframes for reporting and rectifying spills. These details should be included in the Long-term Environmental Management and Maintenance Plan.

- Further discussions with DWLBC regarding use of creek water in the water balance will be necessary.

- House Owner's Charter should, at minimum, refer to the *Native Vegetation Act 1991* and its requirements, including that no remnant native vegetation can be cleared without the prior approval of the Native Vegetation Council, or unless the clearance is in accordance with the provisions of the *Native Vegetation Regulations 2003.*

Department for Families and Communities

- Considers that the proponent has not addressed the aims for 'diverse and affordable housing to meet community needs' as set out in the *Planning Strategy for Regional South Australia*.

- Considers that the project itself will increase the demand for affordable housing/workforce accommodation in Mannum.

Department for Environment and Heritage

- The EIS contains an assumption that Section 770, Hundred of Finniss will be transferred to the proponents by SA Water. This would be the decision of the Minister for Environment and Conservation, which needs to take into account the provisions of *Premier and Cabinet Circular 114.*

- To be consistent with Government policy to retain a strip of land adjacent to the river's edge, it is considered desirable that the existing waterfront Crown land Sections 856 and 587 be increased in

width to create a strip of a minimum of 50 metres, by transfer to the Crown from adjoining titles as part of the land division proposals.

- Consideration should be given to the dedication of the waterfront land to Council for ongoing management consistent with DEH objectives.

- Much of the data presented in Section 11.2.5 (Floods) appears to avoid reference to flood periods. Several issues need to be addressed, including where houseboats will moor when high rivers like 1974 and 1956 occur.

- Measures of how neighbouring properties will be protected during flood periods need to be addressed.

- The discussion about water allocation appears to be flawed by including current state evaporation losses as if the reclaimed area was filled with water, and that is not the case.

Environment Protection Authority

- The EIS does not provide the calculations for the wetland performance.

- The use of salt affected flood plain soil excavated for the development of marina channels and heaped up as levee or banks around the development to separate the ponds, could be problematic from the perspective of growing vegetation on them.

- A potential exists for the red gums at the proposed marina entrance to be undermined if the extent of earth around the root systems of these gums is not carefully determined and appropriate engineering provisions made during the design of the inlet channels and the stabilising of the exposed soils.

- The EIS does not indicate if the capacity exists to directly return water from the wetlands to the River Murray.

- There is likely to be considerable sediment generated around the site during the construction stage of the marina development and this needs to be prevented from entering the water ways.

- There appears to be insufficient groundwater data supporting the assumption of negligible changes in groundwater infiltration used in the Hydrodynamic Modelling of Mannum Waters Marina and Waterways.

- The EMP should identify a responsible party who will ensure the implementation of any conditions, on-going monitoring, and contingency measures and remediation that may be necessary to ensure the long term suitability of the subject land for the proposed use.

- There appears to be no consideration of the impact on amenity of odours that may be generated by the sewage treatment plant.

SA Water

- The location and construction of the new rising main and pump station must minimise environmental impact to the surrounding environment.

- The proponent must incorporate mechanisms to ensure that future development, in particular the proposed commercial precinct of the development, is conducive to the protection of environmental and drinking water quality values.

- SA Water recommends that in addition to pump-out facilities at each individual permanent mooring within the marina and at the six casual moorings, an additional public access pump-out facility be located within the marina development.

- Requirements set out by SA Water must be met to allow the endorsement of a site for the new Mannum WWTP.

- Disposal of all effluent needs to be land based at all times as no disposal to the river is allowed.

- The use and distribution of reclaimed water is subject to SA Water approval and approval by other relevant agencies and meeting ongoing operating requirements.

SA Tourism Commission

- A suggestion for adding value to the northern walking trail (if practical) would be to make it into a loop trail by adding a section to the existing layout along the river bank.

- Advice from the region indicates a need for new tourism accommodation in the Mannum vicinity.

South Australian Murray-Darling Basin NRM Board (SA MDB NRM Board)

- Recommends that further modelling be undertaken to ascertain if groundwater interception will have an adverse effect on adjacent shallow water bodies or vegetation.

- Recommends that details be provided of how the proposal achieves the objectives of the *Planning SA River Murray Marina Strategy*.

- Recommends that the proposed Wetland Management Plan for the constructed wetland be prepared in accordance with the DWLBC/River Murray CWMB "Guidelines for Wetland Management Plans", to the satisfaction of the SA MDB NRM Board.

- Recommends that the "Draft Home Owner's Charter Land Encumbrance Mannum Waters" requirement that "any tank must be…rectangular in shape" be deleted, except for the waterfront villa allotments.

- Recommends that the development be designed such that water use demand is minimised.

- Details need to be provided regarding the anticipated pollutant loads.

- The proponent should prepare a Soil Erosion and Drainage Management Plan (SEDMP) to the satisfaction of the SA MDB NRM Board.

Department of Transport, Energy and Infrastructure(DTEI)

- Shoulder sealing should be undertaken as part of the development at the junctions of Belvedere Rd with Mannum-Murray Bridge Rd and Ramm Rd with Tea Tree Gully-Mannum Rd.

- Has concerns that the predicted traffic increase (of 11387 trips in/1138 trips out per day) will impact the operation of the junctions/intersections where access points to the development meet the arterial road network.

- There appears to be a lack of recognition of the impact such a development may have on the safety of navigation into, out of and within the Marina.

- Requests that the proponent provide further information before the proposal is supported.

- The level of infrastructure required to service the project is noted.

- It is understood that the proponent would fund and provide the necessary infrastructure works for the project. On this basis the Office for Major Projects has no further comment.

Department of Health

- The Aboriginal Health Division recommends that consultation be conducted separately through local community meetings across the Murray Bridge to Swan Reach area to ensure an appropriate level of Aboriginal interaction and community knowledge is achieved.

- It is noted that Aboriginal people may benefit from the development through provision of additional services, employment or increased recognition of heritage.

- The proposal to reuse (domestic) wastewater is welcomed.

- Site contamination may adversely affect both land and waters, including underground waters.

6 ASSESSMENT OF THE MAIN ISSUES

6.1 NEED FOR THE PROPOSAL

The EIS (Section 4) outlines the proponent's views on why the proposal is needed and the potential benefits. It is considered the proposal would:

- provide a facility which safeguards the river, by removing houseboats that moor on the river and placing them in a strictly controlled environment, which would improve management of pollutants, especially grey water.
- remove existing wastewater storage lagoons from the river flood zone
- ensure the preservation of existing wetland habitats and the rehabilitation of degraded floodplain areas through new wetlands and revegetation
- expand the residential living and commercial opportunities of Mannum
- provide new recreational, educational and tourism opportunities
- provide economic development and employment opportunities
- strengthen the position of Mannum as a "central place" by increasing its population, catering for a retirement and working population base and strengthening the local economy
- improve the opportunity for better links (eg. public transport) with Murray Bridge
- be a logical and contiguous extension of the existing township of Mannum

The EIS (Section 4.5) suggests that, if the proposal was not to proceed, then an opportunity will be missed to construct a planned coordinated development, with facilities and infrastructure that achieve environmental benefits and set the standard for future developments of this nature along the River Murray. The EIS (Section 11.4.2) justifies why Mannum is an appropriate township for the establishment of a marina, mainly as it already a major centre for the houseboats industry due its close proximity to the Adelaide metropolitan area. Alternative sites within close proximity are also discussed.

The Department of Trade and Economic Development (DTED) considers that the proposal will result in positive economic outcomes for the town and region, including construction employment, economic benefit to the Mannum township, and the economic benefit associated with protection of natural assets through its contribution to more orderly and environmentally sustainable practices along the river. The South Australian Tourism Commission (SATC) considers that the introduction of a defined facility for the management, launching and berthing of houseboats would provide an important focal point for boating tourism in the Mannum region.

The EIS (Sections 4.1 and 4.3.3) states that the proposal aims to develop a facility that will safeguard the river by mooring houseboats and riverboats off-river in a strictly controlled environment, especially through the removal of existing houseboat berths on the river channel immediately adjacent the site.

This AR concludes that there is a definite need for the proposal.

6.2 WATER RELATED ISSUES

The River Murray water resource is utilised for a large number of competing uses, including domestic supply, primary production, industry, recreation and for the environment. During drought conditions, flows into South Australia become substantially reduced and in extreme situations, such as is being experienced at the time of writing this AR, restrictions are placed on the amount of water that can be extracted from the river. In a market based water management system, when supply cannot meet demand, the allocation of water tends to go to its highest value use. The use of river water for a marina and

residential waterways would provide both economic opportunities and environmental benefits, particularly through the management of impacts related to houseboats.

The objective of concentrating the mooring of houseboats in an off-river marina is to provide the ability to better manage boating related pollutants and activities in a controlled manner. From a monitoring perspective, it is much more effective to identify and address pollutant discharges from a large number of boats in one location than boats scattered along vast stretches of the river. Pollution control and remediation is also more effective. The provision of a boat lift and boat maintenance/repair facilities in a marina is also an advantage. In addition, the physical impacts on the river bank and associated floodplain from houseboat mooring are avoided.

There is growing pressure for urban expansion along the river, especially at Mannum due to its close proximity to Metropolitan Adelaide. There are environmental benefits in providing a master planned residential development that is compact and not located on the river bank or floodplain and incorporates sustainability measures. By combining residential (and commercial) uses with a marina, not only does the marina facility become more economically viable to establish, but opportunities for waterfront living are provided (based on constructed waterways) that can be designed to have minimal impact on the river environment.

This AR concludes that the EIS and Response documents have adequately identified all potential risks to water quality associated with the proposed development. A range of suitable measures for avoiding, minimising and managing such risks have been proposed as mitigation measures. In addition, several factors that currently detrimentally affect water quality would be addressed, especially the impact of houseboat greywater discharges and other pollutants.

6.2.1 Water Availability

A residential marina would require river water to initially fill the marina basin and residential waterways and then to maintain them in the long term (ie. additional water on a yearly basis to compensate for evaporative losses). The amount of water needed for operational purposes would be dictated by river levels (which are influenced by flow levels) and climatic conditions. River water would also be needed for the initial flooding of the constructed anabranch/wetland system, with smaller amounts needed for on-going operation (although this water would be from flows through the marina and waterways). The anabranch/wetland would incur small losses through evaporation, seepage and uptake by vegetation. River water would also be required for domestic and commercial uses, via the standard mains supply provided by SA Water. Stormwater harvesting and water conservation and recycling measures are proposed for reducing total demand on the river resource.

The EIS (Section 11.2.2) provides water balance modelling that calculates the amount of river water needed to initially fill the marina basin, residential waterways and the constructed anabranch/wetland system. In addition, calculations have been made as to how much water would be required per year on average to then maintain water levels (ie. annual evaporative losses). The DWLBC advised that the model adequately calculated the amount of water that would be needed to fill and maintain the marina basin, residential waterways and constructed anabranch/wetland system.

The EIS (Section 11.2.2) calculated that the volume of water needed to fill the marina and waterways to an average depth of 2.55 metres would be approximately 520 ML. The Response (Section 5.1) revised this figure down to 380 Ml, which would be the amount required at the time of writing when the pool level dropped to 0.2m AHD (ie. a reduced volume to fill). For the on-going maintenance of water levels, the water balance model calculated a loss of 31 ML in the average year and 119 ML in the 1 in 10 dry years. With the removal of annual creek flows from the model, this figure has been revised in the Response document to 180.5 ML, based on a pool level of 0.75 m AHD. Thus, the existing irrigation water licence that allows an extraction up to 170 ML/annum from the river would need to be supplemented by the purchase of either temporary water or further permanent licences.

The use of ephemeral wetlands as part of the constructed anabranch/wetland system, rather than permanent wetlands, would reduce evaporation losses from this component. The DWLBC has advised that the ELMA allocation cannot be placed on the wetland to then be pumped into the main water body as a means of compensating for evaporative losses from the marina and waterways..

Modelling indicates satisfactory flow outcomes for the marina and wetland.

Compared with domestic or agricultural uses of river water, a marina would only use a relatively small amount of water (ie. ~ 180.50 ML/year on average, taking into account evaporative losses from the marina, waterways and constructed anabranch/wetland and depending upon climatic conditions), as most of the water simply passes through the development. The constructed anabranch/wetland system has been designed to improve water quality, mainly as a measure to remove any pollutants, to a better standard than river water. In addition, the adoption of water efficiency practices for the residential development aims to reduce traditional demand on domestic supplies sourced from the river.

The proponent also has an Environmental Land Management Allocation (ELMA) of 127 ML for use associated with the constructed anabranch/wetland system, which would be adequate for its requirements. During drought periods, the wetlands could be dried out in order to save water (as has recently occurred for other wetlands).

The existing irrigation water allocation would need to be used for the establishment of revegetation plantings, that would commence soon after approval (if granted). This would occur during the initial stages of construction, before water would be needed for the staged flooding of the marina basin and waterways. Existing water pumps are expected to be used for this purpose. The amount of water needed for revegetation works, or for landscaping/streetscaping and open space reserves, has not been calculated but it is not considered to be significant. In addition, the exact level of demand on the mains water supply for use by residents, houseboats (especially for permanent living), commercial and tourism related aspects of the development has not been calculated but will need to be provided at the proponent's cost. Measures to reduce demand on river water supply should be implemented for all components of the proposed development.

The DWLBC has indicated that the proponent has a reasonable prospect of securing a mix of water allocations to secure the necessary amount of river water to initially fill the proposed waterways, to maintain sufficient water levels and to operate a functioning constructed anabranch/wetland system. In addition, there is no reason why a water licence would not be granted. At current river levels, approximately 380 ML would be required to fill the marina basin and waterways. The proponent currently has an entitlement to 170 ML as an existing irrigation licence. Securing the balance of the water needed will be the responsibility of the proponent. During periods of water restriction when full allocations cannot be secured, the proponent would need to enter the water trading market. However, the Response (Section 5.1) states that the marina and waterways may be filled in stages based on water availability. The Response (Figure 2) illustrates how such staging could occur. The proponent may decide to only partially fill the development based on the level of restrictions, the cost of water and demand for marina berths and waterfront allotments. For example, the Response (Section 5.1) states that only 10 – 80 ML may only be initially required. Thus, the proponent has indicated that a flexible approach to securing water allocations would be adopted. Filling the first sections of the development would occur approximately two years from the granting of development approval (if granted).

If the proposal is granted development approval, the proponent would then need to further negotiate a water licence and allocation with the DWLBC under the requirements of the *Natural Resources Management Act 2004*.

The SA MDB NRM Board considers that the proponent must demonstrate how equitable and transparent water accounting would be achieved in accordance with the River Murray Water Allocation Plan, particularly seasonal and year to year variations in surface water inflow and losses through evaporation. Additional information provided by the proponent (Appendix 1) states that the proponent believes that an

equitable basis for determining the annual water requirement should be based on the previous five year average figures for evaporation and rainfall. This would allow a water balance to be prepared each year and provide a stable basis for determining what level of water purchase (either permanent or temporary) would be required for the coming year. It is considered that a permanent weather station should be established on-site to accurately record rainfall and evaporation data (if approval is granted). The results can then be used for comparison with predictions to determine the accuracy of such calculations and to develop a suitable correction factor (if required). This would enable a more precise water balance for the proposal to be calculated for on-going water allocations.

The EIS (Section 4.3.6) states that an environmental benefit of the proposal would be the input of creek flows to the river, via the gully in the north-western corner of the site. This water currently cannot enter the river due to the modified nature of the floodplain (ie dairy flats and levee banks), with much of it lost through evaporation. The 'flash flooding' characteristics of this creek means that discharges to the river, via the marina discharge outlet, would be very sporadic. Thus, the environmental benefit would be limited to highly intensive rainfall events.

In addition, the Response (Section 5.1) suggests that the marina and waterways would provide an additional storage of ~ 220ML (between the average high pool level and the current river level) that would be a benefit for water extraction during drought conditions. The belief is that, during low river levels this storage would then flow into the river as levels drop, the water would flow back into the river and be available for downstream users (similar to a release from a dam). The SA MDB NRM Board has questioned whether this is a real benefit, to which the proponent (Appendix 1) has acknowledged that this is an inconsequential benefit.

In conclusion, this AR considers that the amount of River Murray water required to fill and maintain the marina and waterways has been accurately calculated. The are no legal impediments to the proponent gaining the quantity of water needed under the current water licensing and allocation regime. If the proposal is approved, the proponent would need to meter flows of river water into the development and to monitor climatic conditions on-site, in order to accurately determine the quantity of water that would need to be secured on an annual basis.

6.2.2 Water Quality

Water Quality Modelling

The EIS (Section 11.2.3 and Appendix I) used hydrodynamic modelling of the marina and waterways to predict water flows at various locations, under both natural river flow conditions and with the additional assistance of pumping (based on early 2006 river levels). The effects of wind and boat movements were perceived to be minor and were not modelled. The modelling indicates that, in order to achieve the EPA design requirement of complete water turn-over every 10 days, pumping would be required. A pump would also be installed at the end of the north-western waterway to ensure adequate flows for flushing. This pump would be located near the proposed Commercial Area, with a pipe placed within the road reserve to deliver water to a water feature at the end of the waterway.

The model also calculated that, on average, approximately 20% of the total flow entering the entrance way would be subject to backflow. The DWLBC expressed concern that, during low or entitlement flow in the river, there would be regular periods during which direct discharge from the marina and waterways to the river will occur via backflow. This is because wind effects can cause the river level to fluctuate over the course of a day, causing the level in the marina development to fluctuate with the river level. As the river level rises, water flows into the marina, then when the river level drops, water flows out of the marina as backflow. This backflow would regularly be at a rate that cannot be offset by pumping. The backflow would not pass through the constructed anabranch/wetland system and would, therefore, not be afforded the benefits provided by natural treatment processes. The DWLBC is satisfied that the design of the marina and the proposed water quality protection measures (esp. for managing stormwater run-off) would be effective in reducing pollutant loads to the marina and waterways and that the proposed treatment

anabranch/wetland system would further reduce loads prior to discharge to the river. However, it should be recognised that not all water that passes through the system would be discharged via the treatment wetlands. In some circumstances, there will be discharge that backflows directly to the river, such that the proposed measures may reduce but not entirely prevent pollutant loads reaching the river. The Response (pg 39) states that a floodgate is now proposed for the northern inlet to prohibit backflow from this location, which will reduce backflow by 3% (ie to 17% of total inflows).

It is considered that backflow would only pose a very low risk to river water quality, as such conditions would not occur on a regular basis and only for short time periods. The greatest risk is posed during times of low flow when winds persistently blow from a southerly direction (mainly during summer). The worst case scenario would be if a substantial pollution spill occurred in the marina when backflow exceeded the capacity of the pumping system to generate adequate through-flow. The implementation of a spill contingency plan (especially the ability to place a boom over the entrance way) would significantly reduce this risk. It is considered that a permanent monitoring stations should be established near the northern inlet and southern outlet and within the waterways, marina basin and anabranch/wetland system to continuously measure flow rates (if approval is granted). This would enable backflow to be measured and used to verify the model, in order to refine the predicted risk level.

Risks to Water Quality

The EPA (2007) identified a range of options for the management of factors that pose a risk to water quality in the Mannum – Wellington Local Action Plan (LAP) Area, including raw water intakes, recreation and environmental values. Marinas and vessel moorings were identified as a moderate risk (mainly due to pollutant sources, black water and greywater), whereas residential developments pose a moderate – high risk (mainly due to sewerage systems and direct discharges of stormwater).

Risks associated with marinas and moorings should be managed by:

- Auditing, licensing and enforcement of the EPA *Code of Practice for Vessel and Facility Management: Marine and Inland Waters (2007)*
- locating berths in off-river marinas
- introducing a requirement for all houseboats to be slipped and surveyed
- ensuring emergency spill response procedures and spill kits are in place
- bunding fuel stores
- educating marina owners and boat operators on appropriate waste disposal
- establishing additional waste disposal stations
- monitoring greywater discharge concentrations and supporting the development of greywater treatment systems
- monitoring nutrients and other pollutant levels in marinas

The EPA (2007) also considered that marina planning guidelines for new marinas should also be developed.

Risks associated with residential developments should be managed by:

- requiring new developments to incorporate stormwater management systems (eg. retention basins and wetlands) and use water sensitive design principles

- the installation of traps and other pollution prevention mechanisms
- community education on the pollution of stormwater

It is considered that the proposal addresses and adopts these management measures.

Risk Management

Wetland design and physical or management measures to minimise potential environmental impacts and improved facilities for houseboats have been proposed in the EIS. Improved facilities for houseboats reduces the impact of pollutant discharges and damage from mooring on riverbanks. Adequate facilities will be provided at the marina to mitigate the impact of concentrating a large number of boats together in one place.

Currently there are insufficient formal moorings and no pump out facilities for grey water along the river. All occupiers of berths within the marina would be governed by a Marina Owner's Charter and be required to abide by the conditions set by the EPA for the marina licence. Refuelling stations, grey water, and sewage effluent disposal facilities would be provided for 156 houseboats (150 permanent and 6 casual). The Response (pg 51) indicates that the preferred option is to require all houseboats using the marina to be equipped with storage facilities for both blackwater and greywater, to enable connection to the vacuum sewer system (ie. as prescribed in the Houseboat Owners Charter). This would apply to all houseboats used for permanent living.

Protection of the high conservation status Baseby Linear Riverine Wetland, and the need to protect water quality and minimise water extraction from the river are important management goals of the proposal.

The change in land use from primary production (especially dairying and grazing) to residential marina would reduce the pollutant load on the river and adjacent floodplain and wetlands. The proposal has been designed to mitigate the impacts of marina and urban land on adjacent areas of conservation significance and the river.

Water flowing through the marina and waterways will be protected from pollution by providing facilities for houseboats in an off-stream marina (vacuum sewerage connections, solid waste disposal bins and regulated refuelling stations), a sealed wastewater disposal system, bunding of fuel service supply and the provision of a spill response plan (ie. as part of the overall EMMP for the site). Water from the marina and adjacent residential development will flow through a constructed wetland as an additional safeguard prior to discharge back to the river. The EIS (Section 12.2) states that potential short term impacts from construction will be managed through a Construction Environmental Management Plan (CEMP).

The EIS (Section 2.3.8) states that riparian buffers (five metres wide) are proposed for the embankments adjacent to all residential waterways, comprising native grasses, shrubs and trees. The buffers would be designed to stabilise the banks (ie. to minimise erosion and turbidity), protect water quality (ie. by filtering out sediment and trapping pollutants and nutrients) and to provide habitat and amenity. The buffer would be established by the proponent, with residential allotment owners responsible for supplementing the buffers. Waterfront allotments would range from 40 – 70 m depth, which would allow for a possible 15 m buffer on all allotments (or up to 40m on some). The buffer approach aims to establish a vegetated zone between the residence and the waterways, in order to intercept and absorb run-off and any associated pollutant load (especially sediment and nutrients).

The proponent and the EPA have recently held discussions on the issue of setback requirements. Default setbacks requested by the EPA in situations where no measures are put in place to address water quality, requires the building envelope to be a minimum of 25 metres from the water's edge at pool level. It has been agreed that the following measures would be adopted to ensure a suitable buffer:

- Setbacks from building envelopes to pool level are to be no less than 19 metres for 40 metre deep

allotments and 40 metres for 70 metre deep allotments.

- Construct allotments such that the 40m deep allotments have an approximate slope of 1:16 (3.6 degrees) and the 70m deep allotments have a 1:42 (1.4 degrees) slope.
- Plant selected species at water's edge with the view to intercepting any sediments or nutrients.
- Plant selected species within a 5m riparian corporate zone designed to minimize transportation of sediments into the watercourse.
- Undertake slope stabilisation/on-block mitigation via "lawn" establishment during site preparation.

The EIS (Section 2.2.3) states that waterfront allotments would have a 15m wide easement, comprising 5m of land and 10m of water, in order to control the design, construction and maintenance of the riparian buffer strip and edge treatment (including landing and mooring structures). The House Owners Charter would provide guidance on how to establish a suitable buffer.

To improve the riparian buffer, it is considered that the edge of the waterways should be designed as a natural river bank (if approval is granted). For example, low profile rock armour (such as limestone) should be used to stabilise the bank edge and protect it from erosion and minimise turbidity. Riverine and semi-emergent native vegetation should be encouraged to establish to provide a natural ecosystem for water quality improvement and habitat. The EIS does not provide a cross-sectional depiction of the treatment proposed for the waters edge of waterfront allotments. Further detailed designs would be required prior to construction commencing (if approval is granted).

The EIS (Section 2.3.6) states that the edges of the marina basin would be lined with bulkheads, comprising vertical, vinyl sheet piling and a hardwood timber capping. This would stop bank erosion and prevent turbidity problems associated with the mooring of boats.

The EPA (2007) states that there is a water quality monitoring site at Mannum where testing is carried out on a regular basis on a range of parameters. This data would provide a good baseline for inclusion in the monitoring program for the proposal. It is considered that a monitoring site should be established at the marina outlet that replicates the current testing program (if approval is granted). The exact location of the sampling point would need to consider the proximity of the adjoining Baseby Irrigation Area to ensure results are not affected by irrigation discharges, especially during backflow conditions.

In conclusion, this AR considers that the proponent has satisfactorily identified all potential risks to water quality (especially for the River Murray) and has proposed adequate mitigation measures to avoid or minimise such risks. The control of pollutants sources (especially from houseboats), stormwater management, establishment of riparian buffers and the operation of a constructed anabranch/wetland system are key measures for protecting water quality.

6.2.3 Stormwater Management

Untreated stormwater discharges from urban catchments have been identified as a significant risk to water quality of the River Murray, due to potential loads of sediment (coarse and fine particles), organic matter and pollutants from roads (heavy metals and hydrocarbons), activities on residential allotments (nutrients, herbicides, pesticides, pathogens) and reserves (especially nutrients from fertilisers and lawn clippings). Hard surfaces associated with the marina facility and commercial areas (mainly roads and car parks) could also generate significant volumes of polluted run-off over time. High intensity rainfall events, especially after periods of no rainfall, pose the greatest discharge risk.

The EIS (Section 2.7.2) considers that the best practice for preserving stormwater falling on road sides is to return that water as cleanly and as quickly as possible to the waterways. Consequently, a

comprehensive underground stormwater drainage system is proposed for the residential and commercial areas. The proponent's objective to return as much clean run-off as practical to the River Murray (via the marina and treatment wetlands) would substantially reduce the proposal's requirement for river water (ie. by providing a significant input to the water balance). However, modern stormwater principles often seek to progressively slow and capture run-off flows to enable infiltration and uptake by vegetation (ie to encourage use of the resource and to reduce volumes and velocities at discharge points to receiving waters).

It is considered that the proposal can achieve both these objectives, as it comprises a suitable mix of 'hard' and 'soft' measures that make up the 'stormwater treatment train' for dealing with run-off generated by all components of the development. A 'stormwater treatment train' approach comprises the employment of a variety of run-off treatment measures 'in-series', with each component effective in trapping and removing particular pollutants. The proposal incorporates a range of best practice Water Sensitive Urban Design (WSUD) options, based on recent research (such as that produced by the Stormwater Industry Association Ltd).

Clean stormwater (such as roof runoff) could be discharged directly to the nearest water body (if not collected for re-use). The EIS has not specified the types of areas that could yield "clean" stormwater and suggests that WSUD techniques may have limited usefulness, due largely to the poorly drained geology underlying the site. Permeable foundations and drains could be laid under hard surfaces that, if porous, can filter out pollutants from the overlying land use, such as car parking and pedestrian access. Permeable paving, subsurface storage tanks and leaky wells could also be used. Grassed swales and porous surfaces could be used to absorb and filter stormwater on ground that permits infiltration (especially to replace or supplement irrigation in areas requiring it). Water would be returned to underlying soils where possible. The final design work to determine the best selection and location of these techniques has not yet been undertaken for WSUD options for the site. The need for a high flow bypass on detention basins would need to be investigated as a measure to prevent resuspension of accumulated sediments.

The proponent would need to manage stormwater in the following ways.

Residential Allotments

- Roof run-off should be collected in rainwater tanks, with overflows to be discharged to the road drainage systems and a retention pond nearest to its collection point (and ultimately discharged into the waterways). Roof runoff is typically of sufficient quality that pollution or public health impacts are minimal. 'First flush' flows from tanks would also need to be discharged to the road (ie to enable rainwater use for domestic purposes).

- Vegetated riparian buffer zones (including grasses strips) would be developed on all waterfront allotments to provide an additional water quality and erosion safeguard. The use of an organic growth product should be addressed in the House Owners Charter and management plan for the marina.

- A vegetated riparian strip should be established along the waters edge of waterfront allotments.

- Porous paving should be used for residential driveways to increase on-site infiltration. Stormwater storage should also be encouraged under driveways to enable re-use on gardens or for domestic purposes.

- Management of resident's activities and garden design through the House Owners Charter

Commercial Allotments

- Roof run-off should be collected in rainwater tanks, with overflows to be discharged to the road drainage systems.

- Porous paving should be used for parking areas (and possibly roads) to increase on-site infiltration and/or for underground storage. Vegetated swales should also be used.

Road Network

- Stormwater run-off should be diverted into Gross Pollutant Traps (GPT's) located in open space reserves within the residential sub-division. GPT's are intended to remove larger refuse such as litter, and substantially reduces oils and greases that may be washed into the stormwater system. GPT's are generally poor in intercepting fine particles which include microbes and nutrients attached to clay or fine suspended or dissolved organic matter. These pollutants are responsible for the majority of heavy metals, turbidity, nutrient caused algal blooms, and high bacterial counts making the water unsuitable for contact recreation. GPT's would treat a typical one year storm event or annual return interval (ARI), with larger flows being bypassed. This would capture the 'first flush', which usually contains most gross pollutants.

- GPT's should discharge to small wetland retention ponds within the reserves, before discharge into the waterways. Vegetated swales should also be used to direct stormwater into the retention ponds to reduce the level of contamination reaching the waterways. The swales and local retention ponds would reduce the levels of pollutants that escape the GPT's before discharge to the waterways. The ponds should have a residence time of 8 – 10 days (for typical winter inflows), which should reduce pollutants loadings to acceptable discharge levels. This would result in acceptable levels of water quality within the receiving waters, which should be verified by ongoing monitoring. The base of all ponds should be above the 1956 flood level and all outlets should have a floodgate to prevent backflow and flooding from the waterway.

Marina and Boating Facilities

- Porous paving should be used for parking areas (and possibly roads) to increase on-site infiltration and/or for underground storage. Vegetated swales should also be used.

- Vegetated riparian buffer zones (including grasses strips) should be established along waterway edges.

- Stormwater should be managed for the boat lift and boat ramp, especially to avoid run-off into waterways.

- Bunding of fuel and chemical stores.

Constructed Anabranch/Wetland System

- Normal flows of water returning from the waterways and marina to the river would be directed through a constructed anabranch/wetland system. This should provide suitable improvement in water quality for discharge to the river, by intercepting or allowing natural breakdown of pollutants that escape the treatment mechanisms within the development. The EIS (Section 11.2.1) states that the wetland would have a total water surface area of approximately six hectares, which is required to achieve a ten-day residence time, to satisfy the water quality requirements. Approximately 4 ha of the wetland would comprise a deep zone and the remaining 2 ha would incorporate the macrophyte zone. The 10 day residence time allows a suitable period for settlement and biodegradation of pollutants.

The stormwater collection capacity of the road network has been designed for a 1:100 yr rainfall event, whilst the retention ponds have been designed for a 1:10 yr event. The proponent will need to ensure that the capacity of the ponds is not exceeded during high rainfall events so as to cause a flooding or erosion problem.

The SA MDB NRM Board expressed concern that the EIS did not include modelling of pollutant sources and loads, to quantify potential discharges to the marina basin and waterways. Nor did the EIS model the point of discharge to the River Murray. To address this concern, the Response (Section 5.2.2) included the results of modelling, using the stormwater management 'MUSIC' computer program. Whilst the EIS states that modelling was undertaken for the treatment train, it only calculates the pollutant reduction efficiency of the GPT upstream of the retention pond. Pollutant loads and reduction efficiencies for the retention pond and discharges to the waterways and marina were not modelled. Neither were other WSUD measures, such as vegetated swales and the riparian buffer strip.

Additional information provided by the proponent (Appendix 1) states that additional MUSIC modelling has been undertaken (as requested by the SA MDB NRM Board) for both stormwater discharges from the residential development into the marina waterways and for discharges from the treatment wetland into the river. Modelling was also undertaken for wetland performance capabilities for pollutant removal. It showed that the volume of water (and loadings of nitrogen, phosphorus and suspended solids) entering the marina from the sub-division is a small fraction (<1%) compared to water entering from the river. It concluded that water being discharged back to the river was essentially river water that entered the development. The wetland will be able to reduce the small pollutant load generated by the marina and residential components. In addition, natural processes associated with fringing vegetation and aquatic ecosystems (particularly macrophytes and biofilms) established along the residential waterways would assist in improving water quality.

The proposal will deliver a range of overall water quality benefits to the river (such as the removal of the WWTP pollutant risk, removal of grazing and the treatment of sewage/greywater from houseboats).

Whilst the amount of pollutants that would be generated by the various components of the proposal (and the pollutant reduction efficiency of all stormwater management options) has not been calculated comprehensively, it is considered that the approach and range of measures proposed for addressing all potential pollutant sources would ensure that water quality of the River Murray is protected. In addition, most of the pollutant sources associated with the proposal would be of low – moderate risk and would be manageable. However, further modelling of the stormwater treatment train would need to be undertaken at the detailed design stage to verify that proposed measures would be effective. Modelling would establish a baseline for comparison with monitoring data collected during operation to provide further verification of the model or for ameliorative measures to be put in place (ie. as part of an adaptive management approach).

Management procedures will need to be developed for the stormwater management system to ensure that each component operates efficiently and meets design requirements/objectives. Regular inspection and maintenance may be needed. Disposal options for waste material (that may be contaminated) would also need to be addressed. The long-term responsibility for the stormwater management system would rest with the Mid Murray Council.

It is often standard practice for residential marina developments to have in place a Soil Erosion and Drainage Management Plan (SEDMP), which is also an EPA requirement for large land divisions, to address the management of stormwater and other causes of soil erosion and dust. Given the high priority need to protect water quality in the River Murray, it is considered that a separate Stormwater Management and Monitoring Plan should be prepared (if approval is granted). The Plan would need to identify and quantify the stormwater and pollutant loads for each catchment (or sub-catchment) and design an appropriate 'treatment train' using WSUD methods. Construction related aspects of the Plan may need to be included in the SEDMP. The SEDMP would address standard construction matters. The Plan would also need to identify measures that would be needed for managing stormwater associated with future commercial and tourism related components.

Complementary measures for the management of stormwater associated with residential and commercial uses, especially harvesting and reuse, would need to be enforced through appropriate mechanisms. Design guidelines would need to be put in place to ensure stormwater collection from rooves and driveways/car

parks and re-use (ie. for garden watering or plumbed into buildings) is maximised as far as practicable. Such guidelines would need to be incorporated into Development Plan policies for the site. The preparation of a suitable SEDMP should also be a requirement for future development applications for residential, commercial and tourism related building sites.

In conclusion, this AR considers that the proponent has adequately addressed all stormwater management issues, particularly the control of pollutants, stormwater harvesting and the input of clean stormwater to the river. Water Sensitive Urban Design principles and measures would be adopted to achieve these objectives.

6.2.4 Groundwater Implications

Being located on the floodplain of the River Murray, a key issue associated with the proposal is the risk of intercepting saline groundwater that could potentially be discharged to the river during construction or operation.

The EIS (Section 6.5.3) states that groundwater is likely to be encountered below a depth of about 1.0 m (-1.6 to -2.1m AHD) on the low lying floodplain sections. The marina basin and residential waterways would be excavated to provide a water depth of 2.55m at normal pool level. Thus, some excavations for the basin and waterways are expected to slightly extend below the groundwater level. The basin and waterways lie over the Coonambidgal Formation, which has very low hydraulic conductivity. The proposed excavations would be cut into this formation, although due to very poor infiltration of water, it is not expected that much water will be lost and there should be no significant increase in local groundwater as a result. Infrastructure trenches within the residential areas would be located well above groundwater levels. However, the response (pg 53) states that preliminary investigations suggest that the groundwater table would not be intersected by excavations down to 2.55 metres below existing ground levels (0 to -0.65m AHD).

The DWLBC indicated a concern that excavations close to the highland/cliffs may minimise the protective interception function of the low-lying land, resulting in regional inflows from the limestone aquifer reaching the marina to cause an increased salinity risk. It is considered that this risk would be low, as waterway excavation would occur along the base of the cliff on the floodplain and would not cut into the limestone cliff. The proponent has instigated a groundwater investigation to determine flow gradients towards the river and to identify any groundwater contamination, in order to quantify salinity risks. The Response (Section 5.3) states that groundwater data would be used in a conceptual and numerical groundwater model capable of simulating the effect of the proposal on the environment. This would confirm whether the proposal would pose a salinity risk to the River Murray.

Impact on the nearby Council landfill is expected to be low due to the low rainfall resulting in minimal leaching of pollutants to groundwater. The landfill is to be closed and capped in 2010. Detention of stormwater on the landfill site and the operation of monitoring bores are expected to appropriately control any movement of materials onto the marina site to within safe levels. If the monitoring bores indicate unpredicted issues with pollutant leaching off site then appropriate measures will be required to protect the marina waters. This could involve interception pumping, for instance.

The proponent should develop plans for the exclusion of leachates from the landfill site, should monitoring indicate a significant threat to water quality or health.

It is considered that a Groundwater Monitoring and Management Plan should be prepared, with aspects of the Plan incorporated into the proposed Site Remediation Plan and Construction/Operational EMMP's where appropriate (if approval is granted). The Plan would need to include the monitoring bore program and contingencies for addressing any contamination, salinity or groundwater mounding problems that could potentially be detected.

In conclusion, this AR considers that the proposal is unlikely to result in contaminated or saline groundwater being discharged to the marina or the River Murray, provided standard construction management practices are adopted. The proponent has undertaken, or will be undertaking, further hydrogeological investigations and monitoring to verify that the proposal would pose minimal risk, prior to construction commencing.

6.2.5 Discharges to the River Environment

The establishment of the marina will create a point source discharge to the river environment, via the southern outlet. During backflow conditions (ie when the river flows upstream due to certain wind conditions), the entrance channel would become the discharge point. The channel will provide an avenue for potential pollutants originating from the road network, from the residential land and from the boating, commercial, semi-industrial, retail, recreational and tourist related uses of the site. The main concerns are:

- elevated nutrient levels, which can promote algal blooms
- heavy metals and hydrocarbons, which can affect the health of riverine communities
- sediment, especially fine fractions, that increase turbidity (reducing light penetration to aquatic vegetation), attract pollutants and can accumulate as a pollutant sink

Discharges to the waterways would need to be avoided through the careful management of run-off and pollutant sources.

An upgrade of the Mannum WWTP would eliminate a potential pollutant risk to the River Murray (and a reduction in any diffuse discharge of nutrients from underground leakage into the river), which would compensate for any nutrient risk from the marina development.

The excavation of the marina basin and waterways would be undertaken in the dry. The existing levee banks separate the site from the river, allowing any turbid waters generated by construction (or the interception of saline groundwater) to be contained and managed. The greatest incidence of increased turbidity would be when the entrance channel is opened to allow the gradual flooding of waterways. In addition, the construction of the northern inlet and southern outlet structures could also result in increased turbidity in the immediate vicinity. This impact is expected to be of short duration. It is suggested that silt curtains should be used during any excavation of the banks.

The EIS did not model the impact of potential pollutant loads on water quality, especially from boating sources. Contaminated run-off from roads, car parks, reserves (especially grassed areas) and residential and commercial allotments could also have been modelled, although it is expected such discharges would be avoided or minimised through suitable management. In this regard, the EIS (Section 5.2.15) proposes to treat stormwater through WSUD measures/devices, to manage discharges from vessels, provide appropriate waste disposal facilities (ie for oil, bilge water, grey water, wastewater etc) and pollutant traps.

The implementation of best practice measures will seek to avoid any contamination of waterways. Any discharge load is likely to be low and would not have a significant effect on the river environment. Ongoing monitoring would be used to determine the magnitude of such discharges, especially on water quality and the river ecosystem.

The proponent would need to ensure that water discharged to the river is the same as, or better than, the quality of water in the river and should be suitable for primary and secondary contact recreation, as prescribed by the ANZECC (2000) *Water Quality Guidelines for Recreational Contact*.

In conclusion, this AR considers that suitable measures have been proposed to ensure that water discharged to the River Murray is equal to, or better than, the quality of water in the river.

6.2.6 Flooding Implications

Generally, no development on the floodplain is allowed that increases the risk of flooding of adjacent areas. Thus, the EIS (Section 11.2.5) states that all development (especially residential areas) would be above the 1956 flood level. However, the EIS (figures 2.13 and 2.16) also indicates that the base of the garage for some waterfront allotments would be below the flood level. In addition, the garden areas adjoining all water frontages, all small craft private moorings (ie. jetties and pontoons) and the public walkway along the villa waterfront allotments would also be below the flood level. These would all be prone to flood damage during the biggest floods that can be experienced by the river. In addition, small moorings could become detached during floods and become floating debris.

It is considered that adequate controls should be put in place for structures on the floodplain. Under croft storage areas and garages should not be fully enclosed or should have walls that are removable or capable of being raised above the 1956 flood level. The storage of chemicals and fuels should also be above this level. All private moorings should be extendable or be capable of being easily removed. These requirements should be addressed in design guidelines, the House Owners Charter and/or any future complementary Development Plan policies for the site.

Houseboat service points would be located above a flood level of 1 in 50 years return frequency and would be capable of isolation if inundated during larger floods. Mooring piles for houseboats would be extendable to allow for mooring at a level equivalent to a 1956 flood level. The Department for Environment and Heritage indicated a concern that, during flood periods (ie. such as occurred in 1956 and 1974), extendable moorings may not be appropriate. During such floods, boats may be at risk from breaking moorings or could be damaged by floating debris (especially large fallen trees). Thus, it is considered that a Flood Management Plan that addresses contingencies for very large floods, should be incorporated into the Operational EMMP. In addition, all private mooring structures for waterfront allotments should be addressed in the same way.

Flooding of the low-lying areas (encompassing the marina, waterways and constructed anabranch/wetland), would result in floodwater being diverted back into the river by a levee constructed on the southern boundary, thus protecting downstream properties. The flooding implications for the constructed anabranch/wetland system would need to be addressed in the proposed management plan.

In conclusion, this AR considers that suitable measures have been proposed to ensure that the proposal would not result in flooding problems.

6.3 ENVIRONMENTAL ISSUES

Any multi-component marina has the potential to cause a number of impacts on the terrestrial and riverine environment, including:

- effects from construction activities, especially landscape disturbance from earthworks, disturbance of contaminated groundwater or soils (including. acid sulphate soils), soil erosion, dewatering, dust, noise and increased heavy vehicle traffic. Elevated turbidity can also be a problem for river water quality and riverine ecosystems
- loss of native vegetation cover and habitat (both permanent and temporary)
- mortalities and disturbance of fauna communities
- introduction of and/or increased magnitude of pollutant sources, especially toxic chemicals from recreational/commercial boating activities and roads, sediment from exposed soils and nutrients from residential gardens and reserves
- increased pedestrian, vehicular and boating traffic, including off-site impacts on the riverine environment
- effects from human habitation and activities, especially greater ‘people pressure’, cats/dogs, garden escapees, illegal dumping, off-road vehicle use

- litter and waste sources, including effluent from residences and houseboats
- altered hydrology, especially for wetlands and river salinity
- discharges to the river environment, especially pollutants or saline water
- introduced plant and animal species, especially pests

The EIS proposes to alleviate many of the existing environmental problems in the area, including the following measures:

- impacts on the river bank and river water quality from houseboats and boating activities (through greater pollution control and monitoring)
- soil salinisation, mainly from the evaporation of groundwater through capillary action (marina and constructed wetland to form a groundwater mound)
- potential pollution risk from the Mannum WWTP (existing plant to be relocated away from the floodplain)
- removal of grazing on the floodplain and river bank
- control of erosion and weed invasion of the river bank and floodplain
- support of floodplain habitat by the re-creation of riverine and wetland habitat
- supporting Baseby Wetland by removal of recreational activities from river bank and creation of a buffer

This AR concludes that, on balance it is considered that the benefits of the proposal in environmental, economic and social terms would offset any impacts on the natural environment. These impacts should be managed sensitively by the proponent, in consultation with relevant Government agencies, the Natural Resources Management Board and community groups.

6.3.1 Native Vegetation (Terrestrial and Riverine)

The proposal has the potential to detrimentally affect a small amount of terrestrial native vegetation through direct clearance. Large scale earthworks for the excavation of waterways and the formation of land would result in the removal of nearly all floodplain vegetation. However, the loss would not be significant, as the communities affected have been highly modified due to agriculture and are largely degraded (ie. exist as depauperate or disclimax communities). The affected vegetation mainly comprises a Samphire Low Shrubland community type that has a low number of native species and a high number of introduced species. Smaller areas of Chenopod Low Shrubland (+/- Samphire) and Nitre Bush Open – Very Open Shrubland would also be cleared. These community types have minimal habitat value due to low species diversity and a dominance of weeds. Saline floodplain soils, resulting from past irrigation, currently limit regeneration potential.

The EIS (Section 11.3.2 and figure 11.6) states that up to four individual River Box Trees located along the tributary emanating from the north west corner of the site would need to be removed. The remainder of such trees in this location (around 55) would be retained and incorporated into the design of the residential sub-division. The Response (Section 4) and further information provided by the proponent (Appendix 1) states that minor adjustments have been made to the conceptual layout plan to ensure all River Box trees are retained.

The DWLBC (Native Vegetation Group) indicated a concern that retained trees may be at risk of removal during housing design or construction, especially given that the House Owners Charter does not encourage the retention of native vegetation. The Response (pg 41) suggests that a clause be included in the Charter stating that remnant native vegetation must not be cleared. The wording of such a clause would be to the satisfaction of DWLBC. Strict controls will need to be put in place to ensure that retained trees are protected from future removal (or excessive pruning), especially during road construction or when allotments are sold and developed for housing. In addition, the root zone of each tree would need to be protected during construction and inadvertent damage avoided.

The valley slope and highland (which is proposed to be developed into a residential sub-division) has been extensively cleared of its original shrubland vegetation communities for agriculture and is now dominated by pasture, with scattered Nitre bush and chenopods.

Native vegetation associated with the river bank and the Baseby Wetlands would not be directly affected, apart from possibly some minor disturbance to the root zone of several River Red Gum (*Eucalyptus camaldulensis*) trees during the construction of the entrance channel and northern water inlet. The existing levee bank would ensure that construction vehicles do not inadvertently damage or disturb wetland and riverine vegetation.

The EIS (Section11.3.2) states that approximately 50 ha of native vegetation would be cleared, with ~ 22 ha retained. It is proposed to revegetate a substantial part of the site with locally indigenous native species, mainly on land adjoining river bank communities or associated with the constructed wetland. These areas would form an important buffer along the river that would mitigate many of the impacts of the development. The management of saline floodplain soils would need to ensure that plant growth is able to be maintained in the long-term. Revegetated areas would also be supplemented by landscaping around the marina and residential sub-division. This approach ensures that the proponent is more than able to satisfy the need for a SEB under the *Native Vegetation Act 1991* (ie. as compensation for vegetation clearance).

In conclusion, only a small amount of low habitat value native vegetation would be cleared and would be compensated for by the extensive revegetation program proposed. High conservation value riparian and wetland vegetation would be protected and enhanced through improved management.

6.3.2 Native Fauna

The EIS (Section 7.6) provides an adequate description of the fauna that occurs (or is likely to occur) on the site. Fauna data was collected from existing literature (particularly Hyde, 2000) and two brief, opportunistic surveys conducted in 2002 and 2005. The EIS does not identify the survey methodology used nor the season during which the surveys were undertaken. Fauna trapping, using standard survey techniques such as pitfall traps and Elliot traps, was not undertaken. The SAMDB NRM Board expressed concern that fauna surveys were only carried out during summer months, which would affect the number and species recorded. However, the majority of vegetation that would be cleared (ie Samphire and Chenopod shrublands) has a low habitat value and would not support many native species. Areas with high habitat value and greatest species diversity, mainly the Baseby Wetland complex, would not be cleared. It is recommended that a more thorough fauna survey would need to be undertaken in the riverine zone to establish a suitable baseline for monitoring the effects of the development, if it is approved. The proponent has made a commitment in the EIS to undertake such further survey work. Fish and bat surveys would also need to be included. This would need to be conducted in consultation with relevant Government Agencies and the community (especially the Mannum – Wellington LAP Group).

The majority of the proposed site is largely devoid of significant stands of native vegetation cover and hence there is little significant habitat to support a diverse range of fauna. Floodplain land directly affected by construction predominantly supports shrublands that have naturally regenerated on modified, saline soils during the 10 years since primary production on the irrigated dairy flats ceased. The EIS (Section 7.6) states that a low number of fauna species were recorded on the floodplain, with bird species being the most numerous. None of the species are specifically reliant on the habitat types, with most using it on a transitory basis.

The river bank still retains a narrow strip of high conservation value wetland and riverine habitat (the ‘Baseby Wetlands’) that extend from the Mannum WWTP downstream to the Reedy Creek swamp. This habitat would not be directly affected by construction activities.

With such a large number of residences being established, a considerable cat and dog population could develop. The use of fencing to prevent cats and dogs entering habitat areas will assist in controlling unwanted activities. The walking of dogs within the constructed wetland area and along the riverbank should be avoided. Control of domestic pets should be addressed in the House Owners Charter and by Council by-laws.

In conclusion, this AR considers that existing fauna would not be detrimentally affected by the proposal. Existing riverine and wetland habitat would be protected and enhanced through improved management. In addition, a substantial area of supplementary habitat would be provided through revegetation and the construction of an anabranch/wetland system. These would not only provide additional habitat for the expansion of fauna populations, but would provide a buffer for existing fauna.

6.3.3 Riverine and Wetland Ecosystems

The river bank adjoining the site contains habitat of high conservation value as it supports a small chain of freshwater wetlands (the 'Baseby Wetlands') and fringing riverine vegetation. These wetlands stretch downstream to the Reedy Creek Swamp, providing an important wildlife corridor. This habitat is separated from the development site by a levee bank. The river bank is regularly used for recreation (houseboat mooring and camping) and has a high level of weed infestation (mainly willows, thistles and box thorn). Thus, the habitat value is compromised by degrading factors including:

- bank erosion and increased water turbidity, especially from boating traffic and mooring
- houseboat mooring, including structures along the bank, physical damage and shading of aquatic ecosystems
- pollution from boats (hydrocarbons, grey water and possibly black water)
- erosion and compaction from camping and vehicle access
- fire wood collection (including the cutting of tree limbs) and increased risk of wildfires
- noise and disturbance
- litter

The river bank communities would not be directly affected by the marina as there is no development proposed for this area. In fact, the habitat and scenic values of the bank would be improved through environmental rehabilitation measures, mainly the removal of disturbance factors. An improved river bank would not only improve the conservation value of the bank and water quality in the river, but would also screen the built form of the development from the river and provide an amenable backdrop for the development. The proposed constructed wetland and revegetation areas would provide a buffer. In order to maintain the secluded nature of the wetlands, it is considered that both vehicular and pedestrian access to them should be avoided. Access to the bank by boats should also be avoided. The EIS indicates that houseboat mooring and use would be removed from the bank.

Whilst the EIS states that rehabilitation measures would also be implemented, the proponent has no management control over the river bank and wetlands as they are currently on Crown land. The existing licence to occupy Crown land for boat mooring purposes (5 houseboats) currently held by the land owner (Mr Reschke) would need to be terminated. The DEH has advised that it would enforce removal of the existing permanent houseboat moorings on the river bank, once houseboats are able to be moored within the marina (if approved). A management plan for the river bank and wetlands (ie. that would be included in a 50 m wide Crown land reserve) would need to be prepared. Thus, it is considered that a Riverine and Wetland Management and Monitoring Plan should be prepared, that would be linked with the proposed

Operational EMMP and the Management Plan for the constructed anabranch/wetland system where appropriate (if approval is granted).

Resolution of ownership and management responsibilities would need to be negotiated with the Department for Environment and Heritage and the Mid Murray Council. It is anticipated that Council would be granted 'care and control' of the Crown land, as often occurs for other river bank reserves.

In conclusion, this AR considers that the existing riverine and wetland ecosystems would not directly be affected by the proposal, although they may be impacted upon by human and boating activities. These impacts would be suitably minimised by the provision of a suitable buffer from the marina and residences and through improved management, especially the removal of houseboat moorings and camping along the river bank.

6.3.4 Human (Anthropogenic) Activities

Increase in Human Activity

The proposal would result in a significant increase in the residential population (ie greater urbanisation) and the number of visitors to Mannum.

The EIS proposes to minimise the impact of increase in human activity on the river environment by establishing a substantial buffer zone between the river and development. Revegetation, weed and feral animal control would not only address existing environmental threats, but would also compensate for the impacts associated with urban encroachment. In addition, the removal of the current road access, boat ramp, moorings and other structures along the river bank would relieve some of the people pressure on this area.

Houseboating and Recreational Boating

In general, mooring of boats on the river bank can result in:

- erosion (from boat wash and un-regulated bank access)
- compaction (from trampling)
- shading (reduced sunlight reaching fringing and river bed ecosystems)
- pollution (especially hydrocarbons and grey water)
- physical damage (especially to fringing and river bed ecosystems from berthing and from using trees for mooring sites and firewood)
- disturbance of wildlife (especially due to noise and human activities)
- damage, disturbance or interference to sites of Aboriginal heritage
- litter and other waste (including 'bush toilets')
- wildfires
- modifications to the bank (by establishing mooring structures, grassed areas, artificial beaches, gardens, storage sheds, entertainment areas and vehicle parking)
- damage and disturbance caused by associated recreational activities (especially waterskiing).

In addition, houseboats can be a navigation hazard and pose a risk to water supplies when moored near intake points. Many of these issues were addressed in the EIS (Section 11.3.1).

The provision of off river facilities and removal of mooring activities would enable ecological communities associated with the river bed and bank to regenerate. River bank erosion would be reduced, which would not only help to improve river water quality, but would also mitigate the erosion potential

from wash associated with increased boating movements. It would also remove a disturbance factor for the Baseby Wetlands.

It is noted that the river bed and bank is Crown land and the proponent does not have the authority to prohibit boat mooring. However, the proposed removal of vehicle access to the river will substantially reduce the current impact of activities.

In conclusion, this AR considers that the proposal would increase the level of human and boating activity on this part of the river. However, the resultant impacts would be suitably minimised through the provision of buffers between the river and the marina/residences and the implementation of appropriate management practices (supported by monitoring).

6.3.5 Introduced Species (Weeds and Pests)

The site is degraded cropping farmland and irrigated pasture. Willows are present in places on the riverfront and would restrict the regrowth of native species as well as affect habitat for aquatic fauna. The understorey throughout the site is largely introduced and includes several weed species. Box thorn (*Lycium ferocissimum*) and Horehound (*Marrubium vulgare*) are the most dominant, 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) .

Pest animal species are present at the site. Rabbits, cats, foxes and house mice are found throughout the area.

Control programmes for the introduced fauna and flora should be carried out before landscaping and replanting of native species commences. This should preferably take place in conjunction with adjacent properties to reduce the risk of reintroduction. Any programme will require several years of follow up as weed seeds in particular are persistent in the soil. Some species such as Boxthorn are reintroduced by birds dropping the seeds under perching spots and control programmes will be ongoing.

Any revegetation will be at risk unless rabbits and their refuge areas are destroyed, eradication programmes will be necessary in conjunction with neighbouring properties to avoid recolonisation and grazing from off site warrens.

Encouraging native fauna to the use the rehabilitated areas would require regular cat and fox control programmes. Wetland areas should exclude domestic cats, and dogs, this will both limit disturbance and predation of native fauna and enable control programmes such as poisoning, without threatening local pets.

The Construction EMP indicates general management plans would be developed to cover these areas, but no details are provided. The EIS (Section 12.2.4) indicates that a feral animal proof fence will be constructed on the SW boundary, although such fences are usually only effective if they surround the protected area.

The Construction and Operational EMMP's should provide plans that address the above issues to the satisfaction of State Government Agencies, the NRM Board and Council.

In conclusion, this AR considers that existing weed and pest species would be removed and controlled in the long-term. Garden plants and domestic pests would also be adequately controlled.

6.3.6 Implications for the Environment and Biodiversity

The proposal aims to provide a number of significant environmental benefits to off-set the potential impacts of the development and/or to rehabilitate the floodplain, including:

- the provision of best practice moorings and pollution control measures for houseboats and large vessels, located in a controlled facility that is off-river

- the relocation of houseboats into an off-river marina, resulting in less impacts on the river bank/river bed, floodplain/wetland habitat and river water quality

- restoration of floodplain habitat through the revegetation and the construction of an anabranch and wetland complex

- protection of existing wetland habitat and the establishment of a natural buffer

- removal of the Mannum WWTP and its potential pollutant risk from the floodplain

- a 'master planned' approach to urban expansion incorporating sustainability objectives and measures, such as stormwater management (using Water Sensitive Urban Design principles) and water/energy efficiencies.

This AR concludes that the proposal is expected to directly result in a relatively low loss of floodplain and terrestrial native vegetation of low conservation value. The clearance of such vegetation can easily be compensated for by landscaping/revegetation; the development of a constructed anabranch/wetland system; and the protection and environmental improvement of existing vegetation, especially within the riparian zone. Existing riverine and wetland habitat adjacent the proposed site could be detrimentally affected by processes associated with urban encroachment, especially human activity and pest plant and animal species. However, these would be minimised and compensated for by improved management of the riparian zone.

6.4 CONSTRUCTED ANABRANCH AND WETLAND

The EIS (Section 2.8) proposes to establish a constructed anabranch channel and wetland system, primarily as a measure to mitigate impacts from the development on river water quality. In particular, the anabranch and wetland has been designed as a final opportunity to remove any pollutants resulting from boating and residential activities, before water is discharged back to the river. It could also be used to contain a spill for treatment using biological processes. It is expected that most pollutants could be avoided or minimised using suitable management and engineering solutions (including stormwater control).

In addition, the anabranch and wetland would provide a natural buffer between the riverine ecosystems and the development. It would also assist in screening the development from the river, provide open space and passive recreation, absorb greenhouse gas emissions and would enhance the overall amenity of the development. The system would rehabilitate a large part of the retired Baseby Irrigation Area (ie. dairy flat) by re-creating natural riverine and wetland habitat that once existed on the floodplain. Water levels within the wetland would also be used to manage river salinity, in accordance with the requirements of the ELMA water licence.

The system has been designed based on the natural characteristics of anabranch channels and wetlands, with a hydraulic capacity that would provide a water quality treatment function whilst providing growing conditions for a diverse range of native vegetation communities. A mechanical pumping system would enable water levels and flows to be manipulated to maintain the health of the system. Pumping would also be used to maintain suitable flows (and flushing/turn-over rates) through the marina and residential waterways, including emergency pumping in the event of a large spill or algal bloom. Cut and fill earthworks would be undertaken to form the anabranch channel, wetland basins, levee banks and islands. Soil surveys would need to be undertaken to ensure that soil salinity levels are not detrimental to plant growth or water quality. Suitable, clean soil may need to be imported. Construction would avoid

intersecting the groundwater table. A freshwater lens (ie. groundwater mound) would form under the inundated wetland that will prevent salinity build up.

The wetland will comprise two basins (each with two ponds) for flexible hydrological management, to enable one basin to be dried out whilst the other still receives water flows. The anabranch includes a wetland lagoon and has been designed to remove most pollutants (including sediment) before water reaches the wetland system. A single diversion culvert on the anabranch channel would be used to direct water into the different ephemeral wetland basins/ponds. This allows a diversity of different wetland types to be created. Water in the marina basin would be directed into the anabranch from the downstream end. An additional inlet enables marina water to be directed into the upstream end of the wetland.

The EIS (Section 11.2.1) and Response (Section 5.2.2) state that water in the wetland (with a six hectare surface area) would have a residence time of 10 days in order to satisfy water quality requirements. Additional information provided by the proponent (Appendix 1) now states that the treatment wetland would have an average residence time of two days, which would only result in a small reduction of pollutant loads (ie. <2%). It appears that the need to pump water through the wetland in order to maintain adequate flushing of the marina basin and residential waterways would significantly reduce the capacity of the wetland to improve water quality.

The anabranch and wetlands would be planted with locally indigenous species and be designed and maintained to control invasive species, such as *Typha domingensis* (Bulrush). Natural regeneration would also be encouraged. Fish screens fitted to the inlet culvert and wetland drying cycles would be used to control Common Carp.

The EIS (Section 2.8.3) states that public access to the wetland is desirable, but would need to be controlled. It is important that access to the Baseby Wetland is restricted in order to minimise human disturbance to fauna.

The EIS (Section 2.8.3) states that earthworks would comprise a balanced cut and fill operation as much as possible, possibly using excess fill from marina and waterway excavations. The proponent would need to ensure that soils used for construction are not saline or contaminated and would not pose a risk to water quality or plant establishment and growth. In addition, any saline groundwater that may be intercepted should be appropriately managed. The maintenance of suitable water levels in the wetlands (ie to create a fresh groundwater mound) would need to ensure that underlying saline groundwater does not enter the wetland and the River Murray.

Whilst the EIS and Response provide a good description of the design, earthworks, revegetation and hydrological manipulation of water levels, further detailed designs, drawings, specifications and management plans (including an operating protocol/regime) will need to be prepared before construction commences. The EIS (Section 2.8.3) provides a brief description of the additional investigations that would be undertaken, if approval is granted.

The EIS (Section 12.1.2) states that a Wetland Management Plan would be prepared for the constructed wetland and the Baseby Wetland. However, it is considered that the constructed anabranch/wetland system and the Baseby Wetland should have separate management plans prepared. The Plan for the Baseby Wetland should also include riverine communities along the riverbank and the adjoining buffer areas that would be established (refer to Section 6.3.3).

The SA MDB NRM Board submitted a recommendation that the proposed Plan be prepared in accordance with the *Guidelines for Wetland Management Plans* prepared by the board in conjunction with the DWLBC. In addition, any risks to threatened species should be identified and suitably managed.

Thus, it is considered that a *Constructed Anabranch/Wetland System: Site Preparation, Revegetation, Hydrology and Management Plan* should be prepared (if approval is granted) that would address.

- suitability of on-site soil or imported material
- final landforms and contours
- infrastructure requirements
- revegetation and landscaping (species selection and planting methodology)
- appropriate hydrological regimes (wetting/drying cycles)
- control of erosion and turbidity
- control of pest plant and animal species or nuisance native species
- maintenance requirements
- monitoring (surface water quality, groundwater, native vegetation and fauna)

The Plans should be prepared in consultation with the Mid Murray Council, DWLBC, DEH, SA MDB NRM Board and the Mannum – Wellington LAP Group.

In conclusion, this AR considers that the establishment of a constructed anabranch/wetland system would ensure that discharges back to the River Murray achieve a suitable level of water quality. In addition, it would provide valuable habitat and a buffer for existing ecosystems along the river bank.

6.5 LANDSCAPE DESIGN & REVEGETATION

The landscape design is a necessary part of the proposal in that it provides a link between the existing landscape, the proposed development and the interface with the river environment. Revegetation, conservation and maintenance is probably one of the key objectives to be used in ensuring that the proposed development does not destroy the visual and scenic amenity, the biodiversity/habitat, cultural/heritage aspects of the riverine environment.

The proponent intends to prepare a more detailed Landscaping Plan at the detailed design stage. Areas to be landscaped are verges, median strips, public open spaces/reserves and roundabouts. Native plantings would be used for riparian buffer zones and revegetation areas. The EIS indicates the proposal aims to retain and enhance naturally occurring native vegetation and to revegetate with plants that use minimal water and are considered low maintenance, preferably a local indigenous species. The EIS (Section 2.9.3) states that revegetation will follow the current *Revegetation and Vegetation Guidelines* developed by the Mannum – Wellington LAP Committee. It is considered that a Revegetation Plan should also be prepared (if approval is granted), that addresses relevant aspects, such as site preparation, species selection, planting methodologies, maintenance and monitoring. The Plan would need to be linked with the Operational EMMP, Landscaping Plan, Constructed Anabranch/Wetland System Management Plan and the Riverine & Wetland Management Plan where appropriate.

The EIS has indicated that Crime Prevention through Environmental Design (CPTED) principles would be used when landscaping public areas. Plant species would also be selected on the basis that sight lines for motorists will not be impeded (within roadways etc).

The EIS indicates that, where applicable, built landscaping components would comply with the latest Australian standards and, if custom made, would be certified by a structural engineer. Guidelines will be incorporated regarding paths, paving, play equipment, earthworks, lighting, street furniture, planting, residential streetscape, turf/grasses, riparian buffer zones, revegetation and irrigation. Seating and shading,

plus drinking fountains are indicated to be placed in conjunction with play areas. The EIS (Appendix E) provides a comprehensive list of design guidelines that would be adopted.

Street trees are to be nominated at one tree per property frontage and spaced to allow for mower accessibility. The EIS indicates trees would be chosen to reflect the local character with a preference for native species. Deciduous trees would be discouraged within 100 metres of a waterway. Approved Council mulch would be used for all plantings.

A major goal discussed within the landscaping process and indicated in the EIS is the minimization of water use and the incorporation of water design principles into the irrigation design. Another major consideration indicated in the EIS is the prevention of adverse impacts to existing wetlands (e.g. Baseby Linear Riverland Wetland), watercourses and water bodies.

In regards to stormwater, the proposed drainage system would maximise on-site infiltration of any stormwater and irrigation water. Any earthwork design adjacent a natural aquatic system would also provide for the containment of proposed surface runoff. Initial drip or microjet irrigation should be employed to expedite establishment and speed growth, otherwise plants may take a lengthier time to form the dense shrubland sought as part of the integrated landscaping.

The EIS indicates water barriers between development and the wetlands, and the establishment of riparian zones immediately next to those watercourses preferably with a minimum width of 10-20 metres on both sides of the watercourse. On the proposed residential side the riparian buffer appears to be land based for 5 metres plus 5 metres within the water way itself. The riparian landscaping would be used as an erosion control measure as well as a buffer for incoming pollutants.

Approximately 50 hectares of waterways and wetlands are to be developed as part of the proposed development. The wetlands are designed to treat stormwater and provide additional habitat value as well as salinity controls. The reed beds within the waterways will comprise a range of aquatic emergent macrophytes, to provide landscape and habitat diversity. The types of landscaping indicated in the EIS will allow for bird, bat and other fauna movement between the riverfront wetland and the residential component.

The concepts put forward in the EIS for an integrated landscaping approach which seeks to preserve the local ecology is a positive use of the site and its environs which would further enhance the amenity value of the proposed development and once established would form an attractive natural foreground to the residential, commercial, houseboat, tourist and marina facilities.

The EIS indicates that public access restrictions would be imposed for the protection of the landscaped and cultural heritage areas specifically where rehabilitation is occurring during the construction stage. Landscaping Plan/Guidelines, used in conjunction with the Construction and Operational EMMP's (including the Wastewater Management Plan, Wetland Management Plan and Revegetation Plan), would be adopted for minimising any adverse effects on the wetlands and waterways.

In conclusion, this AR considers that suitable landscaping and revegetation would be undertaken to ensure a high level of amenity (especially to minimise the visual impact of the proposal) and to provide extensive areas of habitat. Native plant species indigenous to the area would predominantly be used, including for stormwater management.

6.6 CLIMATE CHANGE AND SUSTAINABILITY

A multi-component development such as a residential marina would have substantial resource demands during both construction and operation, especially from the residential and commercial components. In addition, there are many sources of greenhouse gas emissions that need to be identified and minimised. There is a potential that the ecological footprint of the development could be substantial, unless environmentally sustainable practices are implemented. However, a master planned development provides

the opportunity to address these issues in a holistic and effective manner. In particular, a bench mark could be set for reducing the greenhouse implications associated with the houseboat industry.

The EIS (Section 11.4.7) describes a range of resource management initiatives that would be adopted to ensure the development is ecologically sustainable and 'greenhouse friendly', especially for water and energy conservation. The initiatives would be implemented through design guidelines, marina management, a House Owners Charter and a Marina Owners Charter. The constructed anabranch/wetland system and revegetation would provide a significant opportunity for carbon sequestration in order to achieve a development that is carbon neutral. Landscaping and revegetation of riverine buffer strips, stormwater swales and retention ponds, road reserves and open space reserves provide additional opportunities. The proponent has stated that the development would not have a large carbon footprint, and may even be in balance, based on figures provided in the EIS (Section 11.5).

The EIS proposes that the site would collectively provide approximately 93 ha available for planting to combat the issue of carbon emissions. 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 revegetation will have a much greater biomass of vegetation than the existing Samphire community and weeds.

The EIS (Section 11.5) states that the viability or function of the development would not be significantly affected by climate change. The EIS considers that the most significant impacts of climate change are likely to be drought and limited flows in the river. Therefore 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 1.75 m could be experienced at the development without unduly impacting on the operation and structures. However, if they occur, changes in the frequency of larger floods will not impact adversely on the marina, waterways, wetlands and revegetation areas. According to the proponent the design of these areas will allow infrequent submersion, however, residential areas have been located above the 1956 flood level in accordance with normal planning requirements.

Flow conditions are likely to change due to climate change and therefore the uncertainty of flows is likely to increase. As drought conditions worsen and water flows become more static, water quality will become more saline, or suffer from algal blooms. According to the Special Report on Emissions Scenarios, published by the Inter-governmental Panel for Climate Change (2007), it is projected that evaporation will vary from 0 (no change) to 15 % in 2030 and 0 and 45 % in 2070.

The greatest impact of climate change on the proposal would be the effect on the amount of water required to maintain levels in the marina/waterways and the availability of water. Thus, it is imperative that on-site monitoring of climatic conditions be undertaken in order to accurately calculate the water allocation demands of the proposal, which may increase in the long-term.

Generally, it is anticipated that conditions at Mannum will become drier overall with less winter rainfall and more summer rainfall, the weather will become warmer. Heat stress related illness will increase unless buildings and outside recreation areas are designed to cope with higher temperatures.

Warmer and wetter conditions combined with the proximity of the river, adjacent lakes and wetlands will encourage the southward movement of insect and water borne diseases normally found further north in more tropical environments. Climate change will also have significant indirect health effects such as altered distribution of infectious diseases. An example would be the transmission of mosquito-borne diseases that are caused by pathogens being transmitted from human to human or animal to human via mosquitoes. The most common mosquito-borne disease in Australia is epidemic polyarthritis, which is caused by infection with either Ross River virus or Barmah Forest virus. It is believed that as the climate warms up, the tropical regions in Australia will spread south as will these disease vectors. Other mosquito-borne diseases that could increase as the temperature increases are malaria, dengue fever, Australian encephalitis, and Japanese encephalitis– (AMA Position Statement: Climate Change and Human Health – 2004).

It can be expected that communities along the Murray will have higher rates of infection of existing and new diseases as the climate warms and becomes wetter in summer and warmer in winter. This will have a flow on effect to the provision of medical facilities such as local hospitals. At this stage it is difficult to quantify the impacts in this area of South Australia.

Water quality within the marina and waterways would be maintained by a pumping system, which would need to operate for the majority of the time to achieve suitable flushing, especially during low flow conditions. The use of a traditional power source to run the pumps could significantly contribute to the greenhouse gas emission profile of the development. The EIS (Section 11.4.7) states that the standard reticulated power supply would be used, although alternative power sources would be investigated.

The proponent will need to consult with the Department of the Premier and Cabinet (Sustainability & Climate Change Division) for advice on measures that should be adopted to ensure the proposal meets the objectives of the *Tackling Climate Change: South Australia's Greenhouse Strategy 2007-2020.* In particular, emissions data (including negative emissions from sequestration activities) can be calculated using the National Greenhouse Gas Inventory, which is based on the *Australian Methodology for the Estimation of Greenhouse gas Emissions and Sinks (2004).*

In conclusion, this AR considers that the proponent has incorporated suitable measures to reduce the ecological and carbon footprint of the proposal. Greenhouse gas emissions would be minimised and absorbed by carbon sinks created through revegetation. Sustainability measures (especially related to water and energy efficiency) would be implemented through Design Guidelines, a House Owners Charter, a Marina Owners Charter and (if approved) future Development Plan policies.

6.7 EFFECTS ON COMMUNITIES

6.7.1 Impact on Existing Township

The main impact of the proposal on Mannum would be a substantial increase in population and the consequent demand for commercial and community services. The EIS (Section 11.4.1) states that current population of Mannum is slightly over 2100 people (1200 dwellings) and calculates that the permanent population of the proposed development would be less than 1000 people. Increased visitors (especially houseboat users and tourists) would also add to demand. Additional traffic and parking demand would be generated that could potentially affect local residents, including increased demand for ferry services. The provision of walking/ cycling trails connecting the development with the township would reduce vehicle movements. An expanded population base would lead to increased membership of local sporting clubs and community organisations.

The proposed development would incorporate linkages to the existing township by way of Belvedere Road and walking/cycling trails through to River Lane and via the commercial area to the interpretive centre and the wetlands. The proposed development, by way of its location, is not isolated from the township of Mannum and when viewed from the river or an aerial perspective, could be seen as a natural/logical extension of the existing urban boundary.

The establishment of a large marina facility could substantially increase boating movements along this stretch of the river, although Mannum currently has a high level of houseboat and recreational boating activity.

Mannum is currently undergoing a steady expansion due to several residential sub-divisions being established in and around the town. In addition, a new shopping complex would also be developed in the near future.

In conclusion, this AR considers that a substantial increase in the population of the Mannum would progressively occur and could be absorbed by the existing township. The proposal forms a logical

extension to the township boundary and would be linked to the town centre by walking/cycling paths.

6.7.2 Public and Private Health and Community Services

The EIS (Section 11.4.6) considers that the proposal would be developed progressively over 16 year period, which would not lead to a sudden increase in demand for essential services. Mannum is a relatively large regional centre and supports a wide range of health, educational and emergency services that would be able to accommodate increased demand from new residents. The proposal would comprise a mix of permanent and occasional residents, mainly retirees and holiday home owners. Thus, it would not have the same level of impact on existing services as a traditional residential sub-division.

There is unlikely to be an adverse impact of the provision of educational services or child care services, as the general target population for this development would be older retirees or holiday home owners. There may also be some impact on existing Non Government Organisations, such as domiciliary care or the district nursing service. It is likely there would be some increase in demand on these services. In terms of impact on existing businesses in Mannum, the effect of the population increase should benefit these enterprises.

The Response indicates that the Mannum District Hospital is a well equipped health unit offering a range of services for a catchment of approximately 5000-6000 people. Thus, it is inevitable that an increase in population resulting from the proposed development, even though staged, would have an incremental effect. Mannum is more likely to attract an aging population that has retired or is in the process of retirement, which would affect the type of services likely to be provided. The State Government would need to address these trends in the usual manner, through the budget process. The staging of the proposed development will allow the Hospital to take a measured approach in dealing with the impact on the community and health services in the town.

In conclusion, this AR considers that a substantial increase in demand for existing services and facilities in Mannum would progressively occur, with adequate lead times for planned expansion to cater for such demand.

6.7.3 Adjoining/Adjacent Land Use Impacts

The adjacent land uses are unlikely to be affected by the proposed development. The proposed extension to the Mannum Golf Course acts as a partial buffer to nearby residents, as does the proposed reserve near the Baseby Shacks. The linear placement of the residential component is not dissimilar to the existing layout of the outer edges of the township of Mannum. Belvedere Road is the only separation between the proposed residential development and the grazing land to the west. There is sufficient buffering with the wetlands to the grazing land to the south.

The DTED indicated a concern regarding the long-term impact of urban encroachment on existing agricultural operations adjacent the site and on the opposite side of the river. In particular, the lifestyle expectations of new residents may conflict with existing dairying activities nearby. The Response (pg 32) considers that only the neighbour on the southern boundary of the site (The Baseby Pastoral Company dairying operations) may be affected, which would be suitably buffered from the development. As a further safeguard, a clause would be added to the House Owners Charter requiring the new owner to acknowledge the rights of existing agricultural operations.

In conclusion, this AR considers that adjoining land uses would not be detrimentally affected by the proposal.

6.7.4 Affordable Housing

Whilst the EIS proposes a diversity of housing choices, it does not address the issue of housing affordability. The Department of Families and Communities (DFC) indicated a concern that an overall goal of the Planning Strategy for Regional SA is for affordable housing to meet community needs (ie. for people on low incomes, the disadvantaged or older people) has not been met. The State Housing Plan (2008) states that all 'significant new housing developments' should include 15% affordable housing. The DFC further advised that, for regional SA, the affordable housing price point (selling price) is $181,000, which could be for a house/land package or a land price that enables an affordable house/land package (or other arrangements).

The Response (pg 45) states that the proposal would contain a diverse mix of allotments and housing products to suit all segments of the market, including affordable housing. Further information provided by the proponent (Appendix 1) now states that the proposal would include suitable affordable housing opportunities, as negotiated to the satisfaction of the DFC. A layout plan showing the potential location of affordable housing sites integrated into the residential land division has been provided (refer to Figure 4). A Land Management Agreement would need to be executed, as a reserved matter in any approval, to implement the proponent's commitment.

In conclusion, this AR considers that the proponent has provided suitable opportunities and commitments for affordable housing within the residential component of the proposal.

6.7.5 Recreation and Tourism

Recreation has the possibility of many forms within the proposed development. Most recreational activities would be an extension of those currently existing in Mannum. Controlled access tracks such as walking tracks and cycle tracks would be provided through some of the subject site. SA Tourism has requested that the northern walking trail be amended. The houseboat tourism experience will benefit from an improved scenic amenity with the berthing of houseboats within a marina and not along the river banks. Improved boating facilities will assist boating tourism. The marina and surrounding waterways would cater for boating (from small craft to the larger vessels as in houseboats), fishing and water sports. The proposed development includes sufficient public open space which amounts to approximately over 50 percent of the site. The majority of open space is made up of wetlands and revegetated areas (40 hectares of constructed wetlands are proposed to extend natural habitats). The local golf course stands to benefit from the proposed development once the extension of land is negotiated from the subject site to an upgrade of a 9 hole course to an 18 hole course.

The commercial provision allocated for the proposed development is not a substantial part of the development as the overall proposal is predominantly residential and recreational based. Tourism would evolve from the extension of the proposed activities and would add to the vibrancy and visitor appeal of Mannum and further enhance existing tourism in the area.

In conclusion, this AR considers that the proposal would substantially increase recreational and tourism opportunities for Mannum and the region.

6.7.6 Aboriginal Heritage and Native Title

The EIS (Section 2.6) has identified Aboriginal cultural heritage areas on-site, in consultation with the Mannum Aboriginal Community Association Incorporated (MACAI), that would be preserved. The EIS (Section 10) further details the archaeological sites identified, which comprise shell middens and scarred trees. Preservation techniques would be finalised in agreement with the MACAI.

The EIS (Appendix H) included an Aboriginal Heritage survey that identified all sites of significance, which would be protected within open space reserves. The Department of Premier & Cabinet (Aboriginal

Affairs and Reconciliation) has advised that the EIS satisfactorily addresses all issues related to Aboriginal heritage. The DEH has advised that Native Title has been extinguished for all Crown land associated with the proposal.

The Department of Health (Aboriginal Health Division) has advised that Aboriginal people need to maintain their relationships with the land and that the proposed signage and the interpretive centre are important to their spiritual links. Consultation is recommended to be conducted separately through local community meetings across the Murray Bridge to Swan Reach area. The Department of Health also acknowledges that Aboriginal people may benefit from the development, through employment, additional services and further recognition of their heritage. The EIS indicates that consultancy advice from members of Mannum Aboriginal Community Association Incorporated (MACAI) will be part of the process during the design, construction and operational stages. The EIS indicates that consultation regarding Aboriginal Heritage matters has been comprehensive so far.

A good working relationship has been developed between the proponent and the MACAI to involve local Aboriginal people in the protection of significant sites, monitoring during construction and employment and commercial opportunities. In particular, Aboriginal people would have an on-going involvement with the proposed interpretation center and the preparation of interpretive material.

In conclusion, this AR considers that the proponent has undertaken suitable consultation with the Aboriginal community to ensure that sites of Aboriginal significance would be adequately protected and that Aboriginal culture would be promoted.

6.7.7 Noise

The EIS (Section 11.4.5 and Appendix L) includes a preliminary environmental noise assessment that was conducted by the proponent to obtain qualitative information on existing noise levels and potential impacts of the proposed commercial activities on the residential component of the proposed development. The assessment indicates that the potential noise sources that are considered to have the greatest potential to cause annoyance to residences within the development are traffic on the proposed roads, equipment at the wastewater treatment plant, on board houseboat equipment such as pumps and generators and noise generated by the proposed commercial activities.

The new wastewater plant will be a larger facility and the predictions for noise have been based upon a continuous, simultaneous operation of equipment (ie. induction motors, aerators and air conditioning condensers). The noise levels associated with the equipment at a distance 1 metre away ranged from 60 dB(A) to 86 dB(A). At a distance 500 metres away the noise level was measured at 35dB(A), which is below the recommendation of the World Health Organisation (WHO), with the recommendation being 45dB (A) to protect against sleep disturbance. The wastewater treatment plant is to be located approximately 500 metres away from the nearest residence therefore the noise levels associated with the plant are satisfactory.

The EPA indicated a concern that the noise modelling was based on the new plant being located 300m from the nearest residence, not the 500m used for the modelling. The Response (pg 64) states that the location of the plant is still to be determined, although the modelling indicates that noise levels would be well within the relevant guidelines even within a 300m separation distance. Once the final site has been chose, further noise (and odour) modelling would be undertaken to confirm its suitability.

The EIS indicates that traffic noise levels associated with roads is expected to be well below the “desirable ranges” of the most recent Road Traffic Noise Guidelines.

Houseboat noise as stated previously is generally caused by pumps and generators. It is also understood that the houseboats will be moored at distances of approximately 100 metres from the nearest residence and as such the noise from on board pumps is unlikely to cause annoyance. However the EIS indicates

that by providing mains power to the houseboats moored within the marina and ensuring that generators are not used, are further avenues for minimising noise potential.

In regard to commercial properties, the noise factor is dependent on the nature of the activities, operating hours, scale, size and construction of the building, the type of mechanical service equipment and any barriers between the different land uses. However each commercial activity could be designed to meet relevant noise criteria when measured at the closest residence.

The EIS concludes that noise levels associated with the above sources will be well below desirable limits or controlled by appropriate design procedures.

It is suggested that the noise requirements in the EPA *Handbook for Pollution Avoidance on Commercial and Residential Building Sites 2004* be referred to when finalising the management and monitoring documentation. This Handbook indicates that construction noise levels in residential areas should not exceed 45dB(A) outside of standard construction hours and in particular that noisy activities should not occur before 9 a.m. Additional noise control measures, which should be included by the proponent, are outlined in the EPA's Handbook and include:

- Appropriate siting of noisy machinery and the use of proprietary sound reduction measures (e.g. mufflers for relevant equipment for which proprietary treatment is available)
- Regular servicing and maintenance of plant and equipment, particularly for mufflers and other noise control devices
- Provision of a noise monitoring program during construction, and
- Provisions to notify the adjacent community of proposed start and finish times for construction activities, including any activities which may have a potentially greater noise impact.

In terms of operational noise the following activities are applicable:

- Earthworks and the transport of construction materials
- Building construction
- Loading, unloading, fuelling and maintenance of commercial and recreational houseboats
- Launching and retrieval of speedboats at the boat ramp
- Boating movements from the marina and private moorings
- Boat construction and maintenance, including operation of the slip-way
- Transport from commercial activities
- Entertainment activities
- Service infrastructure, including water circulation pumps

There is potential for conflict to arise between noise sensitive uses (residences) and marina operations (recreational and commercial boating activities). It is considered that all residential development should be sited, designed and constructed so that WHO guideline values for community noise are attained, to ensure no “critical health effects”.

In addition, the site should be managed in accordance with EPA policies/guidelines (particularly the *Environment Protection (Noise) Policy 2007*), Australian Standard *AS 2436, Guide to Noise Control on Construction, Maintenance and Demolition Sites* and the proposed Construction Environmental Management and Monitoring Plan. The proposed development should also comply with WHO recommended noise limits for sleep disturbance within the bedrooms of dwellings when exposed to noise from operations within the marina. This is expected to result in specific design of either the façade of the bedrooms or the locations of the bedrooms relative to the noise sources to ensure EPA guidelines are met and an Lmax of 60dB(A) is not exceeded. In terms of day time operations the development should include an outdoor area that is protected from major noise sources such that day time noise levels should not exceed an Leq of 50 dB(A). This will need to be balanced in terms of the objectives of future residents, in that they are seeking to be involved in the whole precinct, where future residents would be interested in the overall 'charm' of viewing the marina operations and being able to see what is happening. Noise control requirements for residential buildings would need to be considered by Council when assessing applications for dwellings in the future (if the proposal is approved).

In conclusion, this AR considers that the potential noise impacts during construction and operation of the proposal are able to be adequately managed. The proponent would be required to prepare noise monitoring and management protocols for incorporation in relevant construction and operational management plans that are consistent with EPA requirements.

6.7.8 Air Quality

The proposal does not include any activities that would result in a significant source of emissions that would detrimentally affect air quality. The generation of dust during the construction stage would be the most significant air emission. Air emissions from vehicles and houseboats would not pose a concern. The constructed anabranch/wetland system and stormwater retention ponds could pose a risk to the amenity of residents if not suitably managed. The WWTP and use of reclaimed water for irrigation could also potentially pose an odour risk. Air emissions from the boat repair/maintenance area would need to be managed by confining such activities within a controlled environment building. In addition, existing surrounding agricultural activities (especially dairying) may affect the air quality.

The EIS did not include odour source modelling of potential impacts on air quality, nor did it provide any baseline information of existing odours in the local environs. The EPA indicated a concern that the impact of odours generated by the new WWTP on the amenity of residents was not modelled in the EIS. This is not considered to be a major omission, given the low risk and the types of emissions would be easily manageable. The selected waste water treatment plant uses an aerobic treatment system that would be effective in controlling odour generation. While odours are expected to be negligible, it is still important that the proponent monitors potential odorous emissions associated with the treatment, reuse and storage of any wastewater. The Response (pg 64) states that the location of the new WWTP is still to be determined, but once the final site has been chosen, odour modelling would be undertaken to confirm its suitability.

It is considered that the proponent should refer to the EPA *Guidelines on Odour Assessment, Using Odour Source Modelling (2003)*, which also outlines 'best practice odour management', when addressing this issue in the Construction and Operational EMMP's.

Dust Emissions

The potential for dust emissions arise mainly during the construction phase and can be generated from excavation and formation of finished allotment levels (residential and commercial), the transport of soil to and from stockpile areas and from the site access roads and haul roads. The development of the constructed anabranch/wetland system would also involve extensive earthworks that would generate dust.

The Response (Section 5.1) states that SA Water supplied mains water would be used for dust control and soil compaction for roads and allotments. Groundwater may be used for construction of the marina basin

and waterways (and possibly for assistance with compaction). The temporary use of groundwater (from bores or excavations into the watertable) or surface water collected in excavations is likely to require a water licence. The proponent anticipates that the quantities required during construction would be very small.

The EIS (Section 11.2.6) identifies dust generation as a major potential impact, but fortunately the site is mostly separated from the existing township by distance and topography. Vegetation along the river bank would offer some protection from wind blown dust entering the river. Dust emissions would still need to be controlled, with suitable protocols developed as part of the CEMMP. The CEMMP would include management measures such as:

- Control of traffic movement
- Controlled application of water for dust suppression
- Establishment of silt fences to prevent the transportation of sediment off-site
- Provision of separation between the existing settlement and the proposed development area as far as practicable to minimise the potential for dust impacts
- Staging to reduce the overall impact and to minimise interaction between stages

In conclusion, this AR considers that the potential air emission impacts during construction and operation of the proposal are able to be adequately managed. The proponent would be required to prepare monitoring and management protocols for incorporation in relevant construction and operational management plans that are consistent with EPA requirements.

6.8 AMENITY

6.8.1 Local Amenity

The EIS (Section 11.4.12) outlines the potential changes that the proposed development will bring to the site and immediate locality. These changes are a vast improvement considering the current state of the site. The changes are to remove the wastewater treatment lagoons and overflow from the flood plains and to introduce a marina and residential sub-division. By containing the marina and creating additional waterways plus the construction of wetlands and further revegetation to the existing riverine environment, the intention of the proposed development is to provide a more attractive visual amenity.

6.8.2 Residential Character and Lifestyle

The EIS (Section 11.4.12) indicates the proposed development will build on the lifestyles that Mannum currently offers, by its very nature of being a quiet country town with opportunities to work in local industries, retire or holiday there. The proposal aims to have a cohesive residential style and character through the provisions of the House Owner's Charter, supplemented by Design Guidelines. The Charter is quite prescriptive therefore uniformity in the design of any proposed dwelling could reasonably be achieved. The EIS indicates that the proponent would have more control over the design aspects through the provision of 'house and land packages'. The EIS states that care is to be taken with the residential waterfront interface.

The proposal would encourage a diverse range of housing types, with each residential allotment to accommodate a single dwelling. The EIS (Section 2.2) states that waterfront and standard residential allotments would have building areas of at least 400m^2, whilst waterfront villa allotments would have a smaller area of at least 240m^2. The northern villa waterfront allotments would be for higher density style living on courtyard size blocks, comprising two story dwellings in groups of 3-5 separated by reserves.

The southern villa waterfront allotments would comprise larger allotments for single or two storey dwellings. The larger allotments would enable the benefits of solar orientation of dwellings to be maximized. A two storey height limit would apply to all detached dwellings.

The EIS (Section 2.2.2 and Figures 2.11 – 2.16) provides preliminary dwelling designs to demonstrate the style of housing envisaged for the site.

Design guidelines would need to be prepared for houseboats, houseboat moorings and private moorings to ensure consistency in design/construction quality to ensure a suitable level of amenity and environmental protection, especially the establishment of outdoor living areas associated with houseboat moorings for permanent residents.

6.8.3 Visual Impacts

The EIS (Section 11.4.12) provides a description of the existing visual amenity of the site and artists' impressions to depict what the completed development could look like when viewed from the river and the existing township.

When viewed from the river there is adequate existing and proposed vegetation to screen the proposed development. However, there would be a view of the proposed development at the entry point from the river into the marina. The impact from this would be minimal and in general the river views would not be compromised. It is likely that the view from River Lane to the proposed development would be obscured by the extension of the Golf Course, if that was to occur. The full impact of the proposed development would occur from Belvedere Road itself and to this extent appropriate 'dry' landscaping should be encouraged within the individual allotments addressing the road frontages.

In conclusion, this AR considers that the visual appearance of the development would be an improvement on the current viewscape. The development would be screened by existing vegetation and supplemented by proposed revegetation. The removal of houseboats from the river bank would enhance the natural views. The views of the marina from the entrance channel would be consistent with the river bank along the southern end of the Mannum township. A high level of amenity would be provided for residents and visitors.

6.9 ECONOMIC ISSUES

Economic Effects

The EIS (Section 11.4.4) states that the establishment of a residential marina has potential for significant economic benefits, in terms of increased employment and investment associated with the construction and operation of the proposed development.

It would appear that the full economic benefit would largely be contingent upon the demand for residential allotments and houseboat moorings. The EIS indicates that there is a need for this type of proposed development adjacent the River Murray.

The EIS indicates the current population of Mannum at 2,100 (although 2006 Census data recorded a population of 2,000), with an increase of 45 percent proposed at the completion of this development (ie. an approximate increase in population of 900 persons). Economic opportunities would be provided through retail and commercial services (ie. for the boating fraternity, tourists and local residents), the EIS (Appendix J) estimates an ongoing economic benefit of $6.3 million in value associated with increased regional retail expenditure. This equates to approximately 77 full time employment jobs that would be created. The residential development would also generate demand for local goods and services. It is considered that the flow-on (or multiplier) effect of the proposal would be greater than the economic opportunities generated on-site.

The EIS states that the local economy of Mannum is dependent on vacation growth and tourism. The EIS (Section 11.4.4) used an input-output model to estimate the potential economic effects of the proposed development. The value-added and employment opportunities associated with the proposal were other factors used to measure potential investment income. This is further broken down into direct and indirect impact and the rate of inflation/deflation at the time plus any structural changes.

Tourist Activity and Investment

The EIS indicates that the marina would generate tourist activity and investment, short term accommodation and holiday rental opportunities. The marina would also provide much needed off-river houseboat moorings close to the existing township of Mannum. Off river moorings are considered to be a better environmental and more sustainable outcome for the houseboat industry, as well as an economic stimulus. Fully serviced moorings would be provided for 156 houseboats, six as overnight stay, and the others a mixture of permanent living and long term berths.

The region would also benefit from new tourist related services and accommodation. There is the possibility of extending the existing 9 hole golf course, upgrading it to a higher standard facility which would encourage further investment from long term and short term memberships and would also create a further attraction to the area. However, a high priority for the region and the township of Mannum is the establishment of convention facilities, which was not initially part of the proposal. Additional information provided by the proponent (refer to Appendix 1) indicates that a conference facility, together with tourist accommodation, has now been added to the proposal.

The South Australian Tourism Commission indicated a concern that, whilst the proposed development is supported for its economic and tourism value, there appears to be limited opportunity for substantial tourist accommodation within the Commercial Zone (ie. only 1,500 metres of floor space). Additional information provided by the proponent (refer to Appendix 1) indicates that the commercial area has now been expanded to include tourist accommodation.

Employment Opportunities

The EIS (Section 11.4.4) outlines the number of construction workers that are likely to be required and employment in general associated with the project. Employment is expected to peak around the year 2010 when taken over a 16 year period. The EIS indicates the opportunities for employment at the construction and post construction stages, via increased demand for local goods and services, the hiring of houseboats, a tavern/restaurant, café, interpretive centre, tourist accommodation and amenities.

During the construction stage, employment opportunities would be generated during the first five years of major construction works. The main construction areas involve site works, marina development, and infrastructure provision and road construction. The value added amount over 16 years would generate approximately $116 million to the local economy, which can mainly be attributed to the construction of the residential component.

During the operational stage there would be on-going employment associated with marina management and the commercial operations of retail, hospitality and tourism.

The proponent has also indicated a desire to encourage indigenous employment within the local workforce, wherever possible.

Costs of Infrastructure to Government

The provision of a new upgraded/expanded waste water treatment plant provided by the proponent would minimise costs to the State Government. Where trunk services need to be upgraded, cost sharing arrangements would need to be negotiated with SA Water. The costs of internal water and power reticulation would be borne by the proponent. The EIS also indicates that the increase in traffic on the Adelaide-Mannum Road will be relatively low and would not impact on existing road infrastructure budgets.

Long Term Costs and Benefits to Council

The EIS outlines that the long term costs to the Mid Murray Council would be sustained by normal rate revenue streams, with the initial costs of roads, stormwater and other services borne by the proponent. The increase in the amount of residents would mean additional road traffic which would incur minor works to modify existing road networks where necessary, with solutions to be explored by the Mid Murray Council.

There would be no external stormwater management costs to Council. The marina would remain as a private operation. The low maintenance landscaping proposed is reasonable, as Council would inherit the public open space and would not need cost prohibitive maintenance. Reclaimed water from the wastewater plant would provide irrigation water for the Golf Course and other reserve areas within the development. Negotiations with the Council, the Mannum Golf Course and the proponent could result in the upgrade of the Golf Course to a higher standard facility which would attract further long term and short term users.

Development of Financial Strategies

The proponent has the capacity to provide the necessary funds to develop the various stages to be undertaken within the project, which includes infrastructure associated with the residential component, the marina berths, waterways, edge treatments, marina entrance, construction of wetlands, embankments and revegetation. The proponent has indicated that it is more economically sustainable to stage the development.

Waterways Maintenance Fund

The EIS states that 50% of monies raised from ratable berths and waterfront jetty levies would be allocated to a special purpose fund that provides for the long term maintenance of the marina waterways and edge treatments. The nature of the fund would be such that it is set up to increase in value over a number of years so as the adequacy can be maintained. The funds would be held by Council, as the body responsible for maintenance works.

In conclusion, this AR considers that the economic benefit estimates presented in the EIS are quite broad, but nevertheless appear reasonable. The proposal would result in substantial economic benefits for Mannum and the surrounding region, especially due to the long-term demand for services and facilities to meet demand from the residential component. Sufficient safe guards have been proposed to ensure that Council and rate payers are not exposed to undue financial risks.

6.10 ROADS, TRAFFIC AND PARKING

The EIS (Section 11.4.6 and Appendix K) considers that traffic generation would be less than that generated by a standard residential area and is estimated at around three to four trips per dwelling per day. 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 the development. Of these trips, approximately 75% are expected to use the main entrance and 25% the secondary access road

Preliminary recommendations have been made in the EIS (Appendix K) for road design components and parking that would be adopted for the proposal. Further recommendations would be provided during final design of the road network, which would be undertaken in accordance with accepted practice.

The Department of Transport, Energy and Infrastructure (DTEI) indicated a concern regarding the impact of traffic on the operations of junctions and intersections where the development site access roads meet arterial roads. Appropriate turning treatments would be required to minimise safety and efficiency impacts through all phases of the development. The Response (pg 77) states that this issue would be resolved to the satisfaction of DTEI.

The main access to the site is via the existing Belvedere Road. Currently this road is sealed from the north to the waste depot area, but thereafter it is unsealed. The EIS indicates that the sealing of Belvedere Road would only extend to the secondary access point of the development. Public submissions expressed concern that many home owners and tourists would access the site from the south, via the Mannum – Murray Bridge Road. This part of Belvedere Road would also be used to access services located in Murray Bridge. Additional information provided by the proponent (Appendix 1) states that discussions between the DTEI, Council and the proponent have resulted in an agreement to seal the full length of Belvedere Road. This upgrade would be undertaken to the standards of DTEI and the Mid Murray Council.

All internal roads would be subject to standard road design practices according to normal Council requirements. The road network would include a comprehensive underground stormwater drainage system for the residential and commercial areas to aid the return of water as quickly and cleanly as possible to the waterways. According to the plan the residential areas will comprise a number of small catchment areas with drainage in these areas being designed on a 10 year return frequency storm. The roads and reserves would be capable of carrying flows from 100 year return frequency. It is very important that WSUD principles and measures are considered when implementing the design plan.

While road reserve widths of 15 metres and 7.2 metre pavements on internal roads would permit drivers to park along the kerbs of these roads, it would be expected that residents generally park on allotments or other provided spaces. The proponent has allowed for the following anticipated needs for public car parking:

- Commercial area – 50 spaces
- Adjacent to casual houseboat area – 20 spaces
- Off the marina road at southern end – 50 spaces (secure long-term)
- At cul-de-sac at the end of the marina road – 20 spaces
- Marina berths – 2 spaces per berth on grassed verge
- Boat ramp – 20 trailer spaces

While roads shown on the conceptual layout plan are subject to more detailed design, they are considered by the proponent to provide a fair representation of the final development.

Further complementary planning policy related to car parking provision should be dealt with as part of the Development Plan Amendment (DPA) process to be instigated by the Mid Murray Council.

In conclusion, this AR considers that the potential effect of increased traffic on the local road network has been adequately addressed. In particular, the main access road, Belvedere Road, would be sealed along it's entire length.

6.11 EFFECTS ON INFRASTRUCTURE

6.11.1 Utilities

The EIS (Sections 2.7 & 11.4.6) states that provision of the usual underground potable water supply, electricity supply, sewer and telecommunication services would be installed in accordance with the relevant standards and requirements of the service providers. Augmentation of the electricity supply would occur in stages in response to demand. Adjoining users would be connected to the new services at the southern end of the site. The main infrastructure impact would be the removal of the existing Mannum WWTP from the floodplain and its replacement with an expanded and upgraded plant on the high ground. This is discussed further in Section 6.12.

SA Water advised that the location and construction of the new water supply rising main must minimise the impact on the environment and the community (including Aboriginal Heritage site and Native Title implications). This aspect would be addressed in the Construction EMMP.

The community may be affected by temporary disruptions to power and water supply when new infrastructure is connected to main supplies.

6.11.2 Recreational and Commercial Boating Facilities

The proposal would provide a range of facilities and services for the commercial houseboat hire industry and for the recreational boating fraternity. In particular an off-river marina would be provided for the mooring of boats in a safe and convenient manner. Connections to the vacuum sewer system would be provided at each mooring for the disposal of both effluent and greywater. Sewer connections would also be provided at temporary berths for use by visiting houseboats, which would complement the existing pump-out station at Mannum (and provide additional capacity during peak use periods). The boat lift and boat repair facilities would enable boats to be inspected and maintained on a regular basis to ensure they comply with EPA standards and do not pose a pollutant risk.

The marina basin and entrance channel would be excavated to provide a depth of 2.55 metres at normal pool level (which is 0.75m AHD). However, under the current river level (0.25m AHD), the water depth would be 2.0 metres. Unfavourable wind conditions could potentially reduce this depth by another 0.50 to 1.0 metres. The proponent would need to ensure that a suitable depth is provided during extremely low river level conditions to enable safe and convenient navigation.

For houseboat owners wanting to permanently live on board, essential services would be provided. A sense of community would also be expected to develop over time, which would provide social benefits for marina ‘residents’ and improve safety due to surveillance. In addition, a shower, toilet and laundry amenity building would be provided that would reduce the need to use on-board facilities. Permanent storage areas may need to be provided as an additional service for permanent residents. Controls would need to be put in place for the establishment of lawns, gardens, landscaping, sun shades and entertainment areas (ie patios) in front of permanent houseboat moorings to protect amenity. Permanent structures that could pose a risk during flooding should be prohibited.

In conclusion, this AR considers that existing service infrastructure could be suitably upgraded and/or expanded to meet demand from the proposed development. In particular, improved infrastructure for houseboats would be provided, especially for the disposal of effluent and greywater.

6.12 WASTE AND EFFLUENT MANAGEMENT

6.12.1 Waste Management

The EIS (Section 12.3.5) states that the following waste management procedures would be adopted for recreational and commercial vessels and other general solid waste from domestic premises:

- Solid waste receptacles with self-closing lids will be located within the commercial wharf, public boat ramp and public wharf with ample facilities provided. These measures should minimise the potential for vermin to access the waste, rainfall infiltration and odours to be generated. Users will be encouraged to segregate waste types to enable recycling. The waste will be collected for disposal by the current Council service.

- It is proposed that general solid waste from the residential area and commercial precinct will be collected by the current waste management program run by the Mid Murray Council. The Council landfill is set to be closed in 2010.

While general waste issues are addressed by the proponent from a sustainability aspect, there is not a comprehensive plan in place for ongoing waste management. Waste reduction and recycling should be addressed in detail, as the proposed development presents an opportunity for the commencement of either a Council wide or regional recycling service. It is suggested that both Council and the proponent consider the issue of long term sustainability in regards to waste management.

6.12.2 Effluent Management

The EIS (Section 2.7.3) proposes to construct a new Waste Water Treatment Plan (WWTP) that would be designed to not only treat the sewage and wastewater from the marina, residential and commercial areas of the proposed development, but also sewage from the township of Mannum. The existing WWTP would be removed from the floodplain, with the land remediated for residential use. The new WWTP would have a substantially increased capacity and improved treatment processes. The existing WWTP would only be decommissioned once the new WWTP becomes operational. New rising mains and pumping stations would also be installed to connect the town's gravity drain network to the new WWTP.

The proposed sewer system would comprise two components:

- vacuum sewer system for the marina, temporary moorings and the commercial area

- standard gravity drain collection system for the residential component

The EIS anticipates that gravity drains would be possible for all residential roads, which would be approximately 4.3 metres above mean water level for all roads adjacent waterways. However, if final designs indicate this is not appropriate, the vacuum system would be extended along lower roads. It considered that the vacuum sewer system should be extended to service all waterfront allotments to further minimise the pollutant risk, as a best practice measure for safeguarding the River Murray (if approval is granted). Telemetry systems and alarm diallers would alert operators of any leaks or breakdowns. There would be a 30 metre buffer between pumping stations and waterways. Pumping stations would be located at various locations within the residential sub-division and would be positioned in reserves that would also be used for stormwater management. Stormwater retention ponds would be used as emergency storages if the stations fail. Pumping stations would have emergency back-up generators and stand-by pumps. The proponent would need to ensure that such emergency arrangements do not pose a risk to public health, amenity or the environment.

The EIS (Section 2.1.5) states that the site of the new WWTP would be away from the proposed development and located in the vicinity of the golf course. The Response (pgs 65 – 69) states that on-going negotiations with SA Water are proceeding satisfactorily to determine the best location for the new

WWTP. A Memorandum of Understanding, setting out the principles of negotiation, has been entered into with SA Water.

SA Water has provided a list of requirements that must be met, including

- site located above the 1956 flood level or at least 100 metres from the River Murray
- a 300 metre buffer to adjoining sensitive land uses
- no impact on visual amenity
- minimal impact on the community (especially noise and odours), the environment and cultural heritage (including all ancillary works)
- sufficient winter storage of treated water to cater for a wet year
- SA Water land ownership of the site and buffer

Treated reclaimed water would be to Class B quality standard for reuse via irrigation of the Mannum Golf Course and other recreational/amenity areas. The EIS (section 11.4.7) indicates that some reclaimed water could be treated to Class A quality standard and be used for toilet flushing and garden watering, if there is excess water available that could not be used on the golf course. It is considered that this option should be further investigated for use by residential allotments close to the golf course or allotments separately developed on golf course land in the future, as a way to reduce demand on River Murray sourced mains supply. An Irrigation Management Plan would be prepared to address the requirements of the *South Australian Reclaimed Water Guidelines* (EPA/Department of Health, 2002). An Environmental Management Plan for Wastewater would be prepared, in accordance with the requirements of State Government agencies, to address issues related to contamination, odour, noise, dust, litter, security, fire risk, spill contingencies and landscaping. These plans would need to be incorporated into the Construction and Operational EMMP's where relevant.

The relocation of the WWTP would remove a potential pollutant risk from the floodplain and the River Murray. The use of a vacuum sewer system on the floodplain to service the marina and waterfront allotments would substantially minimise the risk of a spill as the pipes are subject to negative pressure. Thus, any leaks would either lose pressure or draw water into the system, rather than resulting in a leak out of the system into the surrounding environment. Any break in the system would be identified by a change in pressure or an increase in volume and corrective measures could quickly be implemented. The use of reclaimed water to irrigate the golf course and reserves would reduce the need for River Murray water, which would be an environmental benefit.

Approval of the WWTP would be the subject of a separate application (ie. as it is to be located on land not within the declared area) to the Development Assessment Commission, including a mandatory referral to the DWLBC. Additional approvals would be required from the EPA and the Department of Health. The SA MDB NRM Board would also need to be consulted on the final proposal.

In conclusion, this AR considers that waste and effluent collection and disposal would be appropriately managed. In particular, the relocation of the existing Mannum WWTP would not only provide improved effluent treatment and disposal, but would remove a potential pollutant risk from the floodplain.

6.13 CONSTRUCTION AND OPERATIONAL EFFECTS

The development of a multi-component residential marina is expected to take up to 16 years to complete. Initial construction works comprise extensive earthworks and the installation of services and other

infrastructure related to the marina and the residential land division (including the constructed anabranch/wetland system). The existing Mannum WWTP infrastructure would also need to be removed and the land remediated. The building of dwellings and commercial buildings would progressively occur over the life of the proposal, based on demand and the staged release of land. The impacts of the initial construction stage would be largely restricted to the site. Once the land division is complete, the impact on new residents would increase as building activity increases. During the operation of the development, impacts associated with the activities of boat owners and residents would need to be managed to protect the river environment and amenity. In addition, demand for infrastructure and services in Mannum and the region would progressively increase over time as the residential population increases. Road traffic would also increase over time.

The EIS (Section 11.2.6) describes the anticipated construction effects that would need to be managed by a Construction Environmental Management Plan. The operational effects of the proposal are not specifically addressed in the EIS in the same manner as construction effects, with long-term impacts generally discussed throughout the document (primarily the section on potential impacts and mitigation measures). The EIS (Section 12.3) provides a description of aspects that would need to be addressed in an Operational Environmental Management & Monitoring Plan, especially to protect the environment and water quality.

6.13.1 Construction Phase

Construction of the marina and waterways requires excavation of flood plain materials and their use for the formation of allotments, levee banks and the constructed anabranch/wetland system. In general, soil or groundwater contamination is unlikely to pose a problem during construction, although remediation of the existing WWTP site would require specific management (ie. in accordance with EPA protocols). The marina and associated waterways would be excavated to RL -1.8 m (ie. a water depth of 2.55 metres at pool level). The banks of the waterways would be protected from erosion by rock armour and suitable plantings. The banks of the marina berths would be sheet pile. The soils are expected to be suitable for excavation using temporary haul roads, with conventional earthmoving equipment such as tracked excavators and scrapers.

Construction activities producing dust, would be controlled by normal standards for the civil engineering construction industry and the protocols of the Mid Murray Council. The CEMP outlined in the EIS (Section 12) identifies the protocols that would be adopted by the earthworks contractors. A Soil Erosion & Drainage Management Plan (SEDMP) would be incorporated into the CEMP. The EIS (Section 12) provides an adequate outline of the CEMP, including environmental procedures to mitigate any harmful environmental effects during the construction phase.

Dredging Works and Re-Use of Material

The EIS (Section 12.2.5) states that dredging would be required to construct the entrance channel. Various strategies would be used to minimise turbidity, including timing, use of a cutter suction dredge and the use of shrouds. Dredged material would consist of clays, sands and silts, with loose sand expected below a depth of 1.4m (although preliminary testing could not confirm this). Given the small amount of sediment to be excavated and short dredging duration, turbidity problems should not arise. The use of a cutter suction dredge and silt curtains should be employed as a best practice for minimising the effects of dredging. The disposal of dredged material would need to be addressed in the CEMMP.

EPA licensing requirements would control the impacts of dredging and spoil use or disposal.

6.13.2 Operational Phase

During the operation of the marina, residential, commercial and tourism related aspects of the development, activities need to be comprehensively managed over the long-term. In addition the amenity of the development needs to be maintained to a high standard. The Operational EMMP would be the

mechanism for addressing these matters. The EMMP would be supported by the Marina and House Owners Charters, Design Guidelines, Council by-laws and future Development Plan policies.

6.13.3 Management of Pollution Sources

Recreational & Commercial Boating

Potential pollution sources from houseboats, large vessels and small craft could include:

- blackwater (ie. sewage)
- greywater (ie. from showers and sinks)
- petrol and oil leaks from boats sitting in the water or on the slip-way or maintenance areas
- bilge water (ie. from engine bays)
- leaching of anti-foulants into the water column
- maintenance and repairs, especially hull cleaning
- spills from refuelling
- waste oil
- hard refuse and litter
- chemicals from spas (ie. salts, chlorine, cleaning products and soaps)

Associated car and trailer parking areas can also be sources of pollutants that would need to be managed.

It is suggested that all waste sources should be managed in accordance with the EPA *Code of Practice for Vessel and Facility Management: Marine & Inland Waters (2007)* and the *Code of Practice for Materials Handling on Wharves* (2007).The proposed sewage pump-out facility would need to meet the *Best Practice Guidelines for Waste Reception Facilities at Ports, Marinas and Boat Harbours in Australian and New Zealand (*ANZECC,1997).

It is further suggested that a Pollutant and Waste Source Management Plan be prepared, as part of the Operational Environmental Management and Monitoring Plan (OEMMP), and be implemented for the whole of the development to guide ongoing construction and operation.

Boat Ramp, Boat Lift and Boat Maintenance Facilities

The Response (Section 4) now proposes to include a boat maintenance area, comprising a boat lift and a controlled environment boat maintenance building. The facility would be located in the commercial zone, next to the boat ramp facility. Boat hardstand and wash-down areas are also expected to be integrated with these facilities.

These facilities should be designed and managed in accordance with the EPA draft *Code of Practice for Vessel and Facility Management: Marine and Inland Waters (2007).* In addition, the long-term management of pollutants should be in accordance with the following EPA guidelines (where relevant):

- *Stormwater Management for Washbays*
- *Disposal of Used Hydrocarbon Absorbent Materials (2004)*
- *Disposal of Soaps and Detergents*
- *Abrasive Blasting (2003) and Pressure Water Blasting Activities (2003)*

Such facilities should include cut off drains and collection systems for run-off, with contaminated water discharged to the vacuum sewer system (ie. in accordance with the Code of Practice), the details of which should be incorporated into a Stormwater Monitoring and Management Plan. Boat maintenance, repairs

and building works should occur in workshops or purpose built facilities. that should be managed in accordance with relevant codes of practice. Bunded areas must conform to EPA *Guideline: Bunding and Spill Management* (2007). Wastewater and residues from hull cleaning activities and oil and fuel residues should be diverted and collected in dedicated systems in accordance with EPA requirements, for off-site disposal by licensed contractors.

Should a development approval for the proposal be granted by the Governor, it would not apply to buildings related to the marina (ie boating related businesses) and semi-industrial, commercial or retail uses. Accordingly, mechanisms would need to be put in place to ensure the ongoing development of the various components of the proposal is established in accordance with the above codes and guidelines. Appropriate complementary Development Plan policies would need to be put in place through a Development Plan Amendment process (if the proposal is approved). The proposal should also comply with the EPA *Code of Practice for Industrial, Retail & Stormwater Management.*

Stormwater and Run-off

The proponent would need to ensure that protocols are in place for the consistent application of stormwater management principles and measures in the long-term, especially when Council becomes responsible for the development or for components constructed by other parties.

The long-term management of stormwater should be in accordance with the EPA *Stormwater Pollution Prevention Codes of Practice* for the:

- *Building & Construction Industry (1998)*
- *Community (1997)*
- *General Industry, Retail & Commercial Premises*
- *Local, State & Federal Government Agencies (ie. for Council activities)*

The design, construction, management and monitoring of stormwater measures should be detailed in a Stormwater Management Plan.

6.13.4 Feral, Nuisance and Domestic Animals

Apart from the issue of existing feral animals, primarily foxes, cats and rabbits; there exists the issue of roaming domestic pets.

Unrestrained cats and dogs could negatively impact upon native mammals, birds and reptiles within their range around the residential marina development. However, these risks are likely to be lower than for a standard sub-division, as a substantial proportion of home owners are unlikely to be permanent residents.

A combination of utilising the existing legislation within the *Cat and Dog Management Act 1995*, an education campaign encouraging the containment of cats in enclosures, dogs being restricted to leads when outside properties and an extensive and frequent poisoning programme outside the development and within the riverine and wetland areas, should control the impacts of both existing feral and uncontrolled domestic pets.

Silver gulls and Pelicans also have the potential to become nuisance species, especially around public places. Silver gulls and Feral pigeons can also pose a risk to human health, especially where rainwater tanks are used for drinking purposes.

In conclusion, this AR considers that the potential impacts during the construction and operation of the development have been adequately identified, with suitable mitigation measures proposed. The

avoidance and minimisation of such impacts would be addressed by Environmental Management, Maintenance and Monitoring Plans.

6.14 RISK/HAZARD MANAGEMENT

A risk management approach should be adopted as a method by which individual site characteristics, operational and resources can be taken into account before devising the most reasonable and practical techniques for the management of various risks associated with the proposal. The *AS/NZS 4360 Risk Management Standard* (and accompanying handbook) should be used to determine the best way to identify, analyse, evaluate, treat, communicate and monitor risks.

The potential to cause environmental harm (ie. from pollutant risks associated with marinas and urban development) can be significantly reduced by adopting the following waste management hierarchy promoted by the EPA:

- avoidance
- reduction
- reuse
- recycling
- treatment
- disposal

Avoidance is the preferred approach, with disposal the least preferred.

A risk management approach would need to be adopted during the detailed design stage for the marina, boating facilities, the residential land division, infrastructure and future commercial and tourism related buildings.

Details on potential risks and hazards associated with the proposed development were addressed in section 5.6 of the EIS. In addition the proponent has provided a draft Site Construction Management Plan in Appendix 8 of the EIS.

6.14.1 Soil and Groundwater Contamination (Site Contamination)

The EIS (Section 6.5) included the results from field investigations into the physical and chemical properties of soils on site (and their potential for re-use) and the depth to groundwater. The chemical results indicated that concentrations of chemical substances in soils were generally below laboratory detection limits or the adopted site criteria and that Acid Sulphate Soils (ASS) had not been identified.

The EPA indicated a concern that an appropriate detailed site history investigation and site assessment had not been undertaken. Given that the site has been used for potentially contaminating land uses and in the absence of an adequate site assessment, it has not been demonstrated that site contamination would not exist taking into account the proposed land use and therefore that the land is suitable for its proposed use. The Department of Health and the SA MDB NRM Board also submitted a concern about the lack of soil and groundwater investigations for potential contamination.

The Response (Appendix C) also includes an Environmental Site Assessment (Phase 1), undertaken in accordance with the NEPM *National Environmental Protection (Assessment of Site Contamination)*

Measure (1999). Site ownership history (ie. current and previous land uses) forms a basis of the report, supplemented by soil and groundwater sampling and testing.

The site has mainly been used for primary production with associated risks of contamination resulting from associated activities. The Mannum WWTP site is likely to pose the greatest risk, mainly from nutrients leaking from the unlined lagoons and sludge placement. The Council landfill near the north-western corner of the site may also pose a risk, although the slow movement of groundwater may have resulted in any contamination being confined to the immediate vicinity. Adequate site assessment and groundwater monitoring would identify the actual risk, which is expected by the proponent to be low and manageable. The landfill is proposed to be closed in the near future. The proponent has stated (in the response to agency comments) that issues related to the landfill will be addressed.

The Response (Section 5.4) states that the preparation of a detailed Site Audit report for the site has commenced. An Environmental Auditor (contaminated land) has been engaged to undertake the auditing of land associated with the residential portions of the development. It is expected that the report will be finalised, prior to construction commencing. The proponent has also stated (in the response to agency comments) that a definitive statement (expected in the form of a detailed report) from a person who is an environmental auditor will be prepared. This will provide assurance that potential contamination issues have been appropriately addressed and that the whole of the land which is not subject to residential development is suitable for the proposed use, and that the development will not result in adverse impacts to the Murray River.

The Site Audit report and definitive statement would need to be to be finalised and submitted prior to construction commencing and prior to the marina being breached or opened to the river. This will ensure that in regard to all of the land associated with the development, there is no risk to human health and the environment (especially the River Murray) and that it is suitable for the intended use. This will need to be included in any approval as a reserved matter.

The Response (pg 61) states that site remediation works would be undertaken in accordance with the recommendation of the EPA. A Remediation Management Plan would be required to be prepared in accordance with the EPA *Guideline: Environmental Management of On-site Remediation (2006)* in consultation with, and with the endorsement of the environmental auditor. Appropriate construction and management plans should be prepared for the whole of the project land taking into account all potential issues, in accordance with relevant legislation and guidelines. Plans for remediation, construction and management would also need to be finalised, to the satisfaction of the EPA, DWLBC and the SA MDB NRM Board, prior to remediation works or construction commencing. This would need to be included in any approval as a reserved matter.

The Department for Environment and Heritage expressed concern that the sampling strategy was not developed using standard criteria relating to field indicators of Acid Sulphate Soil and did not refer to the EPA's Draft Acid *Sulphate Soil Material Guideline*. In particular, Borehole 1 recorded a pH of 4.6, when the guidelines state that a reading of less than pH 4 constitutes a field indicator for Acid Sulphate Soil.

Wastewater and Hazardous Chemicals Risks

The EIS proposes to install a new WWTP away from the floodplain, that includes a vacuum sewer system for the marina and residential allotments near the floodplain as a safeguard for protecting water quality and the river environment. The design of the sewer system, including appropriate alarms and emergency response contingencies, would minimise the risk of an effluent spill or leak as far as practicable (refer to Section 6.12.2 of this AR).

All hazardous chemicals that may be required in the proposed marina or commercial area (especially the boat maintenance facility) should be stored in bunded areas designed in accordance with EPA Guidelines. Waste oils should be collected by a licensed contractor for recycling. Emergency response procedures would be incorporated in a Operational Management Plan. Emergency spill kits would be located in the

appropriate locations and any clean-up/disposal should be undertaken by an appropriately licensed contractor.

The refuelling facility would be designed in accordance with EPA and DTEI requirements and be supported by specific refuelling provisions in the Marina Owner's Charter. In particular, the best practice guideline *Protecting Our Coastal Waters: Doing it Better Refuelling Guidelines* (Transport SA, 2003) should be followed. Flammable or potentially explosive chemicals that may be required for use in the commercial area should be managed in accordance with relevant Australian Standards. The proponent is advised that the provisions of the Dangerous Substances Act will also apply should development approval be granted by the Governor. Any installed underground fuel storage systems would require the installation of monitoring wells to ensure that any leakages were detected.

It is considered that a detailed risk assessment should be undertaken for all components of the proposal, to identify all associated pollutant spill risks, including household chemicals and fertilisers (if approval is granted). The findings of the assessment would need to be incorporated into the Spill Contingency Plan and the Operational EMMP where appropriate.

Safety on Waterways

The proposal would encourage a large number of boating movements, especially by houseboats and other large vessels. Safety and boating management guidelines would need to be in place in order to ensure appropriate safety parameters are maintained. Passive recreational pursuits, such as canoeing and swimming, would also need to be suitably managed to avoid conflict with boating activities. Active recreation, such as waterskiing and jet skiing, would need to be discouraged on the river in the vicinity of the entrance channel to ensure safe boating navigation into and out of the marina.

The EIS (Section 12.3.2) states that boating speeds would be restricted to a maximum of 4 knots and jet skiing and waterskiing would be prohibited, to ensure public safety in the marina and on residential waterways. All boat owners would be expected to comply with the international boating code (ie. for navigational requirements and other safety aspects) and marine navigation rules. The EIS (Section 13.2) also states that by-laws would be used to control various activities associated with the marina and waterways, including swimming areas. Conflict between boating activities and passive water activities would also need to be addressed.

Areas intended for primary contact (eg swimming, wading, bathing, and direct contact water sports) and secondary contact (boating and fishing) should comply with relevant guidelines, such as, *National Water Quality Management Strategy* (ANZECC, 1992) and the *Guidelines for Managing Risks in Recreational Water* (National Health and Medical Research Council, 2008).

Safe Navigation

A marina primarily for houseboats is likely to have a mix of both experienced and novice boat users. In particular, people hiring houseboats are likely to be inexperienced (or first time users) at safely navigating such large boats that can be difficult to manoeuvre in strong winds. The EIS (Section 12.3.2) states that the entrance channel would have dual passages, separated by a small island, to facilitate safe boating movements in and out of the marina. Navigational markers would identify the safe passage area, which would be 16 metres wide at pool level. A staging point for houseboat hirers would also be provided at the entrance of the marina to avoid inexperienced users having to navigate marina berths. Temporary berths for visitors would also be provided away from the marina.

The DTEI indicated a concern that the location of the marina entrance channel on the inside of a river bend could pose a navigation risk, primarily due to restricted lines of sight for boats exiting the marina. The proposed removal of houseboat mooring along the river bank was supported as a measure for reducing this risk. It is considered that willow removal (and replacement with River Red Gums) would further minimise this risk.

The DTEI also submitted a number of design and management recommendations, such as pertaining to navigational markers and lighting, that the Response (pgs 78-79) states would be adopted.

In conclusion, this AR considers that the potential hazards and risks of the proposed development have been adequately identified in the EIS. Further investigations are required into potential land and groundwater contamination aspects before construction could proceed. The proponent must prepare Management Plans for further assessment and approval by relevant government agencies before construction commences.

7 PROPOSED MANAGEMENT AND MONITORING OF ISSUES

A multi-component proposal that is of large scale and magnitude and that would be developed over a long period of time, requires the co-ordination and management of a wide range of matters. For this proposal, these include the following:

Infrastructure

- marina (ie entrance channel, basin, revetments, wharf, boat lift, boat ramp, boat maintenance facility, access/parking, boat effluent pump-out facility, refuelling facility, waste management facilities etc)
- residential sub-division (ie waterways, edge treatments, riparian buffer strips, services, stormwater management devices, open space reserves, landscaping/streetscaping, waste management/recycling etc)
- constructed anabranch/wetland system
- waste water treatment plant
- water and electricity supply to the development site
- road network and public car parks
- works compound

Environmental Management

- riverine reserve (ie houseboat mooring activities, public access, pest plant & animal control, erosion control, revegetation, buffer maintenance etc)
- water quality of waterways and marina basin
- buffer zones (ie between the marina/residential development and existing Baseby Wetland)
- revegetation areas
- human disturbance (ie public access, feral animal control and recreational use of the river bank)

Buildings not within the ambit of the Major Development declaration

- residential
- marina facilities (boat repair/maintenance and boating retail etc)
- tourist accommodation and facilities (including tavern, restaurant and café)
- commercial and retail opportunities (including marina and houseboat hiring offices)
- interpretive centre

Design controls and guidelines need to be considered for maintaining the visual amenity of the development (ie to establish a ‘theme’ or ‘look’), for environmental sustainability and for complying with building standards. For example, the following aspects would need to be addressed:

- riparian buffer strips and edge treatments
- appearance and use of suitable materials
- floor and building heights
- stormwater management
- water and energy efficiencies

- landscaping, amenity plantings and revegetation
- noise
- private moorings (ie jetties)
- fencing
- sheds and pergolas
- TV antennas

The activities and behaviour of residents, commercial operations and boat users would also need to be managed to ensure environmental protection, public safety and amenity. In particular, pollution sources would need to be managed to ensure suitable water quality in the marina and waterways, whilst human disturbance factors would need to be controlled to ensure protection of the environment.

These aspects can be addressed through a range of mechanisms (such as environmental management plans, encumbrances, Land Management Agreements, by-laws, Development Plan policies etc), but should be co-ordinated through an overall framework discussed in a Management, Maintenance and Monitoring Agreement. The agreement would also need to address requirements imposed by government, such as conditions of development approval, EPA licences, leases and other related approvals.

The EIS (Section 5.5.8) describes the management agreements with the Mid Murray Council that have been, or will be, put in place for the project during and after construction. A Project Control Group has been formed by the proponent and Council (and to include any relevant infrastructure development consultants or contractors) to provide a regular forum to address any infrastructure related aspects of the development.

After completion of construction, the Council would assume care and control of the marina related infrastructure (excluding all privately owned structures and facilities) and reserves. It will also be responsible for the ongoing management and maintenance of all land division related infrastructure and public facilities. The EIS (Section 11.4.13) describes the land tenure arrangements that would apply after the construction of each stage. Following the practical completion of construction of each stage or component it is anticipated that a 'hand over' period would commence, during which the proponent would be responsible for the maintenance, repair, cleaning and upkeep of infrastructure related to the land division, marina and waterways. Such arrangements would need to be addressed in a Management, Maintenance & Monitoring Agreement with Council.

To ensure the long-term management of the development, a special purpose fund (Waterways Long Term Maintenance Fund) would be established for maintenance of the entrance channel, marina waterways and edge treatments by allocating 50% of rates raised from all owners of marina berths and waterfront jetties (ie. private moorings attached to waterfront allotments). The maintenance of marina berths and associated infrastructure would be the responsibility of the marina Community Corporation. The maintenance of waterfront jetties would be the responsibility of individual owners.

7.1 ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

A multi-component proposal, such as a residential marina, that would be progressively constructed over a 16 year period requires a series of detailed plans to be prepared to manage the potential impacts on the environment and the community. Environmental management plans would be required for both the construction and operational phases. In addition, plans would not only be needed for the initial earthworks, formation of land (ie into allotments) and installation of major infrastructure that would be undertaken by the proponent, but also for the residential sub-division and commercial components that may be undertaken by real estate development companies and/or individual builders. The proponent would initially be responsible for preparing plans to cover all components during the life of the project, which may then be modified or updated prior to the construction of each component or allotment. A

management agreement would also need to be entered into with the Mid Murray Council to clarify all roles and responsibilities (especially the terms and timing of any hand over periods) for the implementation of the proposal. Additional agreements would also need to be entered into for the Waste Water Treatment Plant (and disposal of irrigation water to the golf course) and for management of the river bank Crown land (including the Baseby Wetland) and the constructed anabranch/wetland system.

The Construction Environmental Management Plan (CEMP), Environmental Management Implementation Plan (EMIP) and Operational Environmental Management & Monitoring Plan (OEMMP) would need to be finalised to the satisfaction of relevant stakeholders, including the Mid Murray Council, EPA, Department of Health, DWLBC, DEH, SA MDB NRM Board and the Mannum – Wellington LAP Group.

7.1.1 Construction Environmental Management & Monitoring Plan

A Construction Environmental Management Plan (CEMP) would 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 EIS (Section 12.2) provides an outline of the CEMP structure that addresses the main areas of importance to a reasonable level of detail. Further details and clarification are included in the Response (Section 5.5). Thus, an adequate description of the structure and the elements to be addressed in the CEMP has been provided, which would form a suitable basis for the preparation of the final detailed plan.

It is considered that the CEMP should be re-titled as a Construction Environmental Management and Monitoring Plan (CEMMP) to emphasise the importance of monitoring and to be consistent with other marina proposals approved by the Governor.

An important component of the CEMMP would be the Soil Erosion and Drainage Management Plan (SEDMP). The SEDMP would need to address the management of stormwater for the construction phase and, to a lesser degree, the operational phase of the development. Being located on the River Murray floodplain, the SEDMP would need to detail all measures for protecting water quality and the river environment. Aspects of the SEDMP would also need to be included in the Operational EMMP, especially the long-term maintenance of stormwater management reserves (ie. GPT's, retention ponds and grassed swales) and waterfront riparian buffer strips and edge treatments.

Another important component of the CEMMP would be the Site Remediation Management Plan proposed in the Response (pg 61) to address potential soil and groundwater implications. A Community Consultation Plan, for advising the community on the nature and extent of construction works (including a 24 hour contact point for public concerns), would also be included.

The proposed CEMP indicates general management plans would be developed to cover weed and pest animal control, but no details are provided. The Construction and Operational EMMP's should provide plans that address the immediate and long term issues of sustainable habitat management so that weeds and exotic animals are excluded and suitably controlled.

It is suggested that the CEMMP should also include a Waste Management Plan to ensure the appropriate collection, storage and disposal of all waste streams (including litter), especially to encourage recycling.

7.1.2 Environmental Management Implementation Plan

The EIS (Section 12.2.2) states that all management requirements in the CEMP would need to be documented by the construction contractor in an Environmental Management Implementation Plan (EMIP). The EMIP would need to be completed prior to the commencement of site works. The works would need to be undertaken in accordance with the EMIP, which would need to be reviewed and updated (when required) to ensure it remains current. The EIS states that the performance of the project would be independently audited on a six monthly basis, after an initial audit three months after the start of

construction. It is suggested that the EMIP should be reviewed on a more regular basis, such as monthly or two monthly, rather than "when required". It addition, a protocol should be established for the reporting of environmental breaches that may occur, especially to identify relevant stakeholders that should be informed (ie not just the EPA) and corrective actions that would be required. A system of penalties for breaches of the EMIP (including an appeals process) should also be considered.

7.1.3 Operational Environmental Management & Monitoring Plan

An Operational Environmental Management and Monitoring Plan (OEMMP) would be prepared by the proponent to maintain environmental standards and to undertake corrective actions (based on monitoring) during the operational stage. The EIS (Section 12.3) provides an outline of the EMMP structure, which is similar to the CEMP, that addresses the main areas of importance and provides a general description of most relevant issues.

The proponent has previously prepared a Wetland Management Plan addressing the protection of the Baseby Wetland and proposed constructed anabranch/wetland system. A further plan would be prepared due to modified details and changed designs outlined in the Response document. The EIS states that, for the Baseby Wetland and the constructed anabranch/wetland system, all aspects of protection would be addressed by the Plan, including public access, feral animals, water quality, landscaping and long-term management and monitoring.

A Revegetation Plan would provide information on the staged vegetation establishment programme, a 2-3 year maintenance programme and a long term Weed Management and Feral Animal Management Plan.

The proponent acknowledges that the proposed Environmental Management Plan for Wastewater would be subject to the requirements of State Government Agencies. It is understood that such a plan would require:

- Prevention of ground water and surface water contamination
- Litter control, dust control and sanitary conditions generally
- Odour and noise control
- Fire safety
- Security
- Identification of all design features and response strategies.

The Plan would subsequently lead to the preparation of an Irrigation Management Plan that defines the sustainable reuse of reclaimed water and outlines measures to ensure that no wastewater would reach any watercourse.

Spill control is vital to this project for the containment and clean-up of oils and wastewater, and any other pollutants in the marina waterways and so a Spill Contingency Plan will be extremely important.

It is considered that a Entrance Channel, Marina Basins and Waterways Management & Monitoring Plan should be prepared to address water quality, sediment accumulation, aquatic plant growth (problem species), navigation, boating safety, public safety and the conduct of activities)if approval is granted). The EIS does cover issues related to such a plan.

It is also suggested that a detailed Waste and Pollutant Source Management and Monitoring Plan be prepared to address all waste streams and pollutants, including building waste, hard waste, litter, floating

debris, organic waste, etc. Waste avoidance, minimisation, recycling and reuse of materials should also be addressed.

In addition, a Groundwater Monitoring and Management Plan; Stormwater Management and Monitoring Plan; Constructed Anabranch and Wetland System Management and Monitoring Plan; Flood Management Plan; and a Riverine and Wetland Management and Monitoring Plan would be incorporated into the OEMMP.

The SA MDB NRM Board submitted a range of recommendations for inclusion in the OEMMP that the Response (pg 72) states would be incorporated.

7.2 MANAGEMENT, MAINTENANCE AND MONITORING AGREEMENT

The EIS (Section 13.2) states that a Management, Maintenance and Monitoring Agreement (MMM) between the proponent and the Mid Murray Council would be established prior to the implementation of the proposed development to ensure:

- informed decision making
- co-ordination of the preparation of the PAR (now called a Development Plan Amendment) for the development
- that the project is undertaken in an orderly, economic and efficient manner
- the long term maintenance and care of facilities

The MMM Agreement would clearly identify the respective roles and responsibilities of all parties in respect to the implementation and operation of the development. The MMM Agreement would need to ensure the obligations and responsibilities of each party are clearly defined for both the whole of the proposed development and for off-site impacts.

It is suggested that the MMM agreement be prepared in consultation with all relevant Government agencies to ensure the requirements of all approvals and relevant legislation (especially the *Environment Protection Act 1993* and the *River Murray Act 2003)* would also be addressed.

The agreement should discuss the relevance and relationship of all documents and plans that relate to the development, including:

- CEMMP, EMIP and OEMMP (and other management plans that form these documents)
- Land Management Agreement or Encumbrances
- By-Laws
- Development Plan policies

It is proposed that a Project Control Group would be established to provide a forum for representatives of the proponent and the Council to manage the implementation of the proposal.

The MMM Agreement would need to define and allocate responsibilities for the management and maintenance of all infrastructure associated with the proposal (including stormwater management measures and the constructed anabranch/wetland system), especially the details of any hand-over arrangements. The MMM agreement would also need to consolidate all the monitoring responsibilities that would be required as a result of any development approval, construction agreements or EPA

licensing. Arrangements for the control and management of Crown land (namely the 50m river bank reserve) would need to be clearly defined.

The MMM agreement would also need to address the possible requirements of Council for financial bonds or bank guarantees that may need to be put in place to cover any maintenance costs or for to remedy or complete infrastructure works.

The MMM agreement would also need to address measures that Council would adopt to ensure that future development, which is not the subject of the Governor's development authorisation, is undertaken in a consistent manner to minimise and manage construction and operational impacts (ie in accordance with the standards prescribed in the CEMMP and OEMMP). In particular, Council would need to ensure that the proponent's philosophy and proposed measures to ensure that the development is environmentally sustainable are implemented for the life of the proposal, especially for the residential sub-division component that would be governed by future Development Plan polices that are put in place.

7.3 MEMORANDUM OF ENCUMBRANCE AND/OR LAND MANAGEMENT AGREEMENT

The EIS (Section 13.2) states that all titled property would have a House Owners Charter attached as an encumbrance registered on the title that sets out the various requirements or obligations for the development form, land use, occupation and activities appropriate to the property. There is also proposed to be a Marina Owners Charter that would apply to the use and development of the marina and waterways. Enforcement would be the responsibility of the Council (through the Community Corporation Manager) and the Marina Manager. The types of matters addressed are detailed in the EIS (Section 11.4.6).

Provisions are required for the Council to access and maintain poorly managed edges/moorings, or those structures that Council has been handed responsibility for. It is considered, therefore, that an access easement and suitable set-back distance should be included in a Land Management Agreement (LMA) to enable maintenance of edge treatments and the riparian buffer zone. Standards for maintenance by owners should also be specified to ensure a consistent approach and appearance. In addition, stormwater management devices (such as swales or infiltration trenches) would also need to be included in easements on a LMA (especially to ensure they are maintained in a working order). A two metre wide easement would be required from the top of the revetment in order to allow access for maintenance.

The LMA should include requirements in regard to the management of stormwater, including the collection of stormwater for irrigating gardens (if not used for drinking purposes) and limiting the amount of hard surfaces. The LMA should also make allotment owners aware of their obligations under the *Environment Protection Act 1993* to avoid the impacts of stormwater pollution on waterways and the existence of the EPA *Code of Practice for the Prevention of Stormwater Pollution for the Community*.

It is suggested that the following aspects should also be considered for inclusion in a LMA:

- Allotment owner's obligations for submitting suitable building plans and for the design and appearance of structures and landscaping.
- Types of vessels that may be moored and boat maintenance.
- Disturbances and disorderly behaviour.
- Emergency access.
- By-laws.

A copy of the final LMA document would be attached to the title of the allotment to ensure owners are aware of their responsibilities in regard to the conduct of activities on their land as part of the marina development community.

A LMA would also be used for consolidating the proponent's commitment to include affordable housing opportunities within the residential land division.

7.4 BY-LAWS

Council would need to enact by-laws under the *Local Government Act 1934* to regulate the use of:

- the marina basin (including the vacuum sewer connections for effluent and greywater disposal),
- casual moorings (including the vacuum sewer connections)
- public waterways,
- public reserves,
- public facilities,
- slip-way facility,
- refuelling facility.
- constructed anabranch/wetland system

7.5 HOUSE OWNERS CHARTER

The EIS (Sections 2.2.4 & 11.4.7 and Appendix B) proposes that a House Owners Charter would be put in place to address building design and materials, suitable garden plant species and fertilizers, and owners obligations in respect to a range of planning and management issues. Importantly, the Charter would include the need to incorporate measures for environmental sustainability, especially for energy and water efficiencies. Design Guidelines are also proposed to support the Charter and would address solar orientation, water smart initiatives, ventilation, energy efficient appliances, renewable energy sources, landscaping, building materials and construction. Relevant aspects of the Construction and Operational EMMP's would need to be incorporated in the Charter. The requirements of the House Owners Charter and Design Guidelines should be reinforced through relevant complementary Development Plan policies.

The draft Charter detailed in the EIS would need to be finalised to the satisfaction of Council and State Government agencies (including the NRM Board).

7.6 MARINA OWNERS CHARTER

The EIS (Sections 2.3.7 & 11.4.7 and Appendix C) proposes that a Marina Owners Charter would be put in place to impose conditions on the use of marina berths and the marina water-body. Tenure for marina berths would be created under the provisions of the *Community Title Act 1996*. Under the Act, a Community Corporation would be established for marina management and enforcement, including the appointment of a marina manager (ie. by the Mid Murray Council). A Scheme Description and By-laws would need to be established to cover operational and management requirements, which would be incorporated into the Charter. Importantly, a Procedure and Response Action Plan for pollution spills or hazard incidents (including monitoring, reporting and remediation), would be incorporated. Relevant aspects of the Construction and Operational EMMP's would need to be incorporated in the Charter. The Charter would need to ensure that all risks to the environment, public safety and the amenity of the development are adequately addressed to the satisfaction of Council and State Government agencies (including the NRM Board).

7.7 DEVELOPMENT PLAN POLICIES

The Mid Murray Council would need to prepare a Development Plan Amendment (DPA) for the area under its control to ensure that compatible and suitable Zones and policies are associated with the development, if the proposal is approved under the Major Development provisions of the *Development Act 1993*. In particular, appropriate polices would need to be put in place for the future assessment of development not under the decision-making jurisdiction of the Governor, primarily for residential dwellings and commercial buildings. Policies need to be put in place to ensure the development is ecologically sustainable and that the river environment is protected and enhanced.

The EIS (Section 13.2) provides a list of the matters that would need to be addressed for the rezoning of the site.

8 CONCLUSIONS

The assessment of the proposed Mannum Waters Marina and Residential Development has required the consideration of a range of social, economic and environmental issues. In particular, being located on the River Murray, the proposal raises a range of complex issues related to competing uses of the river (especially as a water source for domestic supplies and primary production) and the need to protect the river environment. The detailed information on which the assessment is based is contained in the May 2007 Environmental Impact Statement (prepared by Tallwood Pty Ltd), the Response document prepared in November 2007 and additional information provided by the proponent (letters dated 1 February and 18 February 2008). It also relies on information and comments provided in public and government submissions through the consultation process and additional advice from relevant South Australian Government agencies.

During the public consultation phase, eight public, one Council and 13 Government agency submissions were received. Major issues raised during the public comment period and Government consultation included:

- Use of River Murray water (including allocation and licensing)
- Impact on the River Murray environment and water resource
- Water circulation and water quality issues (especially pollution risks from houseboats and stormwater).
- Potential to increase houseboat numbers on the River
- Disposal of effluent and grey water from houseboats
- Groundwater implications (especially potential contamination from the existing Mannum Waste Water Treatment Plant and nearby Council landfill)
- Salinity implications
- Increased runoff and stormwater management
- Impacts on existing riverine and wetland ecosystems
- Protection of sites of Aboriginal Heritage
- Provision of affordable housing opportunities
- Siting and impact of a new Waste Water Treatment Plant (including irrigation of the golf course and reserves using reclaimed water)
- Sealing of Belvedere Road
- Impacts on adjacent agriculture
- Management and monitoring of impacts during construction and operation

This assessment makes the following conclusions in relation to issues required to be addressed, as set out in the published Guidelines.

NEED FOR THE DEVELOPMENT

The main justification for developing a marina on the floodplain of the River Murray is considered to be the environmental benefits of providing a high standard facility for the mooring of boats, primarily houseboats, that is located off-river. By adopting 'best practice' design, construction and management measures, the impacts of boating activities (especially the risk of pollutants to water quality) can be better controlled in a suitable location. The disposal of effluent and greywater from houseboats (and other large vessels) would be a significant benefit for improving water quality. The provision of a range of facilities and services would also be of benefit to boat users, especially those who hire houseboats or desire to permanently reside on a houseboat. The provision of a boat lift facility and a boat maintenance area would ensure pollution control standards for houseboats could be maintained.

A potential disadvantage of the proposal could be the concentration of a large number of boats in one location, which could lead to a concentration of impacts. However, the design of the proposal would substantially reduce this risk, especially being located off-river and the incorporation of a constructed anabranch/wetland system as a safeguard for improving water quality to a standard that is acceptable for discharging back to the River Murray. Another potential negative impact, especially during periods of drought when water restrictions apply, could be the use of river water for the initial filling and on-going maintenance of water levels in the marina (and residential waterways). Compared to other uses of river water, the initial quantities required would be relatively small and annual requirements to account for evaporative losses would be even smaller. In addition, during operation most of the water would simply pass through the development and be returned back to the river. The proposal has been designed to minimise water use and to add clean stormwater (that currently evaporates from the floodplain) to the river.

A high quality marina would not be cost-effective unless other opportunities for a financial return on the substantial investment required could be provided. Thus, the proposal includes a substantial residential component and limited commercial opportunities (ie. boating retail, tourist accommodation, conference centre, tavern/restaurant, café and general store).

The design of the sub-division aims to ensure environmentally sustainable measures (especially for water and energy conservation) are implemented to minimise the 'ecological footprint' of the development. In particular, stormwater would be managed to ensure clean water is returned to the river. An additional benefit would be the removal of the risk to water quality posed by the Mannum Waste Water Treatment Plant currently located on the floodplain, that would be replaced by an upgraded/expanded facility on the high ground. A vacuum sewer system would be installed to remove effluent from both residences and boats adjacent to or on the floodplain, as a measure to further safeguard water quality.

Mannum is a strategic location for a marina, as it is a major centre for houseboats and a base for the houseboat hiring industry. It is also a popular, holiday home, recreational and tourism destination. The location of the proposal on the southern residential boundary of Mannum makes it a logical site for a compact expansion of the township. The town is also a major centre for the region and provides a good level of services and facilities for new residents. In particular, it has the capacity to absorb an increase in population, with potential to meet future additional demand. The proposal would strengthen the role of Mannum in the Murray and Mallee Region. Importantly, the proposal would provide economic benefits during both the construction and operational phases.

WATER RELATED ISSUES

The EIS and supporting documents have comprehensively addressed the water related issues that are of concern to the health and use of the River Murray. The water requirements of the proposal, primarily to fill and maintain levels in the marina and residential waterways, have been calculated through a water balance model that has been refined to the satisfaction of the Department of Water, Land & Biodiversity Conservation (DWLBC). Approximately 380 ML would be needed for the initial filling, although this could be staged if water availability is restricted (or cost prohibitive) due to low flow/drought conditions

to reduce demand on the river water resource. For the on-going maintenance of water levels, an annual requirement of 180.5 ML on average would be needed to compensate for evaporative losses.

The DWLBC has confirmed that the proponent should be able to secure a water licence to use water from the River Murray Prescribed Watercourse. The proponent would need to secure a sufficient water allocation from the water trading market, including the consideration of any water restrictions that may apply. An existing irrigation licence (up to 170 ML) could be used to supplement any allocation required for the initial filling. The irrigation licence could then be used for the on-going maintenance of water levels (and also for revegetation purposes), supplemented by an additional small allocation. An existing Environmental Land Management Allocation (ELMA) could be used to meet the needs of the constructed anabranch/wetland system.

A continuous weather monitoring station would need to be established on-site to enable annual water allocation requirements to be accurately determined, especially given that climate change implications may result in increased evaporation (outputs) and reduced rainfall (inputs). This would also allow the water balance model to be verified and calibrated.

Water quality issues have also been comprehensively addressed in the EIS and supporting documents. Whilst the quantity of pollutants that could be generated by the various components of the proposal has not been specifically calculated, principles and measures have been proposed that would adequately manage all pollutant sources. In particular, pollutants associated with houseboats (especially hydrocarbons, effluent and greywater) would be controlled and stormwater (especially from the residential sub-division) would be managed using Water Sensitive Urban Design measures. A range of EPA policies and guidelines would also be complied with, especially contingencies for spill management. As a final safeguard for risks to water quality, a constructed anabranch/wetland system would be established as a natural filter of water discharged to the River Murray. Thus, water would re-enter the river to a similar, if not better, condition than when it entered the development.

ENVIRONMENTAL ISSUES

It is expected that the proposal would directly result in a relatively low loss of terrestrial and riverine native vegetation. The site has already been extensively cleared and modified for irrigated dairying, which was ceased over 15 years ago. As such, the floodplain is disconnected from the River Murray and has salinity problems. Remnant vegetation has slowly recolonised the site, but mainly comprises salt tolerant species (ie. Samphire shrublands), with a low species diversity dominated by weeds. The areas with vegetation of conservation significance are located along the river bank (River Red Gum woodland and wetland communities) and a creek line in the north-western corner of the site (River Box woodland), which would be preserved. The clearance of small areas of vegetation can easily be compensated for by landscaping/revegetation and the protection and environmental improvement of retained remnant stands. Existing riverine and wetland habitat adjacent the proposed site could potentially be detrimentally affected by threatening processes associated with urban encroachment, especially human disturbance and pest plant and animal species.

The proposal would result in the establishment of a substantial resident population and a larger increase in visitors to the area. In particular, the eastern boundary of the development site abuts intact riverine and wetland habitat that stretch south to provide a habitat corridor to the Reedy Creek wetland complex. Suitable buffers would be established between the development and the riverine zone. In addition, anthropogenic impacts (especially an increase in domestic/feral cat numbers, the walking of dogs and increased use of nearby river banks) would also need to be managed so as to minimise any impact.

Overall, the environmental impact is, subject to ongoing management as recommended in this AR, acceptable.

SOCIAL ISSUES

The proposal has the potential to increase the population of Mannum, which was recorded as 2,160 in the 2001 Census, by around 1000 residents. The demographic profile of the proposal is expected to predominantly comprise retirees and holiday home owners. This would result in a substantial increase in demand for commercial and community services. The increased demand would progressively occur over a 16 year period, dependent upon the staged release of residential allotments. This would enable community service providers to forward plan an expansion of services, especially emergency and health related. Mannum currently provides a range of services capable of meeting future demand. In addition, Murray Bridge and, to a lesser degree Adelaide, are major centres that are within relatively close proximity for services not provided in Mannum. Commercial services would expand in response to market forces.

A key community benefit of the proposal would be the inclusion of residential allotments for affordable housing, which would ensure that a wide range of demographic groups would be able to secure housing within the development. In addition, marina berth owners would have the ability to permanently 'live aboard' on houseboats, which could provide a greater 'sense of community' (and a range of services and less environmental impact) than permanently living on the river bank. The development would be linked to Mannum via walking/cycling pathways, which would also promote healthier lifestyles and less vehicle use. The proponent has placed a priority on maintaining a high standard of amenity for residents (especially through residential design, landscaping, open space reserves and the preservation of the river environment) and reducing the visual impact of the development from the river and surrounds.

The proponent has also place a high priority on the preservation and recognition of Aboriginal heritage. Sites of significance would be protected in reserves and indigenous culture would be promoted via an interpretive centre. In addition, employment and commercial opportunities would be pursued. Consultation with the Mannum Aboriginal Community Association Incorporated would continue, in order to achieve these objectives.

The community may experience some minor impacts during construction, mainly from increased movements of heavy vehicles. However, the site is relatively isolated from the majority of the township and impacts could be managed so that they are largely contained within the site. Dust would be the main potential effect that would need to be carefully controlled.

ECONOMIC ISSUES

The proposal has the potential to be of substantial economic benefit to Mannum and the Murray and Mallee Region. Whilst the greatest direct employment opportunities would initially be associated with the major construction phase (ie. for earthworks and infrastructure), on-going jobs would be created through the construction of housing. Of greater economic benefit would be the flow-on or multiplier effect on Mannum, as the town would have to meet the majority of service needs of new residents (including holiday home owners) and houseboat owners. Recreation and tourism would also increase, especially through the strengthening of Mannum as a base for the houseboat hiring industry. Houseboat maintenance, repair and retail opportunities would be an added economic benefit.

The Mid Murray Council would benefit financially from an increased rate base (boosted by high value properties), although a proportion of rates would need to be used for maintenance of infrastructure related to the marina, waterways and the residential sub-division, especially for stormwater management and the constructed anabranch/wetland system.

The commercial opportunities would largely cater for demand from marina residents and would not detrimentally compete with existing businesses in Mannum. The proposal has been slightly modified to include an expanded commercial area so that a conference facility can be provided to meet the needs of the town and the region.

The proposal also provides an opportunity for the expansion of the Mannum Golf Course (including potential housing) through the availability of reclaimed waste water for irrigation of fairways. Existing sporting, social and community organisations would benefit from an increase of the town's population.

HAZARD AND RISK MANAGEMENT

The proponent has identified all the potential hazards and risks associated with the proposal, especially those related to water quality of the River Murray. Additional soil and groundwater investigations have been undertaken (or are planned) to identify any sources of contamination that would need to be managed during construction. In particular, the existing Mannum Waste Water Treatment Plant site and the nearby Council landfill may require remediation works to be undertaken. Further groundwater sampling and modelling are to be undertaken to confirm what is expected to be a low risk to the development.

In regards to flooding, all buildings, roads and the majority of service infrastructure would be above the 1956 flood level. The vacuum sewer system for the marina would be below this level, but has been designed so that it would be shut down during large floods. A levee along the southern boundary of the site would protect the adjoining dairy flat.

Hazards and risks associated with the marina (ie. boating related pollutant sources, flammable materials and activities) and the residential sub-division (ie. stormwater and sewerage) would be suitably controlled and managed, especially by the Construction and Environmental EMMP's and legislative requirements (particularly the Environment Protection Act).

INFRASTRUCTURE ISSUES

The main infrastructure issue would be the replacement of the existing Mannum Waste Water Treatment Plant with a new upgraded and expanded plant located off the floodplain. Electricity supply, water supply and telecommunications infrastructure would be installed in accordance with the standard requirements of the utility providers, including augmentation works.

The marina would provide a range of infrastructure for boating users, such as secure and convenient berths (and associated parking), effluent and greywater pump-out connections, a refuelling facility, boat ramp, boat lift, boat repair facilities and ablutions (ie. toilets, showers and laundry). Berths would be provided for both permanent and temporary mooring, including for permanent living on board.

The proposal would result in the sealing of Belvedere Road, which would benefit residents of the Mannum region and not just the marina development.

MANAGEMENT AND MONITORING

The potential impacts of the proposal have been identified, with suitable mitigation measures proposed. Impacts would be managed through the implementation of Environmental Management & Monitoring Plans (EMMP's) for both the construction and operational phases of the development. The EMMP's would include specific Management Plans for site remediation; soil erosion and drainage; stormwater (including Water Sensitive Urban Design measures); waste and pollutant sources (including spill contingencies); weeds and feral animals; the entrance channel, marina basin and residential waterways; and the constructed anabranch/wetland system. Separate management plans would also be needed for the Waste Water Treatment Plant and irrigation using reclaimed water.

The proponent has provided suitable draft EMMP's that address the majority of aspects that relate to the proposal. The EMMP's would need to be finalised to the satisfaction of the Mid Murray Council, Planning SA, other relevant Government Agencies (especially the EPA and the Department of Water, Land & Biodiversity Conservation) and other key stakeholders (especially the South Australian Murray Darling Basin Natural Resources Management Board).

In addition to EMMP's, a House Owners Charter, Marina Owners Charter, Design Guidelines, Encumbrances and Council By-laws would be used to manage impacts and activities of boat owners and residents.

A Land Management Agreement would be used as a mechanism for ensuring affordable housing opportunities are achieved.

A Management, Maintenance and Monitoring Agreement would be entered into by the Mid Murray Council and the proponent to define the roles and responsibility of each party to guide the implementation and operation of the proposal.

DEVELOPMENT PLAN AND PLANNING STRATEGY

An assessment against the Council Wide Principles and Objectives of the Mid Murray Development Plan indicates that the proposal is generally compatible in regard to the proposed tourist, recreational and residential uses. The proposed development is within a defined area and as such there are some incompatibilities with the types of envisaged land uses within the River Murray Zone and as such, the proposed development is at variance with some detailed polices within the Zone. In particular, marinas are non-complying in the *Conservation Policy Area* and the *Floodplain Policy Area*. Nonetheless, the proposal appears to be orderly development. It appears reasonable to locate a tourist/ recreational marina and residential development adjacent to an existing town and close to existing facilities and infrastructure. The proposed development further reinforces the significance of Mannum as a tourist destination and major town centre along the River Murray. The location and the intended use of the land would seem appropriate, contingent upon the necessary environmental provisions being put in place and the land's ability to accommodate any foreseeable future demand. A significant area of land identified in the Conservation Policy Area is to be maintained and enhanced. The Aboriginal heritage areas identified in the EIS are to be preserved. The construction and ongoing tourist and recreational facilities associated with the marina are likely to create an economic flow on effect that will benefit the immediate and broader locality.

The residential component will have minimal impact, although the relevant policy areas don't envisage the type of density proposed and the placement of residential uses, where primary production is encouraged as the prime economic use. Nonetheless, the proposed designs for the waterfront dwellings, whilst conceptual, are interesting and of a high standard. The living levels are above the 1956 flood level as per Development Plan requirements. The stormwater, sewerage and traffic aspects meet the general provisions.

The proposed development is, on balance, in accordance with the relevant provisions of the appropriate Development Plan.

If approval is granted, a Development Plan Amendment (DPA) process would need to be undertaken to establish appropriate zoning and policies commensurate with the proposed land uses. In particular, policies would need to support the priority issues relating to housing sustainability and the protection of water quality, the environmental and the River Murray in general.

It is considered that the overall development of a residential marina is consistent with the general objectives contained in the *Planning Strategy for Regional South Australia (2003*), especially the objectives that encourage economic development (particularly in the tourism sector) and that focus on the natural and cultural assets of the region, in this case the River Murray.

9 RECOMMENDATIONS

This Assessment Report concludes that the environmental, social and economic impacts of the proposed Mannum Waters Marina and Residential Development are acceptable, based on the proposed design, mitigation and management measures.

Should the Governor grant a provisional development authorisation, the conditions should be based on the following requirements:

PART A: RESERVED MATTERS

a.The following are the matters reserved for further assessment:-

(a) Detailed designs, drawings and specifications for each of the following matters:-

i. Land division to create certificates of title;
ii. Marina moorings and other marina facilities;
iii. Public boat ramp, boat lift, hard stand, wash down, boat maintenance facilities and car park areas;
iv. Boat refuelling facility;
v. Navigational aids; and
vi. Pedestrian Bridge.

(b) Compliance with the Building Rules in relation to all aspects of the proposed Major Development;

(c) The arrangements for the relocation and upgrade of the Mannum Waste Water Treatment Plant to cater for the demand from the development and the Mannum Township;

(d) The final Site Audit Report and Remediation Plan;

(e) The finalised plans, drawings and specifications for the Constructed Anabranch/Wetland System;

(f) A Land Management Agreement pursuant to section 57 of the Development Act 1993 in regard to the provision of affordable housing in the land division;

(g) A Management, Maintenance, and Monitoring Agreement between the Mid-Murray Council and the proponent;

(h) A Construction Environmental Management and Monitoring Plan (CEMMP) covering preconstruction and construction phases;

(i) An Environmental Management Implementation Plan (EMIP);

(j) An Operational Environmental Management and Monitoring Plan (OEMMP);

(k) Stormwater Management Plan;

(l) A Site Preparation, Revegetation, Hydrology and Management Plan;

(m) Compaction specifications for areas designated residential allotments, commercial development, retail development, tourist development, car parks, public boat ramp, boat hardstand and boat maintenance area;

(n) Engineering construction plans for roads, drainage, footpaths and intersections;

(o) Engineering designs for entrance channel, edge treatments, other waterway related structures, pedestrian bridge, marina moorings, public boat ramp (including associated car parking and access), boat lift, hardstand, wash-down, boat refuelling facility and boat effluent/greywater pump-out connection points;

(p) A permanent weather monitoring station; and

(q) A Management Plan for the land referred to in condition 7 hereof.

PART B: CONDITIONS OF PROVISIONAL DEVELOPMENT AUTHORISATION

1. The development authorisation granted hereunder is provisional only, does not operate as a final development authorisation, and does not therefore authorise implementation of the proposed Major Development. Only an authorisation granted under section 48(2)(b)(i) can operate to authorise implementation of the proposed Major Development, which authorisation will only be granted after the reserved matters have been assessed and approved.

1a. Except where minor amendments may be required by other legislation, or by conditions imposed herein, the proposed Major Development shall be undertaken in strict accordance with the following documents:

- Development application dated 28 June 2005 (except to the extent that it may be varied by a subsequent document in this paragraph);

- Environmental Impact Statement (Volumes 1 & 2), Mannum Waters Marina and Residential Development by Tallwood Pty Ltd dated May 2007 (except to the extent that it may be varied by a subsequent document in this paragraph);

- Response to Submissions, Mannum Waters Marina and Residential Development by Tallwood Pty Ltd dated November 2007 (except to the extent that it may be varied by a subsequent document in this paragraph);

- Correspondence from Tallwood Pty Ltd to Planning SA dated 1 February 2008 and 18 February 2008 containing additional information and modified plans; and

- Assessment Report prepared by the Minister for Urban Development and Planning dated May 2008.

2. All works and site activities shall be undertaken in accordance with an approved Construction Environmental Management and Monitoring Plan and an approved Environmental Management Implementation Plan.

3. All contamination management or remediation works shall be undertaken in accordance with an approved Remediation Plan and to the reasonable satisfaction of the Environment Protection Authority.

4. Transport routes for the delivery of construction materials shall be selected to the reasonable satisfaction of the Mid Murray Council.

5. Stockpiled soils shall be suitably managed to control dust emissions, erosion and weed infestation.

6. Armour rock used for waterway revetments shall not be contaminated by fine sediment.

7. The proponent must maintain a 50-metre wide strip of land adjacent the river's edge as public land.

8. The wastewater collection and treatment system shall be designed to ensure that the general obligations of the Environment Protection (Water Quality) Policy 2004 are met, and to ensure that effluent does not overflow or escape from any drains, pipes, sumps, tanks, storage/treatment basins into any watercourse, or into stormwater drains which do not drain into the effluent collection, treatment and disposal system; except where the effluent complies with criteria in the above policy.

9. All marina moorings and waterfront residential allotments shall be connected to a vacuum sewer system.

10. The proponent shall provide underground public lighting, power supply, water supply and telephone supply to each allotment in accordance with, and to engineering design standard plans approved by the electricity, mains water and telephone public utility authorities.

11. The proponent shall ensure that all waters discharged to the River Murray are equal to, or better than, the quality of water in the River Murray at the point of discharge.

12. The land to be used for land-based allotments shall be formed to prevent stormwater flows entering into the waterways without suitable treatment.

13. Water-sensitive urban design measures and practices shall be adopted for the management of run-off, including stormwater capture and reuse.

14. All buildings shall have a floor level above the 1956 flood level.

15. All infrastructure relating to the management of stormwater (including rainwater tanks) shall be located above the 1956 flood level and/or be designed so as not to be affected by flooding.

16. All residential allotments that are a minimum of 40 metres in length shall be constructed to have a finished slope of approximately 1:16 (3.6 degrees).

17. All residential allotments that are a minimum of 70 metres in length shall be constructed to have a finished slope of approximately 1:42 (1.4 degrees).

18. Setbacks from building envelopes to pool level shall be no less than 19 metres for all residential allotments that are a minimum of 40 metres in length and 40 metres for all residential allotments that are a minimum of 70 metres in length.

19. Undeveloped allotments shall be left in a neat and tidy condition, with soil surfaces stabilised to minimise erosion.

20. Riparian buffer strips shall be established by the proponent for all waterfront allotments, prior to titles being issued for residential allotments. The buffer shall be a minimum of five metres wide and be planted with suitable species of native vegetation.

21. The edges of all residential waterways shall be designed and constructed to replicate a natural river bank as far as practicable.

22. Road designs shall not affect existing natural lines in such a way as to cause flooding. All roads and drainage works shall be built according to approved designs.

23. Appropriate navigational aids shall be erected in prominent locations, in consultation with the Department of Transport, Energy & Infrastructure, prior to use of the facility for boating purposes.

24. Access systems for all floating boat moorings shall be capable of adjustment or be readily adaptable to variable river levels and all marina mooring structures shall be designed in accordance with the Australian Standard AS 3962-2001 Guidelines for Design of Marinas and AS 4997-2005 Guidelines for the Design of Maritime Structures.

25. The public boat ramp facility shall be designed in accordance with the South Australian Boating Advisory Committee's Guidelines for Planning, Design and Construction of Boat Launching Facilities.

26. The boat refuelling area and boat effluent/greywater pump-out connection points shall be designed to meet the requirements of the Environment Protection Authority, the Department for Transport, Energy & Infrastructure and the Country Fire Service (CFS) respectively, and shall be in place prior to commencement of operation of the marina.

27. The proponent shall ensure satisfactory oil-spill and fire-fighting facilities and contingency plans, determined in consultation with responsible officers within the Department for Transport, Energy & Infrastructure and the Metropolitan Fire Service (MFS) or the Country Fire Service (CFS) (as applicable), are in place prior to commencement of operation of the marina.

28. The water contained in the marina basin shall be kept as a minimum to a quality appropriate for secondary contact recreation, public amenity and the maintenance of aquatic ecosystems, as stipulated from time to time by the ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters.

29. Normal operating hours for construction activities and truck movements to and from the site shall be from 7.00am to 7pm, Monday to Saturday inclusive. Only if it is considered necessary by the proponent, shall construction be undertaken on Sundays, in which case construction hours shall be from 9.00 am to 6.00pm.

30. The Environment Protection (Noise) Policy 2007 shall be complied with during construction activities and truck movements.

31. Landscaping and street scaping of the site shall commence prior to the issuing of Certificates of Title for each stage of the land division, and when established shall be maintained in good health and condition at all times. A plant shall be replaced if or when it dies or becomes seriously diseased within the first growing season after the plant dies or becomes seriously diseased. A weed control program shall also be implemented.

32. Permanent water flow and water quality monitoring stations shall be established at suitable sites within the development, to the reasonable satisfaction of the Minister for Environment and Conservation prior to the commencement of operation.

33. All water pumps within the development must be metered to the reasonable satisfaction of Minister for Environment and Conservation.

34. The Mid Murray Council shall be given seven days notice, prior to the commencement of works, and be provided with the name and contact facilities for the person responsible for co-ordinating site works by this approval.

35. A site audit report, completed by an Environmental Auditor (Contaminated Land), must be presented to all purchasers of allotments.

36. The proponent shall address the reserved matters and submit relevant documentation to the Development Assessment Commission for its approval.

PART C: NOTES TO PROPONENT

1. In respect of the reserved matters, the following is advised to the proponent:-

(a) Detailed designs, drawings and specifications for each of the following matters:-

i. Land division to create certificates of title;
ii. Marina moorings and other marina facilities;
iii. Public boat ramp, boat lift, hard stand, wash down, boat maintenance facilities and car park areas;
iv. Boat refuelling facility;
v. Navigational aids;
vi. Pedestrian Bridge.

Appropriately detailed designs, drawings and specifications for each of the above-mentioned should be provided to enable their proper assessment.

In respect of land division documentation, surveyed plans sufficient to satisfy Lands Titles Office procedure should be provided.

(b) Building Rules

The proponent must obtain a Building Rules assessment and certification from either the Mid-Murray Council or a private certifier (at the proponent's option) and forward to the Development Assessment Commission all relevant certification documents as outlined in Regulation 64 of the *Development Regulations, 1993*.

Pursuant to Development Regulation 64, the proponent is especially advised that the Mid-Murray Council or private certifier conducting a Building Rules assessment must-

- provide to the Minister for urban Development and Planning a certification in the form set out in Schedule 12A of the *Development Regulations 1993* in relation to the building works in question; and

- to the extent that may be relevant and appropriate-

(i) issue a Schedule of Essential Safety Provisions under Division 4 of Part 12; and

(ii) assign a classification of the building under these regulations; and

(iii) ensure that the appropriate levy has been paid under the Construction Industry Training Fund 1993.

Regulation 64 of the *Development Regulations 1993* provides further information about the type and quantity of all Building Rules certification documentation for Major Developments required for referral to the Minister for Urban Development & Planning. The Mid Murray Council or private certifier undertaking Building Rules assessments must ensure that the assessment and certification are consistent with this provisional development authorisation (including its Conditions and Notes).

(c) Arrangements for the relocation and upgrade of the Mannum Waste Water Treatment Plant

The plans, drawings, specifications and financial arrangements for the provision of an adequate Waste Water Treatment Plant (including the disposal of reclaimed water) for the development site and the Mannum Township shall be finalised to the reasonable satisfaction of SA Water prior to their submission to the Development Assessment Commission for approval.

Furthermore, the proponent and SA Water must enter a binding agreement for the relocation and upgrade of the Mannum Waste Water Treatment Plant to cater for the demand from the development and the Mannum Township and seek approval for the agreement from the Mid Murray Council, the Environment Protection Authority and the Minister for Health prior to its submission to the Development Assessment Commission for approval.

(d) Site Audit Report and Remediation Plan

These must be prepared to the satisfaction of an Environmental Auditor (Contaminated Land) and the Environment Protection Authority before submission to the Development Assessment Commission for approval. Both the auditor and the EPA will need to certify that the Remediation Plan addresses adequately any soil or groundwater contamination that could affect the development of the River Murray. The proponent is advised that additional investigations are required to assess the extent of soil and groundwater contamination at the proposed development site and to assess the potential impacts from off-site contamination on the proposed development.

(e) The finalised plans, drawings and specifications for the Constructed Anabranch/Wetland System

These must be prepared to the satisfaction of the Environment Protection Authority, the Minister for Environment and Heritage, and the Mid-Murray Council before their submission to the Development Assessment Commission for approval.

(f) A Land Management Agreement pursuant to section 57 of the Development Act 1993 in regard to the provision of affordable housing in the land division

This must be approved by the Minister for Families and Communities before its submission to the Development Assessment Commission for approval.

(g) A Management , Maintenance, and Monitoring Agreement between the Mid Murray Council and the proponent

This must be submitted to the Development Assessment Commission for approval.

(h) A Construction Environmental Management and Monitoring Plan covering preconstruction and construction phases

A Construction Environmental Management and Monitoring Plan (CEMMP) covering both pre-construction and construction phases shall be prepared in consultation with and approved by the Environment Protection Authority, the Minister for Environment and Heritage, and the South Australian Murray Darling Basin Natural Resources Management Board before its submission to the Development Assessment Commission for approval.

(i) An Environmental Management Implementation Plan

This must be prepared in conjunction with the Environment Protection Authority and the South Australian Murray Darling Basin Natural Resources Management Board before its submission to the Development Assessment Commission for approval.

(j) An Operational Environmental Management and Monitoring Plan

This shall be approved by the Environment Protection Authority, the Mid-Murray Council, the South Australian Murray Darling Basin Natural Resources Management Board and the Minister for Environment and Heritage, prior to its submission to the Development Assessment Commission for approval.

(k) Stormwater Management Plan

A Stormwater Management Plan detailing the approach to the collection, storage, treatment and reuse of stormwater run-off for all components of the development during the operational phase of the development, shall be prepared to the reasonable satisfaction of the Environment Protection Authority, the Mid Murray Council before its submission to the Development Assessment Commission for approval.

(l) A Site Preparation, Revegetation, Hydrology and Management Plan for the Constructed Anabranch/Wetland System

This shall be approved by the Environment Protection Authority, the Mid-Murray Council and the Minister for Environment and Heritage prior to its submission to the Development Assessment Commission for approval.

(m) Compaction specifications for areas designated residential allotments, commercial development, retail development, tourist development, car parks, public boat ramp, boat hardstand and boat maintenance area

These shall be approved by the Mid-Murray Council before their submission to the Development Assessment Commission for approval.

(n) Engineering construction plans for roads, drainage, footpaths and intersections

These plans shall be finalised in accordance with the requirements of the Department of Transport, Energy & Infrastructure and the Mid Murray Council prior to their submission to the Development Assessment Commission for approval. Road and drainage designs shall include water table levels, drainage inverts and pavement details.

(o) Engineering designs for entrance channel, edge treatments, other waterway related structures, pedestrian bridge, marina moorings, public boat ramp (including associated car parking and access), boat lift, hardstand, wash-down, boat refuelling facility and boat effluent/greywater pump-out connection points

A certificate from a registered engineer (certifying the soundness of the designs) shall accompany these designs on their submission to the Development Assessment Commission for approval.

(p) Permanent weather monitoring station

This station is to be installed on site to collect rainfall and evaporation data for the purposes of calculating the annual River Murray water allocation required. Its design shall be submitted to the Development Assessment Commission for approval.

(q) A Management Plan for the land referred to in condition 7 hereof

This is to be approved by the Minister for Environment and Conservation before its submission to the Development Assessment Commission for approval. This should be prepared in consultation with the Mid Murray Council, and responsible officers of the Department for Environment & Heritage, the Department of Water, Land & Biodiversity Conservation and the South Australian Murray Darling Basin Natural Resources Management Board.

2. Should the proponent wish to vary the Major Development or any of the components of the Major Development, an application may be submitted, provided that the development application variation remains within the ambit of the Environmental Impact Statement and Assessment Report referred to in this provisional development authorisation. If an application for variation involves substantial changes to the proposal, it will be processed pursuant to section 47(2)(b) of the *Development Act 1993*.

3 . The proponent is advised that a suitable water licence and water allocation would need to be secured under the *Natural Resources Management Act 2004* for the initial filling of the marina basin, waterways and the constructed anabranch/wetland system and for the on-going maintenance of water levels.

4. The proponent's Construction Environmental Management and Monitoring Plan (CEMMP), Environmental Management Implementation Plan (EMIP) and Operational Environmental Management and Monitoring Plan (OEMMP) should be prepared taking into consideration, and with explicit reference to, relevant Environment Protection Authority policies and guideline documents, including but not limited to: the Code of Practice for Vessel and Facility Management: Marina & Inland Waters (2007); Environment Protection (Water Quality) Policy 2003; Environment Protection (Air Quality) Policy 1994; Guidelines on Odour Assessment: Using Odour Source Modelling 2003, EPA Handbook for Pollution Avoidance on Commercial and Residential Building Sites 2004, EPA Bunding and Spill Management Guidelines 2004 and the EPA Stormwater Pollution Prevention Codes of Practice, in addition to other legislative requirements and Guidelines/ Australian Standards requiring compliance.

5. The following management and monitoring plans may be incorporated into the CEMMP, EMIP or OEMMP as appropriate.

- Remediation Plan
- Soil Erosion and Drainage Management Plan

- Stormwater Management and Monitoring Plan.
- Groundwater Monitoring and Management Plan
- Waste and Pollutant Source Management and Monitoring Plan
- Riverine and Wetland Management and Monitoring Plan
- Flood Management Plan
- Site Preparation, Revegetation, Hydrology and Management Plan for the Constructed Anabranch/Wetland System
- Revegetation Plan
- Landscaping Plan
- Weed and Feral Animal Management Plan
- Spill Contingency Plan
- Traffic Management Plan
- Entrance Channel, Marina Basin and Waterways Management and Monitoring Plan
- Wastewater Environmental Management Plan
- Irrigation Management Plan;

8. The following activities in relation to the components of the development hereby approved and/or requiring future approval will require licences under the *Environment Protection Act 1993*:

- Earthworks Drainage: the conduct of earthworks operations in the course of which more than 100 kilolitres of waste water containing suspended solids in a concentration exceeding 25 milligrams per litre is discharged directly or indirectly to marine waters or inland waters.

- Marinas and Boating Facilities: the conduct of-

  (a) facilities comprising pontoons, jetties, piers or other structures (whether on water or land) designed or used to provide moorings or dry storage for 50 or more powered vessels at any one time; or
  (b) works for the repair or maintenance of vessels with the capacity to handle five or more vessels at any one time or vessels 12 metres or more in length.

- Dredging: removing solid matter from the bed or any marine waters by any digging or suction apparatus, but excluding works carried out for the establishment of a visual aid to navigation and any lawful fishing or recreational activity.

It is likely that as a condition of such licences the Environment Protection Authority will require the licensee to carry out specified environmental monitoring of water quality and to make reports of the results of such monitoring to it.

9. All works associated with the rehabilitation and remediation of the site are required by law to be undertaken in accordance with section 25(1) of the *Environment Protection Act 1993* which requires that a person must not undertake any activity, which pollutes, or may pollute without taking all reasonable and practical measures to prevent or minimise harm to the environment); the Environment Protection (Water Quality) Policy 2004; other relevant Environment Protection Policies made under Part 5 of the *Environment Protection Act 1993.* Works should also be undertaken in accordance with the ANZECC Best Practice Guidelines for Waste Reception Facilities at Ports, Marinas and Boat Harbours in Australia and New Zealand, guideline Environmental Management of On-Site Remediation and other relevant Environment Protection and Authorisation publications and guidelines.

10. The proponent is advised of the Duty of Care under the *River Murray Act 2003*, which requires that a person shall ensure that their actions do not cause harm to the River Murray.

11. The proponent is advised of the requirement under the *Native Vegetation Act 1991* to obtain permission under that Act for any clearance of native vegetation or otherwise to bring itself within an exemption under that Act. Neither this development authorisation nor any final development authorisation granted under section 48(2)(b)(i) of the *Development Act* operates as an authorisation to clear native vegetation.

13. The proponent is reminded of its obligations under the *Aboriginal Heritage Act 1988* whereby any 'clearance' work, which may require permission to disturb damage or destroy Aboriginal Sites, must be undertaken with the full authorisation of the Minister for Aboriginal Affairs and Reconciliation, according to section 23 of the *Aboriginal Heritage Act 1988*.

14. The proponent, and all agents, employees and contractors, such as construction crews, should be conversant with the provisions of the *Aboriginal Heritage Act 1988*, particularly the requirement to immediately contact the Department of Premier & Cabinet (Aboriginal Affairs and Reconciliation) in the event that archaeological items (especially skeletal material) are uncovered during earthmoving.

15. The proponent, and the Council after hand-over, should comply with the *Public and Environmental Health Act 1987* in regard to the maintenance of suitable water quality within the marina basin, residential waterways, stormwater retention ponds and the constructed anabranch/wetland system to protect public health and amenity.

16. For the purposes of condition 28, it is noted that the expression 'secondary contact recreation' includes activities such as wading, boating and fishing in which some human contact with the water may occur, but in which the probability of bodily immersion or the intake of significant amounts of water is minimal.

17. It is recommended that the proponent approach the Mid-Murray District Council with a view to the Council enacting by-laws to manage activities associated with the:

- Entrance channel and waterways to ensure safe navigation and to protect water quality
- Boat ramp, boat lift, hard stand and boat maintenance facilities (including car parking and access)
- Refuelling facility and boat effluent/greywater pump-out connection points
- Residential development and reserves (including stormwater management devices and the pedestrian bridge)
- Constructed anabranch/wetland system
- Crown land reserve along the river bank and associated wetlands and buffer zones

18. The Mid Murray Council will need to review and amend the zoning policies in the relevant Development Plan to reflect any development approved by the Governor and for future assessment and decision-making for buildings and structures not forming part of this provisional development authorisation. In particular, policies will need to address sustainability matters (especially water and energy efficiency), environmental protection requirements, flood protection requirements and amenity aspects.

19. A common building scheme encumbrance or equivalent device for the purpose of ensuring compliance with design standards for residential and other buildings will be required at the land division stage.

20. Binding legal arrangements (e.g. easements, encumbrances, charge-back arrangements etc, as appropriate) between the proponent and allotment owners must be put in place, prior to application to the Registrar General for the issue of new Certificates of Title, to ensure financial and management responsibilities related to the maintenance of edge treatments, the maintenance of the

riparian buffer strip and the design and appearance of structures are clearly allocated. These arrangements must be to the reasonable satisfaction of the Development Assessment Commission.

21. The proponent will need to satisfy the requirements of the Mid Murray Council relating to the provision of 12.5% Open Space as part of any land division application.

22. The Marina Owner's Charter and House Owner's Charter documents should be finalised to the satisfaction of Planning SA, prior to application to the Registrar General for the issue of new Certificates of Title. The relevant Charters should be presented to purchasers of marina berths or allotments.

23. Approvals from the Environment Protection Authority and the Department of Health would need to be sought for the Waste Water Treatment Plant and the use of reclaimed water for irrigation purposes. An Environmental Management Plan for Wastewater and an Irrigation Plan would be required.

24. The Minister has a specific power to require testing, monitoring and auditing under section 48C of the *Development Act 1993*.

25. It is noted that the provisional development authorisation granted herein does not apply to any residential, commercial, retail, tourist-related or other buildings, for which a separate application for approval, addressed to Council, will be required. Additional design and infrastructure/service plans will be required by Council when application is made for approval for any such buildings.

10 REFERENCES

EPA (2007) *River Murray and Lower Lakes Catchment Risk Assessment for Water Quality.* Environment Protection Authority, South Australia.

Major Developments Panel, (2005). *Issues Paper – Mannum Waters Marina and Residential Development.* Planning SA, Department of Primary Industries and Resources, South Australia.

Major Developments Panel, (2005). *Guidelines for the preparation of an Environmental Impact Statement for the Mannum Waters Marina and Residential Development.* Planning SA, Department of Primary Industries and Resources, South Australia..

Premier of South Australia (2003) *Planning Strategy for Regional South Australia*. Planning SA

The Mid Murray Council (2007). *Mid Murray Development Plan*.

Kahrimanis, M.J., Carruthers, S., Oppermann, A. and Inns, R. (2001). *Biodiversity Plan for the South Australian Murray-Darling Basin*. Department for Environment and Heritage, South Australia.

11 GLOSSARY

The 'Act'	*Development Act 1993* and *Regulations*
AR	Assessment Report
DAARE	Department of Aboriginal Affairs and Reconciliation
DWLBC	Department of Water, Land and Biodiversity Conservation
DAC	Development Assessment Commission
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
MACAI	Mannum Aboriginal Community Association Incorporated
Panel	Major Developments Panel
RD	Response Document
WWTP	Waste Water Treatment Plant
WHO	World Health Organisation
WSUD	Water Sensitive Urban Design

APPENDIX 1

ADDITIONAL INFORMATION PROVIDED BY THE PROPONENT DATED 1 FEBRUARY AND 18 FEBRUARY 2008

Tallwood Pty Ltd
Project Development

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1st February 2008

Mr Elmer Evans
Manager Assessment Branch
Planning SA
GPO Box 1815
Adelaide SA 5001

Dear Mr Evans,

Re: Mannum Waters, Marina and Residential Development Proposal – Reply to Agency Comments on Response Document

As requested, please find enclosed our replies to the Agency comments on the Response document for the Mannum Waters proposal.

Our replies have been inserted in green where appropriate after the various comments made by the agencies.

Please contact me if you have any queries relating to our replies.

Yours faithfully,

David Potter
Tallwood Pty Ltd

Mannum Waters, Marina and Residential Development Proposal
Replies to Agency Comments on Response Document

South Australian Murray-Darling Basin National Resources Management Board

Dear Sir.

Re: Mannum Waters Marina and Residential Development Proposal

Thank you for the opportunity to review the response to submissions received for the Environmental Impact Statement of the above proposal. The SA Murray-Darling Basin Natural Resources Management Board takes a keen interest in this development, due to its potential impacts on natural resources in the area (positive and negative).

As a result of our review of the Developer's most recent submission, we recommend the following actions:

Submission Reference (as numbered in Developer's Response to EIA Submissions)	**SA Murray-Darling Basin NRM Board comment on adequacy of Developer response**	**Further action required**
G10-1	It is noted that the Developer will cover these issues in the Environmental Management and Maintenance Plan (EMMP).	Draft EMMP to be submitted to NRM Board for comment and approval prior to adoption by Council.
Reply	The proponent acknowledges the requirement to submit the draft EMMP to the NRM Board for comment and approval prior to adoption by Council and will comply with the requirement.	
G10-2	With reference to Page 8, Section *5.1, Table 2 (Water balance), Item 2; final paragraph of remarks from Developer*. This paragraph suggests that an additional 220ML of storage between high and low river levels is of benefit to other extractors of water from the river. This suggestion is either poorly explained or incorrect.	Developer to either: discontinue use of this point as a benefit of the development; or explain in more detail how this benefit could be realised by any other river user given the operational context of the River Murray.
Reply	The proponent believes that this is of insufficient consequence to continue to use the point as a project benefit and is happy for it to be deleted from the project assessment.	
	With reference to *Page 6. Figure 3 (Revised water balance):* This table makes no reference to the demand and inflow variations throughout the year and between years. For example, the majority of rainwater inflow will generally occur during winter months, while the majority of evaporation and irrigation demand will occur during summer months. Given that the Developer proposes to maintain a marina water level equivalent to the river level (ie. constant connection), how does the Developer propose to achieve winter storage for use in summer?	The Developer must demonstrate how equitable and transparent water accounting will be achieved according to the River Murray Water Allocation Plan. This water accounting must address seasonal and year-to-year variations in marina inflows from the local catchment and outflow via evaporation
Reply	Annual evaporation and rainfall for the site can not be identified prior to the events. The proponent believes that an equitable basis would be to determine the annual water requirement based on the previous five year average figures for evaporation and rainfall. This will allow a water balance to be prepared each year and provide a stable basis for determining what level of water purchase (either permanent or temporary) is required for the coming year. Restrictions applied to permanent licenced allocations will be supplemented by temporary water purchases. Desalinated groundwater will only be used if it is practical and approved by the relevant government agencies.	
G10-3	Method of addressing Issue is satisfactory	NRM Board to be provided with copy of draft groundwater investigation report for comment and approval prior to adoption.

G10-4	Refer above	Refer above
Reply	A copy of the draft groundwater investigation report will be forwarded to the NRM Board for comment and approval prior to adoption.	
G10-5	Satisfactory response	No action required
G10-6	Satisfactory response	Draft Wetland Management Plan and EMMP to be submitted to NRM Board for comment and approval prior to adoption by Council
Reply	The proponent acknowledges the requirement to submit the Draft Wetland Management Plan and EMMP to the NRM Board for comment and approval prior to adoption by Council and will comply with this requirement.	
G10-7	Satisfactory response	Home Owner's Charter to reflect Developer's response
Reply	The proponent has previously agreed with this requirement within the response document.	
G10-9	Satisfactory response	NRM Board to be consulted at commencement of detailed design stage on expectations regarding WSUD elements (including stormwater treatment train, wastewater reuse and demand management measures).
Reply	The proponent will consult with the NRM Board at commencement of the detailed design stage regarding WSUD elements.	
G10-10 and G10-11	The stormwater quality modelling does not satisfactorily address the original request from the NRM Board. The original request is copied below, with those aspects NOT addressed by the Developer underlined and in bold: *7.1 Details be provided regarding the anticipated pollutant loads expected to emanate from the development (when fully established) at:* *a) The points of discharge to the marina waterways, and* ***b) The point of discharge from the wetland to the River Murray*** *7.2 Details be provided of modelling undertaken to ascertain the ability of the proposed treatment measures, including GPTs, retention basins and the constructed wetlands, to treat the anticipated pollutant discharges to the acceptable standards for aquatic ecosystems, including:* ***a) compliance with the EPA Environment Protection (Water Quality) Policy, and*** **b) *compliance with the Australian and New Zealand Environment and Conservation Council (ANZECC) Australlan and New Zealand Guidelines for Fresh and Marine Water Quality (2000) ("the ANZECC guidelines), for aquatic ecosystems,* and** *c) the storm water quality load reduction targets detailed in Table I below:- (table not included as Developer response did address this fable*	The Developer shall submit a detailed water quality modelling report that addresses the omissions detailed in the column to the left. According to standard water quality modelling practice, this report must also demonstrate: • How the water quality model has been calibrated to the Mannum Waters site? • What data sources have been used in modelling the site, and what is the quallty/reliability of this data? (the NRM Board is able to provide continuous stormwater quality monitoring data for a nearby catchment in Mannum on request) • What assumptions have been made in modeling the effectiveness of various treatment train elements? eg GPT effectiveness is highly variable with type of GPT and catchment Characteristics.

Reply

Item 1: Discharge into the River Murray

Section 7.1 (b) states *"Details to be provided regarding the anticipated pollutant loads expected to emanate from the development (when fully established) at the point of discharge from the wetland to the River Murray"*.

As requested, additional MUSIC modeling has been undertaken to include the stormwater discharge into the marina from the full development and the River Murray water passing through the marina and the treatment wetland before it re-enters the River Murray. This is outlined below.

However, in the first instance, in order that it is seen in its proper context, the overall potential benefits of the project on water quality and the role of the treatment wetland are briefly restated.

(A) Overall Water Quality Benefits

As outlined in Section 5.2 of the Response Document, water quality in the waterways and River Murray is to be protected by the control of all major sources, including:

- The interception and treatment of all urban stormwater runoff.
- The collection, treatment and reuse of all sewage and greywater from vessels using the marina, noting that currently grey water is not treated and is discharged direct to the river.
- The cessation of grazing on the property and removal of stock, which currently access the river front.
- The removal of the SA Water Effluent Ponds.

The treatment wetland is not intended to be the prime water quality protection mechanism, but provides a valuable safeguard. Overall, as described in the previous documents, water quality in the marina waterways will be the same as that of the River Murray. The high rate of turnover, controlled by pumping, ensures that this is the case. Even though it is 6 ha, the treatment wetland will have only a short residence time because of the high turnover. The modelling undertaken still indicates a small net pollutant reduction, even though the removal of greywater, stock contamination etc are not quantified.

(B) Modeling

The model has been set up to include the following parameters:

- 6-minute rainfall data for Karoonda from June 2002 to April 2006.
- Daily inflow pumped through treatment wetland: 52,000kL/day (10% of the volume of the marina based on the requirement for the entire marina volume to be turned over every 10 days)
- Marina volume is 519,000kL with a surface area of approximately 25 hectares
- Volume of treatment wetland: 103,000kL
- Area of treatment wetland: 6 hectares
- Median TSS of River Murray water: 20mg/L
- Median TP of River Murray water: 0.12mg/L
- Median TN of River Murray water: 0.77mg/L

River Murray water quality data has been obtained from the water monitoring station at Mannum.

The proportion of water, nitrogen, phosphorus and suspended solids entering the marina from the River Murray in comparison to the subdivision is shown in Table 1. It shows that the volume entering from the subdivision is a small fraction compared to the water entering from the Murray. Essentially the water leaving the treatment wetland is River Murray water.

Table 1: Pollutant Load Sources

Parameter	From subdivision	From River Murray	% of total entering marina from subdivision
Flow	27.6ML/yr	18,900ML/yr	0.15
TSS	978 (kg/yr)	379,000 (kg/yr)	0.26
TP	5.2 (kg/yr)	2,270 (kg/yr)	0.23
TN	44 (kg/yr)	14,600 (kg/yr)	0.30

The total pollutant loads entering (from the River Murray) and exiting the marina are summarised in Table 2. It shows a small reduction in loads based on the improvement in water quality due to the treatment wetland. Based on the flow rate through the wetland average residence times will be in the order of two days. Even though additional pollutants are generated by the subdivision, the treatment train proposed within the subdivision combined with the treatment wetland shows that there will be no increase in annual pollutant loadings after the development is completed and established.

Table 2: Inflow and Outflow Pollutant Loadings

Pollutant	Inflow from River Murray* (kg/yr)	Outflow to River Murray (kg/yr)	% reduction
TSS	379,000 (978)	372,000	1.8
TP	2,270 (5.2)	2,240	1.3
TN	14,600 (44)	14,400	1.4

* numbers in brackets show the annual loading derived from the subdivision

Due to the small fraction of pollutants entering the marina from the subdivision compared to the inflow of River Murray water, the annual loading of water entering the Murray from the marina has a very low sensitivity to the concentration of the pollutant load being generated by the runoff from the subdivision. In absolute terms the pollutant load entering the marina from the subdivision is also low due to the high effectiveness of the proposed treatment train within the new development, as detailed in Section 5.2 of the response document by the proponent (October 2007).

Item 2: Calibration to Mannum Waters Site

The first dot point in the further action required column states *"the report must demonstrate how the water quality model has been calibrated to the Mannum Waters site"*

The pollutant load from the new development has been based on typical parameters generated by an urban catchment. The water quality parameters in Table 3 have been used for the MUSIC modelling. Due to the developed nature of the catchment the majority of annual pollutant loads will be generated by storm flow (runoff from impervious areas) rather than from base flows (only generated from pervious areas).

Table 3: MUSIC pollutant parameters for residential area of catchment

Pollutant	Base flow Concentration (mg/L)	Storm flow Concentration (mg/L)
TSS	16	200
TP	2.6	3.3
TN	0.2	0.45

The model has taken into account the likely proportion of the catchment that will be roofs and has directed this runoff through tanks with a demand on the tanks based on the likely number of people living in each dwelling.

The rainfall data has been sourced from nearby Karoonda which has similar rainfall characteristics to Mannum. The proportion of impervious area has been based on the proposed allotment sizes and an estimate of average dwelling sizes.

The wetland performance capabilities have used the pollutant removal algorithms within MUSIC for a wetland. These parameters have been based on a number of field studies of actual wetland performance. Therefore it is believed that the MUSIC model has been set to provide a realistic representation of the likely performance of the proposed treatment train which includes rainwater tanks, GPTs and wetlands (refer Item 4).

Item 3: Data Sources

The second dot point in the further actions required column states *"the report must demonstrate what data sources have been used in modeling the site, and what is the quality/reliability of this data"*

	One of the key components to the model is decent rainfall data. As stated above the model used rainfall from nearby Karoonda from June 2002 to April 2006. The rainfall data is high quality 6 minute data which provides for an accurate model of the fluxes of flow through the wetlands (as opposed to daily time step modeling). Over 4 years of modeling is considered adequate to provide for the purposes of water quality modeling. Runoff quality data for the subdivision has been based on typical parameters for a residential subdivision. The revised modeling has now incorporated inflow of River Murray water into the marina. The water quality data has been sourced from water quality monitoring in the river at Mannum and is considered suitable for the purposes of the modeling. **Item 4: Assumptions** The third and final dot point in the further actions required column states *"the report must demonstrate what assumptions have been made in modeling the effectiveness of various treatment train elements."* The third paragraph of the original Tonkin Consulting advice (see Response to Submissions Appendix B) states the pollutant removal efficiencies of the gross pollutant traps (GPTs). The letter referenced a comprehensive report indicating where the removal rates were sourced from. The pollutant removal efficiencies of the wetlands are based on the calibrated values for wetlands embedded into the MUSIC model. These values have been calibrated against a number of field studies undertaken by the developers of the MUSIC model. The wetlands are to be carefully designed such that they will be highly effective at removing pollutants. This includes correctly sizing the residence times based on the size of the upstream catchment, ensuring that short circuiting cannot occur, spreading flow evenly through the areas of shallow vegetation and providing deep areas to ensure they do not dry out (these details were shown on the attached wetland concept sketch to the letter referenced above). Therefore the default wetland pollutant removal rates are considered appropriate in the MUSIC modeling.	
G10-12	Satisfactory response	No action required
G10-13	Satisfactory response	Draft Construction Environmental Management Plan (CEMP) to be submitted to NRM Board for comment and approval prior to commencement of any construction activity on site, including land clearing.
G10-14	Satisfactory response	Refer above
Reply	The proponent acknowledges the requirement to submit the draft CEMP to the NRM Board for comment and approval prior to commencement of any construction activity on site, including land clearing, and will comply with this requirement.	

Should you have any queries regarding these comments, please contact the SA Murray-Darling Basin NRM Board's *Senior Policy Officer* (*Local Government/Water Quality)*, Mike Penhall, on 8532 1432 or Mike.Penhall@samdbnrm.sa.gov.au at your convenience.

Yours faithfully

Simon Sherriff
Principal Project Officer (Local Government)
South Australian Murray-Darting Basin Natural Resources Management Board

SA Water

Lee Webb
EIA Unit
Planning SA
GPO Box 1815
ADELAIDE SA 5001

Dear Lee

COMMENT ON THE MANNUM WATERS RESPONSE DOCUMENT

In general SA Water are happy with the responses provided in the document, particularly with regard to the responses to SA Water's comments listed in Section 6, Part G8, Items 1-10.

Tallwood have provided additional information in the Response to Submissions document in regard to Water Quality in Section 5.2.

Under paragraph 5.2.1 Overall benefits to water quality of the proposal, Dot Point — The removal of the SA Water effluent and sludge lagoons, Tallwood make a number of statements in regard to the SA Water treatment lagoons being "potentially a significant pollutant source", "river contamination is likely" and "no testing has been undertaken of lagoon water".

These statements are not supported nor endorsed by SA Water.

SA Water monitors influent and reuse water quality (there is no effluent discharge to the river) including metal concentrations on a regular basis. These do not show any levels of heavy metals which would cause concern regarding any detectable contamination let alone a significant contamination as stated in the report.

Further the comparison with the Onkaparinga sludge evaporation lagoons is not valid as these are significantly larger, take waste from a metropolitan catchment serving over 30,000 connections including industry and their method of operation is different.

Tallwood further state that a groundwater assessment has commenced. On this basis it is recommended that the paragraph under Section 5.2.1 be disregarded pending the groundwater assessment results.

Reply: SA Water’s comment is noted. The proponent agrees that statements outlined above and included in paragraph 5.2.1 in the Response to Submissions were premature and should be disregarded pending the groundwater assessment results.

Yours sincerely

Roger Perry
HEAD OF PLANNING & **INFRASTRUCTURE**

Department for Transport Energy and Infrastructure

Manager
Assessment Branch
5'" Floor
136 North Terrace
ADELAIDE SA 5001

Dear Sir/Madam,

RE: EIS RESPONSE DOCUMENT - MANNUM WATERS RESIDENTIAL MARINA PROPOSAL

The Transport Services Division (TSD) and the Policy & Planning Division (PPD) of the Department for Transport, Energy and Infrastructure apologise for the delay in responding and provide the following comments to the EIS response document:

The response document addresses many of the issues raised by DTEI in its response to the EIS document dated 14 August 2007. Notwithstanding this several issues remain unresolved. This includes the carrying out of the required road works at the Mannum — Murray Bridge Road/ Belvedere Road, Tea Tree Gully Road/ Berryman Road and Tea Tree Gully Road/Ramm Road junctions and the undertaking of a survey of the marina basin.

With regards to undertaking the required road works there appears to be a reliance of scheduled works by DTEI to overcome potential intersection shortcomings. DTEI does not support this as the design of shoulder sealing would not be done for the same safety benefit as an auxiliary upgrade of a junction. Subsequently, DTEI requires that all road works required be designed and constructed to the satisfaction of DTEI with all costs being borne by the applicant.

Reply: The proponent acknowledges that all road works required external to the project site will be designed to the satisfaction of DTEI with all costs being borne by the proponent. This was previously stated in G11-1, G11-4 and G11-7 of the “Response to Submissions” document.

With respect to the undertaking of a survey of the marina basin it has been identified that a hydrographic survey is not needed, but a full documented survey is to be prepared reduced to Chart Datum. It is unclear, however, whether this survey will he carried out at the time of excavation, before water is admitted to the area. If so, the depth of the new bed will change on admission of water due to silt being washed into the marina from the river. The survey must therefore take this into consideration. It is also recommended that the depth of the marina should be to the same standard that SA Water is using for the river adjacent to the marina.

Reply: The proponent acknowledges the requirement to prepare a full documented survey of the waterways and marina following completion of the excavation. This will be undertaken on completion of the excavation and prior to the admission of water from the river. Water will be admitted slowly through small bore pipe and the existing levee will not be breached until the water levels on either side of the levee have reached the same height. Under these circumstances silt from the river is expected to be inconsequential. Nevertheless the proponent will consult with DTEI at the time of filling and should it be deemed necessary a further survey after filling will be undertaken to the satisfaction of the DTEI.

DTEI notes that the Spill Contingency Plan does not make reference to the South Australian Marine Spill Contingency Plan Action Committee. This Department should also be consulted in regards to the location of spill response equipment trailers for such a contingency. The applicant should address this requirement within the Marina Owners Charter.

Reply: The proponent acknowledges the request by DTEI to include a reference to the South Australian Marine Spill Contingency Plan Action Committee and will make reference to this requirement within the Spill Contingency Plan after consultation with the Committee. The proponent will consult with the department in regard to the location of spill response equipment trailers.

In view of the above DTEI recommend that the following conditions be attached to any approval granted:
• That the required upgrading of the Mannum — Murray Bridge Road/ Belvedere Road, Tea Tree Gully Road *1* Berryman Road and Tea Tree Gully Road Ramm Road junctions shall be designed and constructed to the satisfaction of DTEI. All costs (including design, construction and project management) shall be borne by the applicant. Prior to undertaking any road works the applicant shall contact DTEI Eastern Region, Investigation & Safety Officer, Ms Allison Allen on telephone (08) 8532 8122.

Reply: Accepted by the proponent. This was previously stated by the proponent in the "Response to Submissions" document

• That the design of the marina shall comply with AS 3962:2001 and AS4997:2005.

Reply: Accepted by the proponent. This was previously stated by the proponent in the "Response to Submissions" document

• That the final design of the marina, all signage and navigational lighting associated with the marina, depths of the marina basin and depth surveys shall be to the satisfaction of DTEI prior to the development becoming operational. The applicant shall discuss these requirements with DTEI Commercial Marine Services Manager, Mr Joe Rositano (telephone (08) 8348 9569).

Reply: Accepted by the proponent

Yours sincerely,

MANAGER, TRAFFIC AND ACCESS STANDARDS
for COMMISSIONER OF HIGHWAYS

EPA

Manager
Assessments Branch
5th Floor
136 North terrace
ADELAIDE SA 5000

Dear Sir

Mannum Waters Environment Impact Statement (EIS)

Officers from the Environment Protection Authority (EPA) met with Mr David Potter, a representative of the Mannum Waters project on Friday 30 November, 2007 to discuss some ambiguities evident in the Mannum Waters EIS regarding setback of buildings from the pool level of the proposed canal.

At the meeting, Mr Potter confirmed that the setback from building envelope to pool level will be 19 metres for 40 metre deep blocks and 49 metres for 70 metre deep blocks. The EIS indicates that setback will be 15 metres.

It was also confirmed that it is intended to:

1. Plant selected species at water's edge with the view to intercepting any sediments or nutrients.
2. Plant selected species within a 5m riparian corporate zone designed to minimize transportation of sediments into the watercourse.
3. Create a House Owner's Charter as per the Draft provided in Appendices to the EIS which includes a restriction on refuelling of vessels while moored on waterfront land.
4. Undertake slope stabilisation/on-block mitigation via "lawn" establishment during site preparation /development.
5. Construct allotments such that the following approximate slopes result:
   - 1:16 (3.6 degrees) on 40m deep allotments, and
   - 1:42 (1.4 degrees) on 70m deep allotments.
6. Allow for infiltration of stormwater via the selection of suitable topsoil during the construction phase.
7. Collect stormwater from rooves into rainwater tanks with overflow to the proposed stormwater system.
8. Collect road runoff to stormwater system.
9. Treat canal water via the proposed wetland prior to return to the River Murray. Wetland discharge to be monitored in accordance with proposed Environment Monitoring and Management Plan.
10. Incorporate spill management provisions which will include the ability to isolate canal system from Rivet Murray.
11. Continue negotiations with SA Water for the removal of existing unlined effluent lagoons and replacement with a mechanical Waste Water Treatment Plant.

In order to address the issue of setbacks, it is recommended that the following conditions are attached to any approval that may he granted:

1. Setbacks from building envelope to pool level are to be no less than:
   - 19 metres for 40 metre deep blocks and
   - 49 metres for 70 metre deep blocks.
2. Allotment slopes will be approximately:

- 1:16 (3.6 degrees), on 40m deep allotments and
- 1:42 (1.4 degrees)on 70m deep allotments

Reply: The proponent confirms and accepts all of the comments addressed by the EPA in regard to setback distances and the treatment of stormwater run-off as outlined above. However, in regard to the conditions of approval the proponent requests that for 70 metre deep allotments the minimum setback distance be relaxed to 40 metres.

For further information on this matter, please contact Peter Torr on 82042136 or peter.torr epa.sa.gov.au or Kym Pryde on 82042136 or kvm.pryde@epa.sa.gov.au

Yours sincerely

Peter Torr
MANAGER, ENVIRONMENT ASSESSMENT
SCIENCE & SUSTAINABILITY DIVISION
ENVIRONMENT PROTECTION AUTHORITY
Date: *14/12/07*

EPA

EPA 05/12306
Manager
Assessment Branch
5th Floor
136 North Terrace
ADELAIDE SA 5000

Dear Sir

Thank you for the opportunity to comment on the "Mannum Waters" Response Document. The following response is on behalf of the Environment and Conservation portfolio.

DEPARTMENT OF WATER LAND AND BIODIVERSITY CONSERVATION

G4 —1 WATER REQUIREMENTS OF THE PROPOSED DEVELOPMENT

Tallwood Pty Ltd has been issued with water licence 131297, which has been endorsed with an Environmental Land Management Allocation (ELMA) of 127356 KL. This water must be used on the land noted on the water licence being CT 5977/589 and CT 5913/489, and must be used for the purpose of environmental land management, particularly reducing the impacts of rising saline ground water.

Any extraction from the River Murray to fill or maintain the level of the wetland would need to be licensed and accounted for. If this was going to be done using the ELMA water licence then the extraction must be within the authorised volumes in any given year eg taking into account any restrictions imposed.

The filling of the basin and associated water level maintenance would be achieved through use of an existing water licence and water to be acquired from the open market, both of which would be licensed.

The amount of water that will need to be held on licence will be dependant on the final size of the basin and the staged development progress and would need to be monitored during the development process. However, the proponent would need to hold on licence sufficient water to fill the basin during any initial fill, possibly a couple of fills if a staged development, and then an annual volume to account for the refilling to top up due to evaporation.

Licensing requirements will need to be the subject of further discussions between the proponent and the Berri River Murray Licensing Office of DWLBC.

Reply: The proponent understands and accepts that all water to be used within the waterways and marina both for filling and to account for annual evaporation losses must be obtained through the holding of water licences acquired from the open market. The proponent proposes to use its water licence endorsed with ELMA for the sole purpose of maintaining the newly constructed wetland and will manage the wetland water use within the available allocation which includes the restrictions that may occur from time to time.

The proponent also acknowledges that the water requirements will depend on the final size of the waterways and marina and the stages of its development.

In regard to the water requirement to account for the annual evaporation losses, as suggested previously within this document by the proponent, an equitable basis would be to determine the annual water requirement based on the previous five year average figures for evaporation and rainfall. This will allow a water balance to be prepared each year and provide a stable basis for determining what level of water purchase (either permanent or temporary) is required for the coming year.

G4-3 LEGAL AND POLICY FRAMEWORK

In order to access desalinised groundwater.

- If it is taken from within the Eastern Mt.Lofty Ranges Prescribed Water Course, as the prescription of the EMLR extends to underground water, no additional underground water can be taken under the current management arrangements (due to the current moratorium). The proponent would need to make application as a new user after the Eastern Mount Lofty Ranges Water Allocation Plan (WAP) is released in approximately 18 months time for the granting of a licence to be considered. However, at this time there is no guarantee of water being available to a 'new user' and in this situation water would need to be purchased.
- If the water is to be taken from the River Murray Prescribed Water Course it would similarly need to be accounted for as with any other River Murray allocation. That is it would need to be licensed, allocation purchased, and use monitored.

Also, if the construction of the basin results in the collection of groundwater, then this would be classed as extracting River Murray water and would need to be provided for under a licensed allocation.

In respect to the utilisation of groundwater through desalination, as this is the first time the idea has been tabled, insufficient information has been made available for comment. This issue was not addressed in the ElS, and requires information to be made available as to whether this would be taken from the River Murray or Eastern Mt. Lofty Ranges ground water resources. (Detailed discussions with regional licensing officers may be required).

Reply: The proponent acknowledges the Department's clarification in regard to the acquisition and use of groundwater. As stated in the proponent's response, above, water for the filling and evaporation from the waterways and marina will be obtained by acquisition on the open market. The use of groundwater would only occur after detailed investigation, consideration and approval by the relevant agencies indicated that it was an appropriate water source.

G4-4 AVAILABILITY OF WATER

The revised water balance for an 'average' year appears reasonable, so the 180.5 ML loss from the marina complex could be adopted as the average water requirement. The revised water balance has excluded creek runoff as requested by DWLBC. It also excludes the ephemeral wetland, which can be managed separately under the ELMA allowance.

Discussion with DWLBC will need to occur as to what is a reasonable water balance regarding the ongoing licence. Given the trend to dry years, licensing conditions will address consumption for dry years, so the water use for the marina would not exceed the licensed amount and provisions to purchase more water if necessary are provided.

Reply: As indicated above, the proponent believes than an equitable basis for assessing the annual losses for each coming year would be to base it on the average rainfall and evaporation figures of the previous five years.

G4-5 WATER QUALITY/SALINITY

The proposed groundwater investigations are quite adequate.

In respect to salinity impact the principle of proponent responsibility of accountability for salinity impacts resulting from the marina and wetland should be acknowledged.

Reply: The proponent acknowledges its responsibility and accountability for salinity impacts from the waterways, marina and wetland developments

G4-6 HYDROLOGY

The ephemeral wetland water requirements could be easily satisfied if the full allocation amount of 127 KL is available under the ELMA licence. However, in drought years when licence allocation percentages are reduced, there may not be sufficient water under this licence to operate the wetland. In this situation

where the continued operation of the wetland may be advantageous for example, for water quality and filtration purposes, purchase of additional water would need to occur.

Reply: The proponent has been advised by its environmental consultant that the allocation of ELMA water will be sufficient to maintain the constructed wetland. Nevertheless, the proponent acknowledges that should additional water be considered necessary to maintain water quality it will be purchased by normal trading on the open market.

G4-7 BACKFLOW TO THE RIVER FROM THE MARINA AND WATERWAYS

It would be difficult for the proponent to prevent backflow from the main entrance given that this entrance is to be used by houseboats. The proponents response that a significant proportion of backflow would be water that had just entered the marina from the River and had little opportunity to mix with marina water is acknowledged. However, it is reasonable to expect that the risk associated with backflow to the river is managed and for the proponent to acknowledge that statements in the EIS that all flow through the complex will pass through wetlands are incorrect. The modelling clearly shows this is not the case, particularly when the pumps are not operating.

Reply: The proponent indicated within the EIS that backflow to the River Murray will occur but noted within the Response to Submissions document that generally water returning to the river would be that water which has recently entered from the River. The proponent does acknowledge that statements which occurred within the EIS "that all flow will pass through wetlands" are incorrect and should have read "that the majority of flow will pass through wetlands".

G4-8 BACKFLOW FIGURES

With the clarification of the backflow percentage calculation, the figure of 20% appears reasonable. However, it should be noted that this figure was determined for a 180 day trial period assuming that all pumps were operating 24 hours a day, seven days a week. During periods without pumping, backflow would be mo*re* significant and the modelling results show that there would be a cumulative flow out of the main entrance rather than in. The issue is that not all water passing through the marina will be treated in the wetland. Monitoring backflow from the main entrance should be addressed in the Environmental Management and Maintenance Plan.

Reply: The proponent intends that pumping will be utilized to assist in the maintenance of water quality returning to the River Murray and also within the waterways and marina of the development. It is proposed that pumping will be linked to field monitoring. In regard to times without pumping, inflows, as a normal consequence, will balance outflows to maintain a level equilibrium between the River/waterways and marina.

The proponent will ensure that monitoring of backflows to the River will be addressed in the Environmental Management and Maintenance Plan

G4-9 WATER QUALITY MONITORING.

DWLBC reiterate that water quality monitoring should address these locations to provide information about any potential discharge of pollutants to the river during backflow events.

Reply: As indicated above, the proponent will ensure that monitoring of backflows to the River will be addressed in the Environmental Management and Maintenance Plan

G4-10 SPILL CONTINGENCY PLAN

The likelihood of a spill near the entrance during a backflow event is low, however this should be addressed in the Environmental Management and Maintenance Plan.

Reply: The proponent will ensure that the Spill Contingency Plan including the possibility of a spill near the entrance will be addressed in the Environmental Management and Maintenance Plan.

G4-11 USE OF CREEK WATER

The proponent has conceded that they can't claim creek flows in their water balance because the resource is covered by the Eastern Mount Lofty Ranges prescription. However they still claim that the creek will provide "effective gains in flows to the river compared to the current situation". This implies they are still working on the assumption that there will be significant flows out of the catchment when hydrological advice suggests that they could expect no reliable flows out of the upstream catchment and therefore, regardless of the EMLR prescription there would not be any significant gains in flows to the river compared to the current situation.

On page 8, point 3 the proponents have agreed to remove the creek contribution of 138ML/annum from their water balance because the resource is covered by the Eastern Mount Lofty Ranges prescription. However, in discussion of the average yearly loss of the marina of 180.5 ML, they still state "in reality this will be off set by flows from the creek". This statement is incorrect and should be removed as it implies the proponent is still working on the assumption that there will be significant flows out of the catchment. However, hydrological advice has been that they could expect no reliable flows out of the upstream catchment and certainly would not be able to off set 180.5 MI/annum regardless of the EMLR prescription.

Reply: The proponent sought advice from two independent consultancies both of which indicated that water of various quantities would be available from the creek catchment. However the proponent does acknowledge that there is no agreement to what the average annual creek flow would be and more importantly that the EMLR prescription precludes the proponent from including any water from the creek catchment within the water balance.

G4-12 Native vegetation

The proponent has included the addition of a clause in the House Owners Charter eg "a landowner or person must not clear remnant native vegetation from the land

The proponent has indicated that the final clause to be included within the House Owner's Charter will be agreed by DWLBC. It would be preferred if the Native Vegetation Act and Regulafions 1991 are referred to in any clause. Wording previously supplied by the DWLBC is considered suitable that:

> “no remnant native vegetation can be cleared without the prior approval of the Native Vegetation Council, or unless the clearance is in accordance with the provisions of the Native Vegetation Regulations 2003".

The advantage of the adoption of this more specific wording would be that there would be less likelihood of confusing prospective landowners, therefore there may be less chance of someone inadvertently undertaking clearance contrary to the Act.

Reply: The proponent will ensure that the words indicated above as supplied by the DWLBC will be included in the House Owner’s Charter.

Additional Comment

Evaporation from the marina, waterways and treatment wetland (pg 8, point 3):

A comparison of the 1956 flood level (shown on Figure 5.2 of the EIS) with Figure 1 in the Response to Submissions shows that the creek meets the north-western arm of the marina below the 1956 flood level. Therefore, any creek water received by the marina would be defined as River Murray water. Taking this water would be subject to the same conditions as taking water from the River Murray channel. The only water the marina development has an unambiguous entitlement to offset against its evaporative demand is direct rainfall to the marina water bodies. Local urban stormwater runoff has also been used in the water balance to offset the evaporative demand, as it is reasonable to expect that the proponents will have ongoing lawful access to the stormwater infrastructure.

Reply: The point is noted by the proponent and that it reflects the basis of the currently accepted water balance.

For further Information: Kent Truehl Tel 8463 6852.

DEPARTMENT FOR ENVIRONMENT AND HERITAGE

G7-3 TRANSFER OF RIVERINE WETLANDS TO COUNCIL
Whilst the proponents support the future dedication of Sections 856 and 857 to Mid Murray Council, it is not known if Council is prepared to accept the land (and/or under what conditions). It is recommended that dialogue be commenced between the proponents, Mid Murray Council and DEH on this matter. The appropriate DEH contact on this matter is David Haslam, Crown Lands Manager River/SE; telephone 8595 2105.

Reply: The proponent has discussed this item with representatives of Mid Murray Council at the working group established between the proponent and the Council. Council has indicated its willingness to pursue the future dedication of Sections 856 and 857 and will participate with DEH and the proponent in arriving at an appropriate Land Management Agreement. A Draft Development Deed and Draft Land Management Agreement have been prepared by Council as an indication of the understanding held between the proponent and Council. Discussions will be held between DEH, Mid Murray Council and the proponent in the near future.

G7-4 VEHICULAR ACCESS TO SUBJECT LAND
Although it is stated that vehicle access will not be permitted to the subject land, DEH would prefer that the proponents acknowledge the fact that the permanent mooring of houseboats on the Crown land will cease, as this appears to have been avoided in their response.

Reply: The proponent does not support the permanent mooring of houseboats on the Crown Land and acknowledges that it will cease.

G7-5 SECTIONS 856 AND 857
As for G7-3 above, further dialogue on this matter is required.

Reply: See G7-3 above

For further information: De'Anne Smith Tel 8463 4824

ENVIRONMENT PROTECTION AUTHORITY (EPA)

WATER QUALITY

G7-13 GREY WATER
Response acceptable to EPA.

G7-15 (B) STORM WATER
Accepted that gross pollutant traps, sedimentation basin and treatment ponds are above the 1956 flood line prior to discharge to River Murray.
EPA recommends a condition of approval giving effect to this requirement.

Reply: The proponent accepts this proposed condition.

G7-18 USE OF "RECLAIMED" WATER
Response acceptable.

G7-22 CONSTRUCTED WETLANDS AND VEGETATION MANAGEMENT
This will be an issue of vegetation performance. The response is acceptable. EPA recommends that Environment Monitoring and Management Plan requires:

a) Monitoring (pH and salinity) of wetlands
b) Contingency plan for extreme readings.
c) Species to be selected following investigation of substrate.

Reply: The proponent accepts the recommendations outlined above.

G7-26 RIVER OPENING
Response acceptable.

G7-28 SPECIFICATION FOR WETLAND
The stormwater treatment system element of the wetland was in the south western corner of the wetland complex. We have not see the scale of the sedimentation ponds (related GPTs) and also the treatment capacity of the wetland has not been modelled yet. Need to "face" the Music model or something similar.

Reply: Please see response to comments by South Australian Murray-Darling Basin National Resources Management Board under G10-10 and G10-11

For further information: John Riggs Tel 81399921

***SITE CONTAMINA*TION**
The following comments are provided in relation to the statements on the issue of site contamination given in Appendix A and Appendix C of the *Mennurn Waters Marina & Residential Development— Response to Submissions,* issued- October 2007, prepared by the proponents,Tallwood Pty Ltd.

It is confirmed that the EPA has received notification (in a letter) dated 27 August 2007 that an Auditor (Andrew Nunn) has been engaged to prepare a site audit report for all of the residential component of the land proposed for the Marina. This incorporates portions only of the following certificates of titles: CT 5871/733, 01 5792/113_1 CT5977/589, CT5913/469 and CR 5267/641. Further confirmation of the engagement and likely elements required to complete the audit were outlined by the Auditor in an additional e-mail dated 13 September 2007.

The EPA understands that a number of residential allotments in the proposed subdivision will be built on land currently occupying the SA Water sludge stock piles, waste water lagoons and sludge evaporation pond. It was noted by the Auditor in an additional email of 13 September that should the NEPM compliant Site History indicate that this portion of the site is potentially contaminated then further confirmation of the engagement and likely elements required to complete the audit will be required.

The engagement of the Auditor and the ultimate preparation of a Site Audit Report will ensure the suitability of the above proposed residential allotments of the proposed development and will fulfill a number of recommendations made in relation to site contamination in response to the EIS.

An Environmental Site Assessment (ESA) prepared by Soil and Groundwater for Tallwood is provided in the Response Document, (Appendix C). The EPA notes that the ESA did not consider land described by titles CR 5749/39, CR 5749/38.

The following comments are provided in relation to responses given by the proponents to issues raised by DEH and EPA for the EIS Mannum Waters:
The objective of the ESA-Phase 1 was to identify site contamination issues associated with the past and present site usage, these were summarised in Table 5 and Figure 6 of Appendix C.

The EPA notes that the proposed development areas have the following potentially contaminating activities as listed from Appendix 1 of the Planning and Advisory Notice 20 (PAN 20) reported in the site investigations of the ESA:

Residential:

- ***Agricultural/horticultural activities and the use of agricultural chemicals;*** dairy, cattle and sheep farming, particularly around the dairy, drain and bull sheds (termite control, washdown of lice control and spraying of chemicals) of the northwest portion of the site: CT 5913/46 land currently owned by the proponent, Tallwood Pty Ltd.

- ***Accidental* spillage *of chemical* wastes/substances;** the above ground diesel and petrol storage tanks (2) which (were filled every three months) and numerous oil drums are located in the vicinity of the central portion of the property on title CT 5S711733, land privately owned by Barry Resche. The servicing of tractors,vehicles, boats and machinery associated with building of houseboats/pontoons was conducted in this vicinity.

- ***Spreading* of sewage *sludge;*** the SA Water lagoons are unlined, except for naturally occurring clay; an evaporation pond in the northeast portion of CR 5267/641 is used to dry the sludge, which is then stockpiled in an area located on the western portion of this title. Treated effluent from one of the lagoons is pumped to the golfcourse and sprinklers deliver lagoon water to higher ground to reduce overflow of the lagoon.

- ***Migration of contaminants into a site from neighbouring land;*** adjacent to the proposed development is the Mannum municipal landfill (EPA licence 2032). It is noted in the responses to Common Issues section of the response to submissions, section 5.3 Groundwater, that a specific program of works was targeted towards providing information on the chemical status of groundwater in the vicinity of this site and the wastewater treatment plant (WWTP) The EPA notes that the field program approved by the DWLBC includes analysis of the Vic EPA screen plus nutrients and biological parameters in the wells adjacent to these sites. The EPA notes that the proponent states in issue G7-35.7 that the Environmental Auditor (Site Contamination) is actively pursuing information, taking into consideration investigations in relation to the proposed conceptual and numerical groundwater model which simulate the effects of the proposed development on the (audited area) current environment. *It is recommended that responses referring to the suitability or interpretation of these investigations he revised to take this into account.*

Reply: The proponent confirms that the results and recommendations ensuing from the current groundwater investigations will be taken into account in identifying the suitability and actions of future development works

The engagement of the Auditor and the ultimate preparation of a Site Audit Report will ensure the suitability of the land proposed for the residential use.

Reply: The proponent acknowledges the requirements for the residential areas of the development and will prepare a Site Audit Report. Where required, the assessment and audit roles will be separated in consultation with the EPA.

Non residential land use: These areas are not covered by the site contamination Audit

- In addition to the potential impacts arising from ***agricultural land use and use of agricultural chemicals*** outlined above in the proposed residential areas, the further migration of contaminants exist on the mid to lower portions of the whole site, excluding the SA Water land. This is through the extensive network of irrigation drains, channels and the dairy wash down drain to the evaporation channel.

- ***Accidental spillage of chemical* wastes/substances;** It is unclear from the ESA the exact location of the above ground diesel tank which was used to power an irrigation pump located in the vicinity of the southern portion of the property, on title CT 5871/733. Given the proximity to the Murray River and the shallow groundwater table on the reclaimed former dairy flats the EPA notes the potential for groundwater contamination at this location. It is further noted in G7-2 of the response document that waterfront Crown Land Sections 856 and 857 be increased to a minimum of 50 metres width which could possibly position this portion of land on CR 5749/38.

- ***Migration of contaminant into a site from neighbouring land;*** an underground petroleum storage tank (UST) is located approximately 40 metres west of the Northwest corner of the subject land. It is stated in the conclusions and executive summary of the ESA and elsewhere, (section 5.4 Contamination) that “the UST identified in the neighbouring property to the west of the site is unlikely to have impacted site groundwater and soils given its location”. In the absence of the existing or predictive groundwater flow information the EPA can only assume that the potential for site contamination exists on this western portion of the site. It is noted that the field program approved by DWLBC was targeted to assess groundwater quality in the vicinity of the landfill and wastewater treatment plant. The EPA recommends that the proposed groundwater

investigative model, projected construction early 2008, be reviewed by an appropriate person[1] to assess the likelihood of impacts to site groundwater given the uncertainty of the changed hydrological regime and the proximity of the pumping operations associated with the wetland and anabranches. The EPA recommends that this be incorporated as an independent review, including attached recommendations and definitive statements regarding the suitability of the site for the proposed land use.

- ***Existence of fill that may be contaminated;***, it is stated in the interview with the WWTP site superintendent that various areas of the property have been built up over the years with imported fill. Imported fill materials were also noted in Table 5 of Appendix C: Areas and Chemicals of Interest on the adjacent title, CT 5871/733 (Resche's property).

- ***Potential Acid Sulphate Soil (PASS)I***; the preliminary investigations presented in the EIS were not developed to any criteria contained in AS 4482.1 — 2005 Guide to the investigation and sampling of sites with potentially contaminated soil Part 1. It was reported by Coffey in these preliminary investigations that the clay is not expected to develop acid sulphate conditions upon exposure to oxygen and that no specific remedial measures are envisaged. However, acidic soil was identified at one location of the limited boreholes on site (Borehole 1) and Coffey outlined the use of three site indicators that may identify PASS during excavations and proposed management measures to deal with any such encounter. The EPA has developed a Draft Guideline: Acid Sulphate Soil Material Guideline which provides information to those involved in activities that may disturb acid sulphate materials, the identification of these materials and measures for environmental management. To eliminate as reasonably practicable this risk, Appendix A of the guideline: Field Indicators and Tests for Soil and Water has been developed.

In relation to further responses given under G7-34 and G7-35 Advisory Notes. - Environment and Conservation (EPA), the following comments are made:

It was stated in the EIS to be outlined in a CEMP, that it is envisaged there will not be import or export of soil. The EPA has not been provided with further details as these are proposed to be outlined in the CEMP and cannot comment on these issues or issues associated with management of remediation that may need to be carried out. This comprehensive CEMP would be expected to have reference to all EPA endorsed standards in reporting on the analysis of environmental samples as contained within the National Environment Protection (Assessment of Site Contamination) Measure 1999 including AS 4482.1 — 2005 and as such will address all on and off-site issues raised above; including potential acid sulphate soil management. The EPA and planning authority would review this CEMP following the review and endorsement by the Auditor or independent reviewer, particularly with regard to any definitive statements which confirm that potential contamination of groundwater arising at or from the site will not impact on the environment or the suitability of the site for the proposed use.

The ESA identified numerous sources of chemicals and their attendant locations. The Planning Advisory Notice 20 provides direction to meet the purpose and desired environmental outcome of the National Environmental Protection Measure with respect to planning practice and how to obtain information that triggers the assessment of site contamination in accordance with the NEPM.

Given the identified potentially contaminating activities that have occurred across the site and in the absence of sufficient site specific assessment given the complex nature of the proposed land uses on the development site the EPA recommends the following:

That either a definitive statement from an environmental consultant who is an Environmental Auditor (Contaminated Land); or a Site Report Audit prepared by an Environmental Auditor (Contaminated Land) be provided to the EPA confirming that (potential contamination of groundwater) arising at or from the site and from off-site sources will not impact the suitability of the site for the proposed use, and consequently outcomes and conditions, will be taken into consideration by the Auditor.

Given the magnitude of the development and the potential impacts to the existing environmental conditions,

[1] Appropriate person' as determined later is either an Auditor (Contaminated Land) or an environmental consultant who is an Environmental Auditor (Contaminated Land).

it is considered that the proponent should provide confirmation that the whole of the land which is not subject to residential development, including land beneath the water at the marina is suitable for its use and that there has been and will be no significant adverse impact to the riverine environment arising from the development, prior-to the marina being opened to the Murray River. *In order to provide this high level assurance it is recommended that this confirmation be provided in the form of a definitive statement by either an environmental consultant (who is an Environmental Auditor (Contaminated Land) or by an Auditor as part of the preparation of a Site Audit Report.*

Reply: The proponent acknowledges the requirements for the non-residential areas of the site. A definitive statement from an Environmental Auditor (Contaminated Land) will be provided to provide high level assurance that the whole of the land which is not subject to residential development (including land beneath the water at the marina) is suitable for its use, and that the development does not present unacceptable risks to the Murray River, prior to the marina being opened to the River.

The issue of potential landfill migration associated with the Mannum landfill is addressed. The EPA considers that any assessment, monitoring and implementation of management measures for the landfill for proposed closure and post closure should be considered in the preparation and implementation of an approved Environment and Maintenance Management Plan for the site. The EPA considers that Council should be engaged in consultation with the Auditor and independent reviewer as changes to the current condition of the landfill may have the potential for associated impacts. **It is recommended that the response referring to the landfilled areas be revised to take this into account.**

Reply: The proponent acknowledges the requirements in regard to the Mannum landfill and will address the issues together with Mid Murray Council, the Auditor and independent reviewer in the preparation and implementation of the EMMP.

For further information: Lesley Cann Tel 82049943

ENVIRONMENTAL NOISE

G7-36 NOISE AND ODOUR

Wastewater Treatment Facility
Due to the uncertainty about location of the WWTF, it is recommended that noise compliance criteria 1 and 2 below be applied to the operation of the WWTF. The rural living criteria is included in the event that WWTF is built near a rural living zone.

Commercial Area
Page 2-1 of the EIS states that the commercial area will contain (among other things) entertainment activities and accommodation. It is recommended that criteria 1 below be applied to development in the commercial area.

In addition to criteria 1, if an 'entertainment' venue involves the playing of live or amplified music, a development application should be lodged with the local Council and be accompanied by a report addressing the certification criterion and other issues set out in the following EPA Guideline: *Development proposal assessment for venues where music may he played* (http://lwww.epa.sa.gov.au/pdfs/guide music.pdf). Such a report should be prepared by a competent acoustic engineer**.

Accommodation in the Commercial Area
The accommodation in the commercial area should be designed so as to achieve a maximum noise level of 45dB(A) at the building facade or 35dB(A) in indoor living areas and 30dB(A) inside bedrooms. *(NB. the above numbers apply between 10pm and 7am when measured and adjusted in accordance with the current Environment Protection Noise Policy.*).*

The internal noise level should ensure the potential onset of sleep disturbance effects does not occur within the bedrooms and that the maximum limits within living and sleeping areas of the proposed units achieve those prescribed by AS/NZS 2107 "Acoustics - Recommended design sound levels and reverberation times for building interiors".

Marina Noise
It is noted that, based on the recommendation of the Sonus Environmental Noise Report, page 11-39 of volume 1 states that mains power will provided for moored house boats and that on board generators will not be used within the marina. It is important that this requirement be complied with to avoid breaching the Environment Protection Authorities noise policies.

Noise Compliance Criteria
Criteria 1 - Noise generated by the wastewater treatment facility and the commercial area should not exceed the following noise levels:

a) 52dB(A) between the hours of lam and 10pm when measured and adjusted at the nearest premises on land zoned residential in accordance with the current Environment Protection Noise Policy*.
b) 45dB(A) between the hours of 10pm and 7am when measured and adjusted at the nearest premises on land zoned residential in accordance with the current Environment Protection Noise Policy*.

60dB(A)Maximum (LmaxFast) between 10pm on one day and 7am the following day when measured and adjusted at the nearest premises on land zoned residential in accordance with the current Environment Protection Noise Policy*.

Criteria 2 - Noise generated by the wastewater treatment facility should not exceed the following noise levels:

a) 47dB(A) between the hours of 7am and 10pm when measured and adjusted at the nearest premises on any land zoned rural living in accordance with the current Environment Protection Noise Policy*.
b) 40dB(A) between the hours of 10pm and 7am when measured and adjusted at the nearest premises on any land zoned rural living in accordance with the current Environment Protection Noise Policy*.
c) 6OdB(A)Maximum (LmaxFast) between 10pm on one day and 7am the following day when measured and adjusted at the nearest premises on any land zoned rural living in accordance with the current Environment Protection Noise Policy*.
d)

**The above measured noise levels should he adjusted in accordance with the current Environment Protection Noise Policy by the inclusion of a penalty for each characteristic where tonal/low frequency/modulafing/impulsive characteristics are present.*

*The above noise levels may be exceeded where it can be shown by an acoustic engineer** that the noise from the development will not cause an adverse impact due to the existing influence of ambient noise, or the limited duration and/or frequency of occurrence of the activity. The onus of proof will rest with the developer.*

***An acoustic engineer is defined for the purposes of this Development Plan to mean a person eligible for membership of both the Institution of Engineers Australia and the Australian Acoustical Society.*

Reply: The proponent acknowledges and will comply with the requirements and in particular the Noise Compliance Criteria for the development and operation of the commercial area, marina area and the wastewater treatment plant (in conjunction with SA Water),

For further information: Max Browne Tel 8204 2073

Yours sincerely

PETER TORR
MANAGER, ENVIRONMENT ASSESSMENT
SCIENCE AND SUSTAINABILITY DIVISION
ENVIRONMENT PROTECTION AUTHORITY
DELEGATE, BOARD OF THE ENVIRONMENT PROTECTION AUTHORITY
Date: 07/12/2007

Department for Families and Communities

Mr Lee Webb
Chief Environmental Officer
Environmental Impact Assessment Unit
Planning SA
GPO Box 1815
ADELAIDE SA 5000

Dear Mr Webb

Thank you for the opportunity to comment on the Response document *Mannum Waters Marina and Residential Development Proposal.*

Government policy sets a target for all significant new residential development to include 15% affordable housing, and in accordance with this policy the Minister for Housing and Minister for Urban Development and Planning have considered that this inclusion should be applied to the assessment of Major Projects.

The Affordable Housing Innovations Unit (AHIU) within the Department for Families and Communities has previously made a submission on the EIS proposing that the provision of at least 15% affordable housing be a condition of approval.

Mr David Potter from Tallwood Pty Ltd met with officers from AHIU on 26 November 2007 and indicated that he believed provision of the 15% was not likely to be a problem, although this would not include any waterfront allotments, and that if necessary, as stages were lodged for land division, some smaller lots would be included to assist in providing affordable opportunities.

Further information is provided below in relation to the description and targeting of affordable housing and is intended to assist the proponent in understanding the requirements and meeting any affordable housing condition. Additional information is available via the Department for Families and Communities Affordable Housing website and through further discussion with the Affordable Housing innovations Unit.

Framework for meeting affordable housing inclusion condition
The affordable housing requirement can be met through:

- Sale of completed house and land packages to eligible buyers at an affordable price; or
- Sale of land allotments to eligible buyers at a price which enables a house and land package to be completed at an affordable price, and where the allotment is constrained to use for affordable housing; or
- Sale to eligible buyers as otherwise determined by the Minister for Housing. This may include for instance use of mechanisms such as shared equity or subsidised loan arrangements in circumstances where affordable sale prices cannot otherwise be achieved.
- In some circumstances, rental or lease to eligible persons which is secured through an Affordable Housing Agreement.

Affordable housing price points: are updated and published annually in the Government gazette by the Minister for Housing. The current prices point for sales in regional South Australia is $181,000.

Eligible buyers:
New affordable housing properties are required to be sold, rented or leased to either:

- A prospective homeowner listed on the SA Home Purchase Eligibility Register maintained by Housing SA; or
- A registered housing association or housing co-operative under the South Australian Co-operative and Community Housing Act 1991; or
- A housing provider that is subject to an Affordable Housing Facilitation Agreement with any Minister, instrumentality or agency of the Crown in the right of South Australia; or
- Such other person as the Minister for Housing may nominate.

Development requirements:

- In the event that the land is to be developed in stages the affordable housing units are to be developed concurrently with the development of surrounding allotments and residences.
- The exterior appearance of affordable housing units is to be reasonably similar to other dwellings built on the landing in the nature and quality of exterior building materials or finishes.
- Affordable housing units should be sited in no less desirable locations than other allotments or dwellings to be developed on the land and where possible integrated across the development and not clustered together. However it is recognised that the siting of affordable housing units on particularly desirable locations such as water or park frontage allotments may not be achievable.
- The quality of materials used and the construction standards for affordable housing must be equivalent to those of other dwellings on the land.

Recommendation:
It is recommended that a condition of the approval of the Mannum Waters development as a Major Project be the requirement to include at least 15% affordable housing in the development and that the approval contain an Affordable Housing Condition which states that:

- Not less than 15% of the residential allotments will be developed and offered for sale as Affordable Housing. The location of which is to be identified by the proponent in a staging or if completed, a land division plan, attached to the approval.
- Prior to the consequential lodgment of any land division application with the Development Assessment Commission, the owner must consult with the General Manager of the SA Affordable Housing Trust to identify the allotments that will be designated for affordable housing. These allotments will be the subject of an agreement between the owner and the SA Affordable Housing Trust and secured as affordable housing allotments by a statutory covenant or equivalent which is registered on those land titles.
    - If the land division application is over the whole of the proposed development the owner should designate the individual Allotments to meet the full 15% Affordable Housing requirement.
    - If the land division application does not comprise the whole of the project, then the individual allotments which are designated for Affordable Housing within the stages being lodged must be identified on the plan of division and the staging plan for the whole of the project must identify where the balance of the affordable housing allotments will be provided to meet the 15% requirement over the whole project.

Reply: The proponent is committed to and will comply with the provision of 15% affordable housing within the development in accordance with the provisions outlined above and in agreement with the Department for Families and Communities. To achieve this requirement the proponent will need to modify the size of a proportion of the allotments thereby increasing the number of allotments within the areas designated as "Residential – Standard" on the Development Proposal plan. This has been discussed with representatives of the Mid Murray Council who have indicated that smaller allotments will be acceptable to Council.

Thank you for the opportunity to address the State Government's affordable housing inclusion objective in this proposal.

Yours sincerely

Philip Fagan-Schmidt
GENERAL MANAGER
AFFORDABLE HOUSING & SECTOR DEVELOPMENT
4/12/07

Department of Health

Major Developments Panel
Mr Lee Webb
Senior Environmental Officer
Environmental Impact Assessment Unit
Assessment Branch
Planning SA
GPO Box 1815
ADELAIDE SA 5001

Dear Mr Webb

Re: Mannum Waters Residential Marina Proposal Response Document

Thank you for the opportunity to comment on the above document. The proponent has addressed the concerns raised by the Department. In particular, the commitment shown by the proponent in endeavouring to obtain optimal outcomes for Aboriginal issues is welcomed. The manifestations of this include consulting with the Mannum Aboriginal Community Association Incorporated (MACAI), the retention of Aboriginal Heritage consultants and the commitment to make employment opportunities available.

The commitment to the protection of water quality of the River Murray is also welcomed and acknowledged.

To ensure that the delay to the proposal is minimised, whilst protecting public health by the issuing of the mandatory approvals under the *Public and Environmental Health Act 1987*, the proponent is urged to hold discussions with the Wastewater Management Section of the Department on the reuse of (domestic) wastewater at the earliest possible stage.

If you have any queries or comments, please do not hesitate to contact me (telephone 8226 7145 or e-mail: frank.callaghan@health.sa.gov.au).

Reply: The proponent acknowledges the requirement to discuss the details of wastewater reuse with the Department of Health and will comply with this requirement as soon as possible after the clarification of the requirements of SA Water for the location of the wastewater treatment plant and distribution of the treated wastewater.

Yours sincerely

Frank Callaghan
PRINCIPAL SCIENTIFIC OFFICER

Department of Trade and Economic Development

Mr Lee Webb
Chief Environmental Officer
Planning SA
Primary Industries and Resouces SA
GPO Box 1815
ADELAIDE SA 5001

Dear Mr Webb

Re: Mannum Waters Residential Marina EIS — Response Document

Thank you for providing the Department of Trade and Economic Development (DTED) with the opportunity to comment on the response document for the Mannum Waters Residential Marina Proposal Environmental Impact Statement (EIS).

In its submission on the original EIS document dated 10 July 2007, DTED was broadly supportive of the proposal but requested further information on the possibility of conflict at the interface between new residential areas and adjacent existing dairying activities adjoining the site.

I acknowledge that the proponent has discussed these concerns with officers of DTED. The response document has indicated that the Home Owner's Charter will include a clause requiring new owners to acknowledge the right of existing agricultural uses to continue with existing practices. The response document further indicates that this arrangement is considered appropriate to adjoining agricultural businesses. DTED is therefore satisfied that the concerns it raised in its original submission have been appropriately addressed.

If you have any questions relating to this matter, please do not hesitate to contact John Barker on telephone number (08) 8303 2372 or via email john.barker@state.sa.gov.au.

Reply: No further comment required.

Yours sincerely

Len Piro
A/CHIEF EXECUTIVE
Department of Trade and Economic Development

MANNUM WATERS

Tallwood Pty Ltd
Project Development

Suite 4/166 Main South Road
Morphett Vale SA 5162

PO Box 897 Morphett Vale SA 5162

Ph 08 8322 0500
Fax 08 8219 0173

ABN 15 078 109 396

1st February 2008

Mr Elmer Evans
Manager Assessment Branch
Planning SA
GPO Box 1815
Adelaide SA 5001

Dear Mr Evans,

Re: Mannum Waters, Marina and Residential Development Proposal – Development Proposal as 1st February 2008

Following a closer look at the design implications of boat movement within the main water body of Mannum Waters, we have made some modifications of the layout in this location. The general development concepts remain the same as previously reported in the Response to Submissions document.

The changes are as follows:

1. An area has been included, external to the secured area for houseboat moorings, where customers may access hire boats.

2. The commercial area has been enlarged to ensure that there is sufficient room for the provision of a boat ramp, future boat lift and other facilities previously indicated for the area.

3. The overnight casual houseboat moorings have been relocated to an area opposite the commercial area to minimise the movement of these boats within the main boat movement areas. Access to the commercial area from the casual moorings will be available from a proposed pedestrian bridge. Full service facilities i.e. sewage pump-out, water and power will be available at the casual berths.

4. A pedestrian bridge has been included from the commercial area over the waterway to the opposite bank. The bridge will facilitate pedestrian access from River Lane and overnight moorings and will enhance the proposed walking trails. The bridge will also restrict houseboat traffic from entering the northern waterways.

5. Roundabouts have been shown at three of the intersections on the main road through the development to achieve traffic calming.

6. Further minor alterations to the road and waterway alignments have been made to ensure native trees will be retained.

Original prints and a disc with the revised layout as proposed for the development are included with this letter

Please contact David Potter on 08 8278 5944 if these modification give you any concern.

Yours faithfully,

David Potter
Tallwood Pty Ltd

MANNUM WATERS

DEVELOPMENT PROPOSAL

1ST FEBRUARY 2008

DEVELOPMENT FEATURES

- RESIDENTIAL - VILLA WATERFRONT
- RESIDENTIAL - WATERFRONT
- RESIDENTIAL - STANDARD
- COMMERCIAL
- WATERWAY
- ROAD
- ABORIGINAL CULTURAL AREA
- RESERVE
- GOLF COURSE EXTENSION
- REVEGETATION AREA
- EMBANKMENT/LEVEE
- B BRIDGE
- PB PEDESTRIAN BRIDGE
- A ACCOMMODATION/CONFERENCE FACILITIES
- C CAFE/RESTAURANT
- S GENERAL STORE
- R BOAT RAMP
- L BOAT LIFT
- V VACUUM SEWAGE PUMP STATION
- WTS WATER TRANSFER STATION
- P VEHICLE PARKING
- ST SCAR TREE
- SG SECURITY GATE
- IC INLET CHANNEL
- OC ANABRANCH OUTLET CHANNEL

WETLAND

- DEEP WATER BODIES
- SHALLOW WATER BODIES
- ANABRANCH WETLAND
- RIPARIAN / ISLANDS

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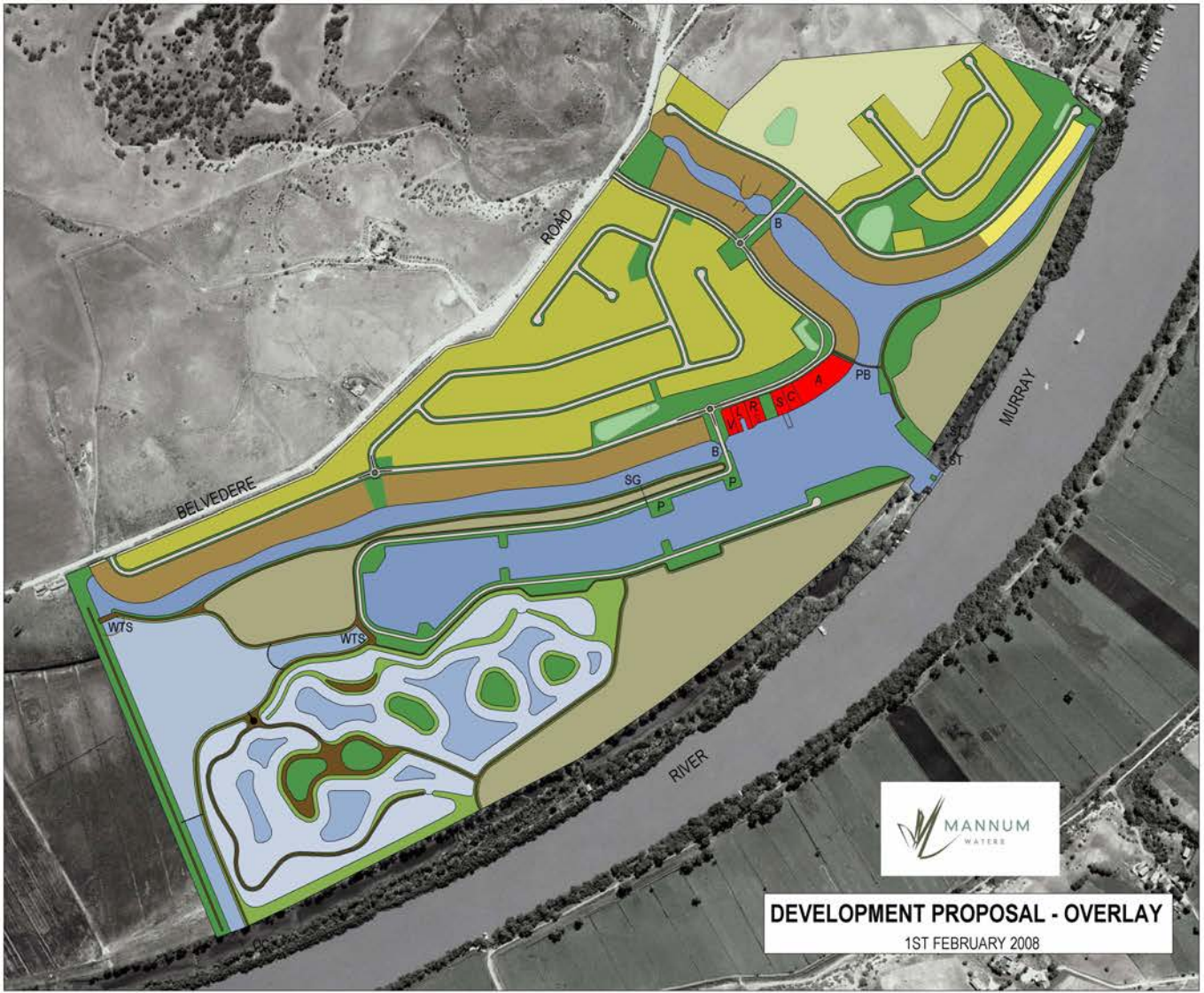

DEVELOPMENT FEATURES

	RESIDENTIAL - VILLA WATERFRONT
	RESIDENTIAL - WATERFRONT
	RESIDENTIAL - STANDARD
	COMMERCIAL
	WATERWAY
	ROAD
	ABORIGINAL CULTURAL AREA
	RESERVE
	GOLF COURSE EXTENSION
	REVEGETATION AREA
	EMBANKMENT/LEVEE
B	BRIDGE
PB	PEDESTRIAN BRIDGE
A	ACCOMMODATION/CONFERENCE FACILITIES
C	CAFE/RESTAURANT
S	GENERAL STORE
R	BOAT RAMP
L	BOAT LIFT
V	VACUUM SEWAGE PUMP STATION
WTS	WATER TRANSFER STATION
P	VEHICLE PARKING
ST	SCAR TREE
SG	SECURITY GATE
IC	INLET CHANNEL
OC	ANABRANCH OUTLET CHANNEL

WETLAND

	DEEP WATER BODIES
	SHALLOW WATER BODIES
	ANABRANCH WETLAND
	RIPARIAN / ISLANDS

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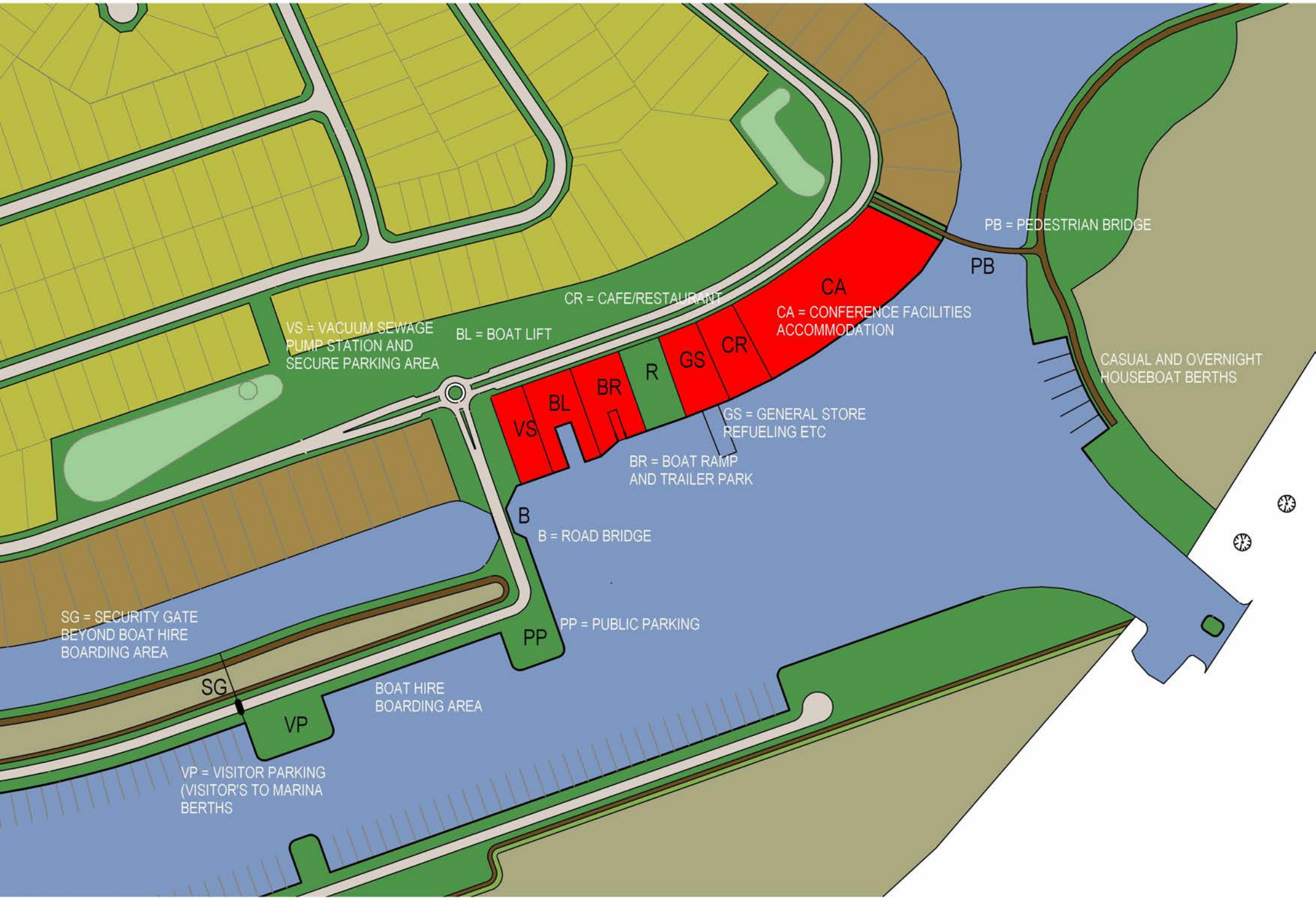
0 100 200 300 400 Metres


PB = PEDESTRIAN BRIDGE
PB
CA
CA = CONFERENCE FACILITIES
ACCOMMODATION
CR = CAFE/RESTAURANT
VS = VACUUM SEWAGE
PUMP STATION AND
SECURE PARKING AREA
BL = BOAT LIFT
CR
GS
R
BR
BL
VS
CASUAL AND OVERNIGHT
HOUSEBOAT BERTHS
GS = GENERAL STORE
REFUELING ETC
BR = BOAT RAMP
AND TRAILER PARK
B
B = ROAD BRIDGE
SG = SECURITY GATE
BEYOND BOAT HIRE
BOARDING AREA
PP = PUBLIC PARKING
PP
SG
BOAT HIRE
BOARDING AREA
VP
VP = VISITOR PARKING
(VISITOR'S TO MARINA
BERTHS

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18th February 2008

Mr Elmer Evans
Manager Assessment Branch
Planning SA
GPO Box 1815
Adelaide SA 5001

Dear Mr Evans,

Re: Mannum Waters, Marina and Residential Development Proposal
Affordable Housing

The South Australian Government, via its "Housing Plan for South Australia" is committed to the target of at least 15% affordable housing in all significant new developments. The provision will apply to the Mannum Waters development.

This letter is to confirm the proponent's (Tallwood Pty Ltd) acceptance of this requirement.

A drawing has been prepared which shows typical locations for 90 affordable homes. A copy of the drawing is attached. Although some adjustment in the locations may be made during final design, 15% of the total allotments within the final development will be provided for affordable housing in accordance with a distribution similar to that shown on the drawing.

It is also acknowledged that Tallwood Pty Ltd will enter into a Land Management Deed with the Minister for Urban Development and Planning and Tallwood Pty Ltd in regard to the affordable housing provisions. To this end, Tallwood Pty Ltd is currently working with the Department of Families and Communities in the preparation of an appropriate draft Land Management Deed.

Yours faithfully,

David Potter
Director
Tallwood Pty Ltd

APPENDIX 2

PROPONENT'S INTERIM HYDROGEOLOGICAL REVIEW

INTERIM HYDROGEOLOGICAL REVIEW

MANNUM WATERS DEVELOPMENT

MANNUM, SOUTH AUSTRALIA

30 JANUARY 2008

DOC. REF: SG071493 RP01

REVISION 1

FOR

TALLWOOD PTY LTD

Soil & Groundwater Consulting

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ACN 100 220 479 • ABN 62 100 220 479

EXECUTIVE SUMMARY

Soil and Groundwater Consulting (S&G) was commissioned by Tallwood Pty Ltd to undertake a hydrogeological assessment and review of the area proposed for the development of a marina facility referred to as 'Mannum Waters' at Mannum, South Australia. The assessment was undertaken to address a number of issues raised by the referral authorities in response to the Environment Impact Statement (EIS).

The investigation comprised the installation of 14 groundwater monitoring wells into the shallow watertable aquifers at the site (the Coonambidgel Formation and Murray Group limestone), followed by gauging, sampling and analytical testing of the wells. The scope of work, including the number and locations of the wells was agreed with Steve Barnett of the Department of Water Land and Biodiversity Conservation (DWLBC). 12 wells were installed into the Coonambidgel Formation, whilst 2 wells (MW14 and MW18) appear to be within the Murray Group limestone aquifer. Additional wells were proposed to be drilled into the Murray Group limestone aquifer in the vicinity of the Council landfill, but due to drilling difficulties these could not be installed as part of this program. Three different locations were attempted using a range of drilling techniques, however each hole collapsed below 30 m depth. These wells will be installed using an alternative drilling technique as soon as an appropriate rig becomes available.

Based on the investigations completed to date, groundwater in the Coonambidgel formation aquifer over the majority of the proposed development site does not appear to be discharging to the Murray River. The groundwater level information indicates that the floodplain area of the site forms a groundwater sink, with groundwater likely discharging to the floodplain from both the regional aquifer from the north and from the Murray River from the south. This is consistent with expectations from the regional hydrogeology presented in Chapter 6 of the EIS document for the site. Evaporation is considered to be the primary driver for the occurrence of the groundwater sink. Elevated groundwater salinities identified in the floodplain are consistent with the evaporation of groundwater from this area.

A discussion on the potential impacts and mitigation measures from the proposed development is presented in Section 11 of the EIS document. The groundwater investigations have confirmed the groundwater elevations and low conductivity of the Coonambidgel Formation aquifer, which were used as assumptions in this Section of the EIS document.

There was some evidence of leakage from the wastewater treatment lagoons which occur in the eastern part of the site. Localised groundwater mounding and lower salinities were reported in this area. The hydraulic gradient appears to be towards the river in this area.

Analytical testing indicates that the groundwater across much of the site is impacted by ammonia with concentrations ranging from 0.05 mg/L to 69 mg/L, that exceed the EPP freshwater protection criterion. Higher results were reported in the central and western areas of the site and generally coincided with higher salinity results. Nitrate results were typically below the EPP assessment criterion for oxidised nitrogen with the exception of two results. One result in the centre of the site was significantly elevated. The higher results for ammonia and nitrate may be associated with concentration of groundwater solutes in response to evaporation. The widespread ammonia may

be associated with the historical use of the site or the natural organic materials present in the clayey formation. Modest exceedances of the total phosphorus criterion were noted at two of the four locations tested in the vicinity of the wastewater treatment lagoons. No other significant contaminants were identified by the analytical testing. Provided that there is no interaction between groundwater and the proposed marina waterways, or groundwater discharge to the River, it is considered that the risk of elevated ammonia concentrations or salinity impacting on the River Murray is low. If deemed necessary by the referral authorities, a numerical groundwater flow and contaminant transport model could be used as a tool to predict the interaction between groundwater and the River post development, and quantify the potential risks associated with salinity and ammonia concentrations in groundwater.

Rising head hydraulic conductivity tests were conducted on a number of wells to assess the horizontal hydraulic conductivity of the shallow floodplain aquifer. The results ranged from 0.01 m/day to 0.76 m/day, with a geometric mean of 0.06 m/day. Based on the steep hydraulic gradients present, the low groundwater levels reported in the centre of the site, and evidence of an evaporative sink, it is considered likely that the hydraulic conductivity of the shallow aquifer is low to very low allowing these hydraulic features can be maintained.

It is understood that the proposed development will be designed to prevent intersection of the marina waterways with the groundwater. Based on the current groundwater elevations, it is considered that the waterways will be above the groundwater with the exception of the reaches in the vicinity of MW5 and MW14. It is understood that the proponent is considering an engineered solution consisting of a low permeability clay liner, together with a permanent head of water in these areas to prevent saline groundwater from entering the marina waterways.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

Appendix A Summary Tables

Appendix B Borelogs & Well Construction Details

Appendix C Laboratory Certificates & Chain of Custody Documentation

Appendix D Rising Head Hydraulic Conductivity Test Analyses

DOCUMENT INFORMATION

Rev.	Status	Date	Company	Name
0	Draft	24 January 2008	Tallwood Pty Ltd	Mr David Potter
			Soil & Groundwater Consulting	File
1	Final	30 January 2008	Tallwood Pty Ltd	Mr David Potter
			Soil & Groundwater Consulting	File

1. INTRODUCTION

Soil and Groundwater Consulting (S&G) was commissioned by Tallwood Pty Ltd to undertake a hydrogeological assessment and review of the area proposed for the development of a marina facility referred to as 'Mannum Waters' at Mannum, South Australia.

The Mannum Waters project will develop a multi-use recreational / commercial marina immediately south of Mannum and comprise residential allotments, houseboat mooring sites, and a commercial centre. The site is located in a flood plain area immediately adjacent the Murray River.

The location of the site, including the proposed development plan and the current title layout is shown in Figure 1.

The project has been designated as a Major Project by the SA Government and an Environmental Impact Statement (EIS) has been prepared. The hydrogeological investigations discussed in this report are in response to questions raised by the regulatory referral authorities in response to the EIS submission. These investigations were noted in the EIS to be required for the detailed design phase.

DEVELOPMENT FEATURES

- RESIDENTIAL - VILLA WATERFRONT
- RESIDENTIAL - WATERFRONT
- RESIDENTIAL - STANDARD
- COMMERCIAL
- WATERWAY
- ROAD
- ABORIGINAL CULTURAL AREA
- RESERVE
- GOLF COURSE EXTENSION
- REVEGETATION AREA
- EMBANKMENT
- LEVEE

WETLAND

- DEEP WATER BODIES
- SHALLOW MARSH
- TALL MACROPHYTES
- RIPARIAN / ISLANDS
- SHALLOW MACROPHYTES
- SHALLOW WATER BODIES
- TREATMENT WETLAND

N

0 100 200 300 400 Metres

Soil & Groundwater Pty Ltd

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Drawn: NBP	Date: 27 September 2007	Job No.: SG071493	Project: MANNUM WATERS - ESA Phase 1
Checked: AKW	Date: 27 September 2007	Title: SITE PLAN SHOWING EXISTING FEATURES, PROPOSED DEVELOPMENT & TITLE BOUNDARIES	Sheet 1 of 1
File Name: F1 site plan ESA	Scale: As Shown A4		FIGURE 1

2. BACKGROUND

2.1 Site History

A site history report has been prepared for the site by S&G titled "*Environmental Site Assessment – Phase 1, "Mannum Waters" Site, Belvedere Road, Mannum, SA*" dated 12 October 2007.

The ownership history of the site indicates that it was originally crown land. Aerial photographs indicate that the site has been associated with farming use since the 1940's. From the 1960's the site has comprised of three different types of land use and it is convenient to consider the site as three portions – the eastern, central and western portions.

- The eastern portion of the site comprises of the Mannum wastewater treatment plant which was established in the 1960's and remains today.
- The central portion of the site was predominantly used for agricultural purposes. In the 1980's the majority of sheds / workshops were constructed. Agricultural farming ceased in the late 1990's and the site is currently used for the grazing of sheep.
- The western portion of the site was used for the grazing of cattle. Operations ceased on the site in the 1990's and since then the site has been vacant.

A council landfill is situated on the adjacent property to the north. According to aerial photographs and a discussion with a current employee of the Mid–Murray Council, the landfill has been in operation since at least the 1970's. It is believed the landfill received mainly municipal waste, but may have also received occasional commercial / building wastes.

It is noted that additional soil and groundwater investigations and preparation of a Site Audit Report are proposed to be undertaken to assess the suitability of the site for use in the context of the proposed development.

2.2 Geology and Hydrogeology

The EIS describes the physical setting of the site and provides a preliminary review of the hydrogeological setting based on the available site specific data at the time of the EIS submission. This background information has been summarised from the EIS.

The site lies on the riverine tract of the River Murray, with the river having incised the Murray Group limestone, which forms the regional unconfined aquifer in this area. With the progressive rise of sea levels over geologic time, the eroded valley has been partially infilled with alluvial clays, silts and coarse sands. Two units have been defined in the valley and are referred to as 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 site, limestones of the Murray Group outcrop on the rising ground.

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

by a levee which results in the river level being above that of the floodplain. The typical elevation of the river is 0.75 mAHD while most of the floodplain area lies between 0 m AHD to -0.6 m AHD.

Groundwater from the regional limestone aquifer is inferred to discharge to the Coonambidgal Formation adjacent the river. The river also effectively discharges to the floodplain area due to the relative levels as noted above. The floodplain was formerly drained via a series of channels with water discharged down stream. The deeper Monoman Formation was reported to have upward hydraulic pressures, possibly in response to a combination of the draining of the upper formation and evaporative affects, with the head provided by the adjacent Murray Group limestone regional aquifer.

The regulatory referral authorities had requested further detail regarding the hydrogeological regime at the site and the salinity of the groundwater in order to assess the potential influence of the groundwater system on the proposed marina development. The works undertaken and the results of the investigations are discussed in the remaining sections of this report.

3. GROUNDWATER INVESTIGATIONS

Intrusive groundwater investigations were undertaken by S&G in November and December 2007 to:

- Determine the level of shallow groundwater across the proposed development site;
- assess the groundwater salinity; and
- provide a preliminary assessment of potential groundwater contaminants arising from previous use of the site.

The aim of the groundwater investigation was to gather sufficient data to provide a robust assessment of the shallow groundwater system at the site and to assess potential interactions between the unconsolidated sedimentary sequence adjacent the Murray River and the regional Murray Group Limestone aquifer.

The following scope of groundwater investigations was undertaken by S&G:

- Prior to drilling at the site, DWLBC well permits were obtained for each well.
- Installation of 14 shallow groundwater wells within the proposed development area into the Coonambidgel Formation (12 wells) and the Murray Group limestone (2 wells);
- An additional 4 wells were proposed to be installed into the regional Murray Group limestone aquifer in the vicinity of the Council landfill, however these wells were not installed due to collapse below 30 m depth;
- Development of wells to provide a suitable connection between the wells and the aquifer;
- Survey of wells to Map Grid of Australia (MGA) coordinates and to Australian Height Datum (AHD) levels;
- Following a stabilisation period, gauging of wells to assess the groundwater levels and infer groundwater flow direction;
- Purging and sampling of wells, with samples collected for field based parameters and preliminary laboratory analytical testing; and
- Performing rising head permeability tests on a number of wells to assess the hydraulic conductivity of the aquifer.

The location of the groundwater wells is shown in Figure 2.

MANNUM WATERS

DEVELOPMENT FEATURES

- RESIDENTIAL - VILLA WATERFRONT
- RESIDENTIAL - WATERFRONT
- RESIDENTIAL - STANDARD
- COMMERCIAL
- WATERWAY
- ROAD
- ABORIGINAL CULTURAL AREA
- RESERVE
- GOLF COURSE EXTENSION
- REVEGETATION AREA
- EMBANKMENT
- LEVEE

WETLAND

- DEEP WATER BODIES
- SHALLOW MARSH
- TALL MACROPHYTES
- RIPARIAN / ISLANDS
- SHALLOW MACROPHYTES
- SHALLOW WATER BODIES
- TREATMENT WETLAND

GROUNDWATER MONITORING WELL

0 100 200 300 400 Metres

Soil & Groundwater Pty Ltd
207 The Parade Norwood SA 5067
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Drawn: AKW	Date: 24 Jan 08		Job No.: SG071493	Project: Groundwater Investigation "Mannum Waters"	
Checked: APN	Date: 24 Jan 08		Title: SITE PLAN GROUNDWATER MONITORING WELLS		Sheet 1 of 1
File Name: Figure 2.wor	Scale: 1:1,500	A4			FIGURE 2

4. RESULTS OF INVESTIGATIONS

4.1 Installation of Groundwater Monitoring Wells

The groundwater monitoring wells were installed and constructed to intersect the shallow watertable aquifer in all instances. The well screens have been placed such that the groundwater level typically falls within the screened interval to ensure the wells measure the standing water level of the watertable aquifer and samples are collected from the upper portion of the watertable aquifer which has the greatest potential to interact with the marina development.

The bores for the wells were drilled using solid flight augers. The wells were constructed using thread joined Class 18 PVC casing and machine slotted screens of the same material. The annulus around the well screen was filled with commercial grade filter pack material to slightly above the top of the screen and a pelletised bentonite seal was placed above this. The remainder of the annulus was backfilled with a bentonite and cement grout. The surface casing was capped and installed beneath a standpipe cover.

Based on drilling resistance and drill cuttings, wells MW14 and MW18 were inferred to have intersected the regional Murray Group limestone aquifer. It was planned to install an additional four wells in the Murray Group Limestone, with three wells located in the vicinity of the former Council Landfill to assess potential impacts of the landfill on the local groundwater system. These wells could not be constructed at the time of the investigations due to continual bore wall collapse, despite attempting a range of options with the available rotary air based drilling equipment. It is therefore intended that these wells be installed in the near future using either a cable tool rig or casing advance tools, as soon as an appropriate drilling rig is available

The following table provides a summary of the groundwater monitoring well locations and the well construction details.

Table 1 – Groundwater Well Data Summary

Well	Easting (m)	Northing (m)	Elevation (mAHD)	Total Depth (m)	Screen Length (m)
MW5	344,125.02	6133187.85	5.1832	8.4	3
MW6	344,814.87	6133038.59	2.9959	4.5	3
MW7	345,015.99	6133113.65	4.0036	6	3
MW8	344,881.57	6132997.85	2.6758	4.5	3
MW9	344,838.18	6132799.10	1.5347	4	3
MW10	344,587.88	6132894.95	1.2887	4	3
MW11	344,693.24	6132584.73	1.0573	4	3
MW12	344,497.43	6132509.83	-0.009	5.5	3
MW13	343,976.23	6132369.26	-0.5393	4	3
MW14	343,006.55	6132366.25	6.6349	9.4	3
MW15	343,312.34	6132045.11	-0.2117	4.1	3
MW16	343,387.97	6131716.20	1.4165	4	3
MW17	345,052.08	6133245.38	1.3747	6	3
MW18	343,749.41	6132807.66	14.9763	17	3

The groundwater bore logs and the well construction details are included in Appendix B. The DWLBC well permits for each well are also included in Appendix B.

4.2 Groundwater Gauging and Inferred Flow Direction

The groundwater wells were gauged on 5 December 2007. The following table provides a summary of the standing water levels (SWL) measured in each well and the reduced water level (RWL) obtained by subtraction of the SWL from the surveyed level of the well top.

The RWL results have been corrected for groundwater salinity to provide equivalent freshwater levels given the variability of salinity at the site. The calculations are included in Appendix A.

Table 2 – Groundwater Gauging Summary

Well	Well Elevation (mAHD)	SWL (m)	RWL (mAHD)	Salinity Corrected RWL (mAHD)
MW5	5.1832	5.281	-0.098	-0.076
MW6	2.9959	2.968	0.028	0.030
MW7	4.0036	4.263	-0.259	-0.257
MW8	2.6758	1.653	1.023	1.026
MW9	1.5347	2.105	-0.570	-0.566
MW10	1.2887	2.195	-0.906	-0.886
MW11	1.0573	3.103	-2.046	-2.044
MW12	-0.009	4.833	-4.842	-4.839
MW13	-0.5393	4.392	-4.931	-4.929
MW14	6.6349	7.183	-0.548	-0.545
MW15	-0.2117	2.391	-2.603	-2.583
MW16	1.4165	2.821	-1.405	-1.376
MW17	1.3747	1.847	-0.472	-0.415
MW18	14.9763	15.09	-0.114	-0.102

The groundwater levels have been contoured to provide inferred groundwater head contours. Groundwater flow is inferred to occur at right angles to the contours with flow from higher to lower contours. The inferred head contours and groundwater flow directions are shown in Figure 3.

The river level at the time of sampling was approximately 0.2 m AHD although the long term average river level is approximately 0.75 mAHD. The current river level of 0.2 m AHD has been used in generating the site head contours.

All groundwater results were reported below 0 m AHD with the exception of MW6 and MW8 which were located adjacent the wastewater treatment lagoons in the east of the site. The relatively higher groundwater levels adjacent the wastewater treatment lagoons suggest that there is some leakage of water from the lagoons to the shallow aquifer leading to localised groundwater mounding.

The groundwater head contours indicate that groundwater flows from both the higher ground to the north and from the Murray River to the south converging in the central part of the floodplain, where

groundwater levels are reported down to -4.93 mAHD. As there are currently no drains to this depth and there is no groundwater abstraction occurring at the site, the low levels are thought to be the result of an evaporative sink occurring in this area. This occurrence would be expected to be accompanied by relatively high salinity values in the groundwater within the sink area. Salt crystals had been reported by others in the upper formation at the site. Groundwater levels immediately adjacent the wastewater treatment lagoons are higher than the river level and so a gradient toward the river may occur in the vicinity of the lagoons.

The water elevations in wells MW14 and MW18 support the contention that the regional groundwater from the Murray group limestone discharges into the floodplain area. It is intended that the wells be installed into the Murray Group limestone in the near future using either a cable tool rig or casing advance tools, as soon as an appropriate drilling rig is available.

Groundwater elevations in the vicinity of MW14 may be influenced by the return drain currently located in this area, which contains permanent water. As part of the redevelopment, a levee will be constructed along the southern boundary of the site, which will remove the requirement for this drain and may remove this local influence on groundwater elevations.

4.3 Groundwater Sampling and Analysis

Following gauging, all wells were progressively purged and sampled using a Waterra foot valve pump and dedicated LDPE tubing. The pump was decontaminated between use in each bore using Decon detergent followed by a rinse in clean water.

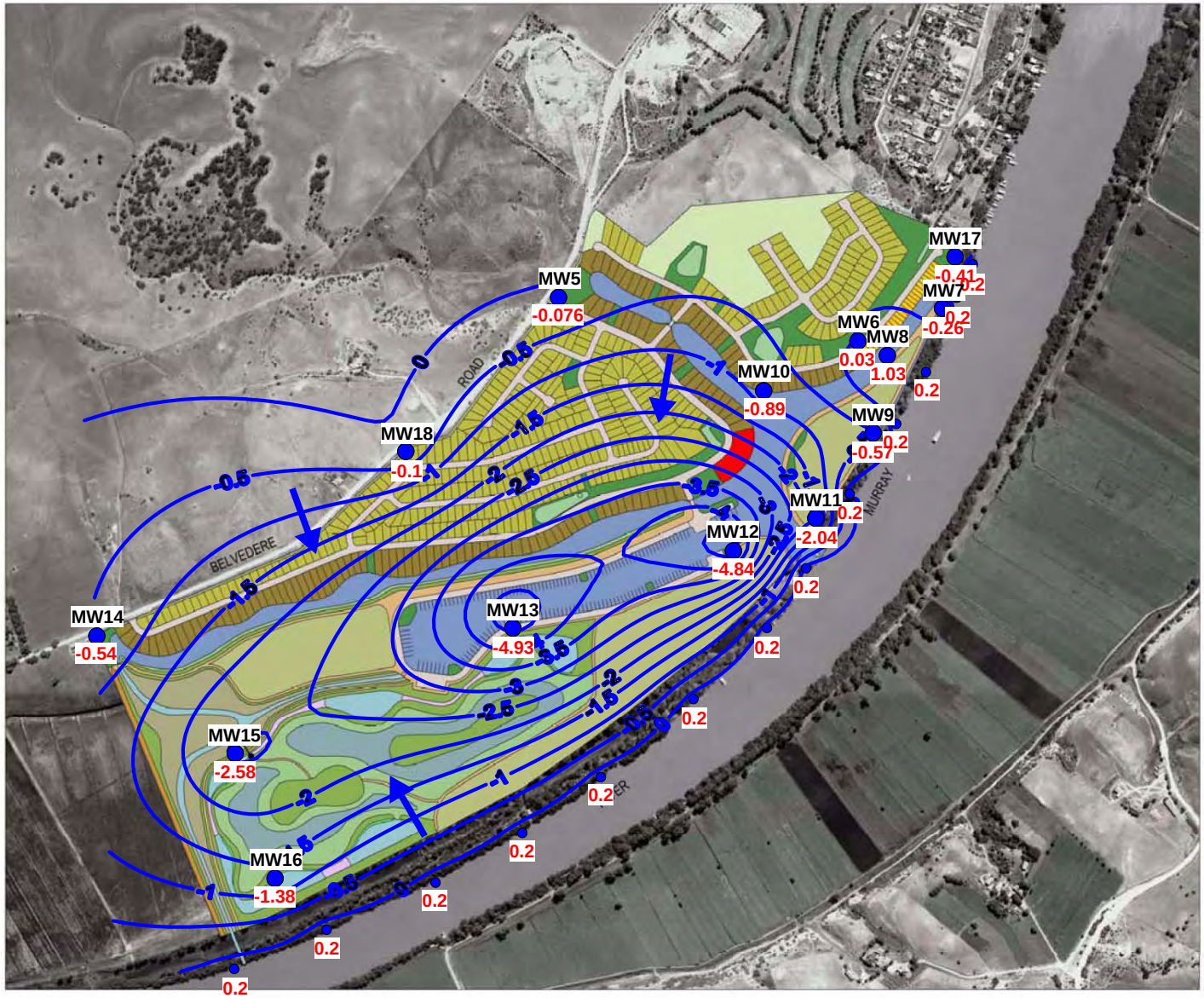
Field parameters were collected during the purging of the wells to verify that a representative groundwater sample was obtained. Where wells pumped appropriately, the wells were purged until the field parameters stabilised. Where there was insufficient flow into the wells to allow this, the wells were purged dry on one or more occasions and then a sample was obtained of the recovered water. A summary of the groundwater field parameters collected at the time of sampling is included in Appendix A.

Samples for laboratory analysis were collected in sample bottles provided by the laboratory. All wells were analysed for total dissolved solids (TDS), major cations and anions, ammonia and nitrate.

Samples from MW6, MW7, MW8 and MW9 (located in the east of the site) were analysed for a broad screen of inorganic and organic parameters referred to as a Vic EPA screen. This includes heavy metals, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons, selected monocyclic aromatic hydrocarbons (benzene, ethyl benzene, toluene and xylenes), organochlorine pesticides, polychlorinated biphenyls, cyanide, chlorinated hydrocarbons and phenols. Samples for heavy metal analyses were field filtered using a 0.45 micron filter so the results represent the dissolved or filterable metal content of the groundwater. These four samples were also analysed for biological indicators of faecal contamination including *E*.coli and faecal coliforms, as these samples were collected in the vicinity of the wastewater treatment lagoons.

A blind duplicate sample was submitted to the laboratory for quality control purposes.

MANNUM WATERS



DEVELOPMENT FEATURES

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WETLAND

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- SHALLOW MARSH
- TALL MACROPHYTES
- RIPARIAN / ISLANDS
- SHALLOW MACROPHYTES
- SHALLOW WATER BODIES
- TREATMENT WETLAND

GROUNDWATER MONITORING WELL
(LABEL & RL m AHD)

0 100 200 300 400 Metres

Soil & Groundwater Pty Ltd

207 The Parade Norwood SA 5067
PO Box 3166 Norwood SA 5067
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Drawn: AKW	Date: 24 Jan 08		Job No.: SG071493	Project: Groundwater Investigation "Mannum Waters"	
Checked: APN	Date: 24 Jan 08		Title: SITE PLAN HYDRAULIC CONTOURS (m AHD)		Sheet 1 of 1
File Name: Figure 3.wor	Scale: 1:1,500	A4			FIGURE 3

4.4 Analytical Results

A summary of the groundwater analytical results with comparison to relevant assessment criteria is included in Appendix A. A copy of the NATA certified laboratory results is included in Appendix C.

Groundwater quality in the vicinity of the Council landfill has yet to be assessed. Whilst the potential for significant groundwater impacts associated with this landfill is considered low, due to the depth to groundwater, expected low infiltration and land use, this issue will be assessed as part of further groundwater investigations in the Murray Group limestone aquifer. It is intended that the wells be installed into the Murray Group limestone in the near future using either a cable tool rig or casing advance tools, as soon as an appropriate drilling rig is available.

Salinity

The groundwater salinity ranged from 2,900 mg/L TDS (MW08) to 65,000 mg/L TDS (MW16). The lowest salinity groundwater occurred adjacent the wastewater treatment lagoons and in the well reporting the highest groundwater elevation.

The two wells reporting the lowest groundwater levels reported relatively high salinities but higher results were obtained in other wells at both the eastern and western ends of the site. Figure 4 shows the distribution of TDS in the shallow groundwater at the site. The average groundwater salinity at the site was approximately 17,300 mg/L TDS.

Based on the measured salinities, the groundwater at the site is expected to have limited environmental values without treatment. The most relevant value of the groundwater is expected to be protection of freshwater ecosystems, although the groundwater contours and levels suggest that groundwater from the site is unlikely to enter the ecosystem of the Murray River. The analytical data has been compared to the freshwater ecosystem protection and potable use criteria of the Environment Protection (Water Quality) Policy (EPP) issued by SA EPA (2003).

MANNUM WATERS

DEVELOPMENT FEATURES

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- ROAD
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WETLAND

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- SHALLOW MARSH
- TALL MACROPHYTES
- RIPARIAN / ISLANDS
- SHALLOW MACROPHYTES
- SHALLOW WATER BODIES
- TREATMENT WETLAND

GROUNDWATER MONITORING WELL (LABEL & TDS (mg/L))

0 100 200 300 400 Metres

Soil & Groundwater Pty Ltd

207 The Parade Norwood SA 5067
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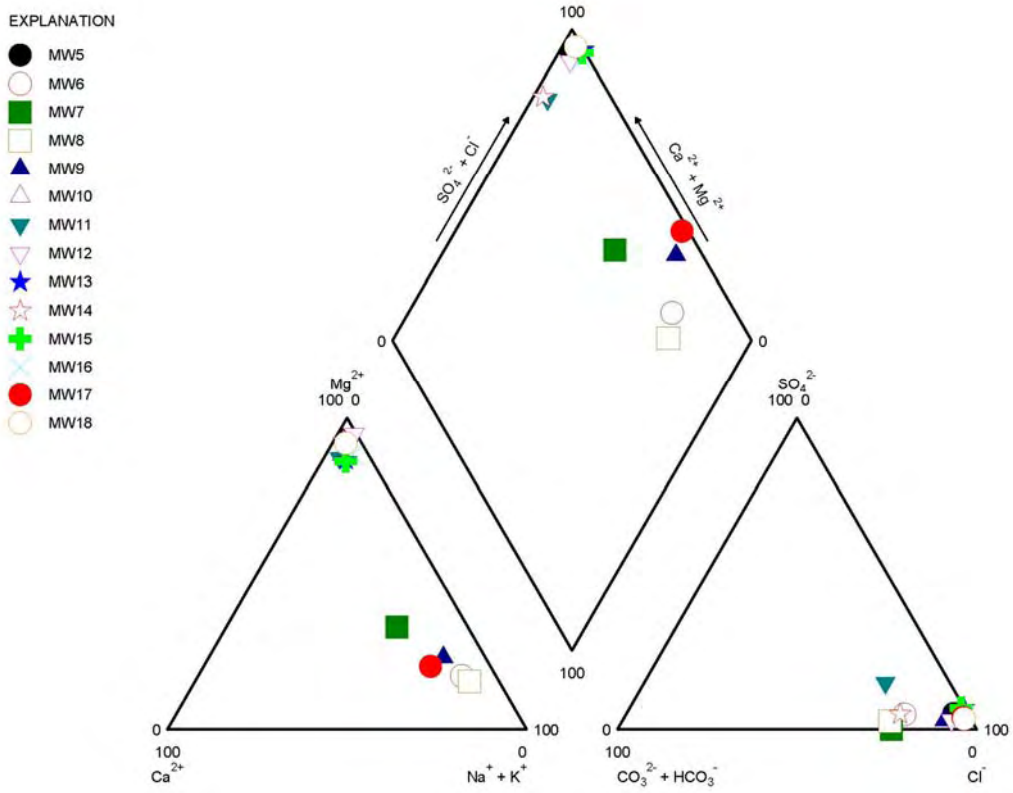
Drawn: AKW	Date: 24 Jan 08		Job No.: SG071493	Project: Groundwater Investigation "Mannum Waters"	
Checked: APN	Date: 24 Jan 08		Title: SITE PLAN TOTAL DISSOLVED SOLIDS (mg/L)		Sheet 1 of 1
File Name: Figure 4.wor	Scale: 1:1,500	A4			FIGURE 4

4.4.1 Anions & Cations

Groundwater samples were analysed for major cations and anions, including calcium, magnesium, sodium and potassium; and carbonate, bicarbonate, sulphate and chloride.

The analytical results are presented in the groundwater summary tables. The results were interpreted using the Piper plotting method which is based on the percent milli-equivalent concentration of each of the major ions relative to the total cationic or anionic strength of the solution. This allows the method to compare and contrast the chemical variations of groundwater of widely varying ionic strength. The Piper plot is shown in Figure 5.

Figure 5 – Piper Trilinear Plot



The Piper plot shows that the samples from the wells on-site exhibit two distinct water types. The background water quality is exhibited by wells high in sulphate and chloride as well as calcium and magnesium. The wells located adjacent to the SA Water ponds (MW6, MW7, MW8, MW9 and MW17) exhibit a different chemistry that is defined by lower concentrations of sodium, potassium and magnesium. This suggests that the wells in the vicinity of the SA Water ponds are being recharged through infiltration of a surface water source.

4.4.2 Nutrients

Ammonia and nitrate were analysed in all monitoring wells. Ammonia results ranged from below the reporting limiting (<0.05 mg/L) to 69 mg/L (MW16). All results other than the two below detection results exceeded the freshwater ecosystem criterion of 0.5 mg/L. Results exceeding the 10 mg/L were reported at MW12, MW13, MW15 and MW16. This included the two wells (MW12 and MW13) reporting the lowest groundwater elevations.

Nitrate (as N) results ranged from below the reporting limit (<0.02 mg/L) to 260 mg/L at MW13. The highest result was reported in a well showing low groundwater levels and it is possible the elevated nutrients at this location are related to groundwater evaporation. The EPP provides a criterion for oxidised nitrogen of 0.5 mg/L. As nitrate is likely to form the majority of the oxidised nitrogen species present, this criterion has been used to assess the nitrate results. Only two results at MW13 and MW14 (2.6 mg/L) exceed the criterion.

Total phosphate (as P) was tested for at MW6, MW7, MW8 and MW9. Two of the four results (MW6 and MW8) both reporting 1.4 mg/L exceeded the EPP freshwater criterion for total phosphorus of 0.5 mg/L.

4.4.3 Heavy Metals

Heavy metal results were reported below the freshwater protection criteria for the four wells tested. Comparison of chromium results with the hexavalent chromium criterion in the absence of a total chromium criterion resulted in a number of exceedances However, there is no expectation of previous industries /activities at the site that utilised hexavalent chromium and it is likely that any chromium is in the natural trivalent form. Comparison with this criterion is therefore not relevant to the assessment.

A number of exceedance of the potable criterion occurred for arsenic and nickel. However, the salinity of the groundwater would make it unsuitable for use without treatment and it is probable that this treatment would also remove any heavy metals.

4.4.4 Organics

No organic results exceeding the laboratory reporting limits were detected in any of the four wells analysed.

4.4.5 Biological

E.coli and faecal coliforms were analysed in four wells located near the wastewater treatment lagoons. Results above the laboratory limit of reporting were noted for one or both parameters in three of the wells (MW6, MW7 and MW8).

There are no EPP criteria for freshwater ecosystem protection. Criteria are provided for primary and secondary contact recreation of 150 and 1,000 orgs/100ml. Results ranged up to 240 orgs/100ml, which were all below the secondary contact criterion.

4.5 Aquifer Hydraulic Testing

Rising head hydraulic conductivity tests (slug tests) were conducted on selected wells to provide a preliminary estimate of the horizontal hydraulic conductivity of the shallow aquifer. Since wells were only able to be installed within the Coonambidgal Formation due to the limitations noted above, the available data only applies to the hydraulic parameters of this formation.

The testing involved the installation of a pressure transducer connected to a data logger in the base of the well. A slug of water was removed from the well using a decontaminated bailer and the recovery of water in the well was measured over time.

The data collected from each test was downloaded from the data logger and analysed using the Aquifer Win32 analytical software using the Bouwer and Rice analysis method. This analysis method is appropriate for unconfined aquifers and yields an estimated value of aquifer hydraulic conductivity. As the water level was located within the well screen in each case, the correction factor for the effective radius of the well which takes into consideration the influence of the gravel pack was included in the analysis. The wells were assumed to be partially penetrating the aquifer and a nominal aquifer thickness of 10m was assigned to represent this for the Bouwer and Rice calculations.

It should be noted that slug testing is only able to test a small volume of aquifer material directly adjacent the well screen and so the results of this analysis are only indicative of the overall aquifer hydraulic conductivity value. Typically slug tests provide an "order of magnitude" level assessment of aquifer hydraulic conductivity. The slug test analyses are included in Appendix D. A summary of the results is included in the following table. Based on these estimated hydraulic conductivities, the yield from any wells within the Coonambidgel Formation is expected to be low.

Table 3 – Rising Head Test Results

Well	Hydraulic Conductivity	
	(m/sec)	(m/day)
MW5	1.8x10-7	0.01
MW10	4.9x10-6	0.42
MW14	8.8x10-6	0.76
MW15	1.8x10-7	0.02
MW16	8.7x10-8	0.01

4.5.1 Quality Assurance / Quality Control

To ensure that results were not biased by field sampling techniques and intra-laboratory variation, groundwater blind field duplicate samples were collected in the field for selected analyses.

The relative percentage difference (RPD) was calculated on these duplicate pairs. The RPD is defined as the difference between the duplicate samples as a percentage of the mean. The RPD is not calculated where one or both of the duplicate results are below the laboratory reporting limits. The RPDs are included in the tabulated results. It is noted that the RPD method is skewed by low laboratory results, where a small actual difference in concentrations returns a high RPD.

Table 4 – QA / QC Program

QA/QC Item	Detail
QA	
Field Procedures	Field Procedures were undertaken in accordance with the NEPM and AS4482.1 (Refer methodology presented in this report)
Decontamination of Equipment	Drilling and sampling equipment was decontaminated between sampling locations using potable water and Decon 90 phosphate free detergent.
Laboratories used and NATA accreditation	MGT Environmental Consulting (MGT) was used as the primary laboratory for the analysis of groundwater samples. Labmark was used as a secondary or quality control laboratory. Both laboratories are NATA accredited for the analyses undertaken.
Sample Tracking	Chain of Custodies documentation was used for the transport of all samples to the laboratory.
Sample Preservation and Storage	Samples were kept in laboratory supplied containers in a chilled esky and transported to the laboratory.
Holding Times	Samples were analysed within holding times.
Volatile Losses	All samples were kept within a chilled esky to minimise loss of volatile contaminants.
Data Transcription	Summary Results Tables have been prepared from electronic files provided by the laboratory.
Laboratory Detection Limits	The PQLs are presented in the laboratory Certificates of Analysis included in the appendices of this report. The PQLs were above the assessment criteria.
QC	
Blind Duplicate Water Samples	One blind duplicate pair was collected during the investigations. The RPDs calculated for field duplicate sample ranged from 5% to 121%, with 3 of the 10 RPD results above the generally accepted maximum value of 50%. The elevated RPDs were attributed to low concentrations of analytes in these samples.
Interlaboratory Split Duplicate Water Samples	One interlaboratory split duplicate pair was collected during the investigations. The RPDs calculated for water field duplicate samples ranged from 3% to 181%, with 3 of the 6 RPD results above the generally accepted maximum value of 50%. The elevated RPDs were attributed to low concentrations in these samples.
Laboratory Internal QC	The laboratory undertook internal QA/QC procedures, which are within the acceptable limits of repeatability, chemical extraction and detection. The chemical results are therefore considered to represent the concentrations of chemicals in samples provided to the laboratory.

5. CONCLUSIONS

Soil and Groundwater Consulting (S&G) was commissioned by Tallwood Pty Ltd to undertake a hydrogeological assessment and review of the area proposed for the development of a marina facility referred to as 'Mannum Waters' at Mannum, South Australia. The assessment was undertaken to address a number of issues raised by the referral authorities in response to the Environment Impact Statement (EIS).

The investigation comprised the installation of 14 groundwater monitoring wells into the shallow watertable aquifers at the site (the Coonambidgel Formation and Murray Group limestone), followed by gauging, sampling and analytical testing of the wells. The scope of work, including the number and locations of the wells was agreed with Steve Barnett of the Department of Water Land and Biodiversity Conservation (DWLBC). 12 wells were installed into the Coonambidgel Formation, whilst 2 wells (MW14 and MW18) appear to be within the Murray Group limestone aquifer. Additional wells were proposed to be drilled into the Murray Group limestone aquifer in the vicinity of the Council landfill, but due to drilling difficulties these could not be installed as part of this program. Three different locations were attempted using a range of drilling techniques, however each hole collapsed below 30 m depth. These wells will be installed using an alternative drilling technique as soon as an appropriate rig becomes available.

Based on the investigations completed to date, groundwater in the Coonambidgel formation aquifer over the majority of the proposed development site does not appear to be discharging to the Murray River. The groundwater level information indicates that the floodplain area of the site forms a groundwater sink, with groundwater likely discharging to the floodplain from both the regional aquifer from the north and from the Murray River from the south. This is consistent with expectations from the regional hydrogeology presented in Chapter 6 of the EIS document for the site. Evaporation is considered to be the primary driver for the occurrence of the groundwater sink. Elevated groundwater salinities identified in the floodplain are consistent with the evaporation of groundwater from this area.

A discussion on the potential impacts and mitigation measures from the proposed development is presented in Section 11 of the EIS document. The groundwater investigations have confirmed the groundwater elevations and low conductivity of the Coonambidgel Formation aquifer, which were used as assumptions in this Section of the EIS document.

There was some evidence of leakage from the wastewater treatment lagoons which occur in the eastern part of the site. Localised groundwater mounding and lower salinities were reported in this area. The hydraulic gradient appears to be towards the river in this area.

Analytical testing indicates that the groundwater across much of the site is impacted by ammonia with concentrations ranging from 0.05 mg/L to 69 mg/L, that exceed the EPP freshwater protection criterion. Higher results were reported in the central and western areas of the site and generally coincided with higher salinity results. Nitrate results were typically below the EPP assessment criterion for oxidised nitrogen with the exception of two results. One result in the centre of the site was significantly elevated. The higher results for ammonia and nitrate may be associated with concentration of groundwater solutes in response to evaporation. The widespread ammonia may be associated with the historical use of the site or the natural organic materials present in the

clayey formation. Modest exceedances of the total phosphorus criterion were noted at two of the four locations tested in the vicinity of the wastewater treatment lagoons. No other significant contaminants were identified by the analytical testing. Provided that there is no interaction between groundwater and the proposed marina waterways, or groundwater discharge to the River, it is considered that the risk of elevated ammonia concentrations or salinity impacting on the River Murray is low. If deemed necessary by the referral authorities, a numerical groundwater flow and contaminant transport model could be used as a tool to predict the interaction between groundwater and the River post development, and quantify the potential risks associated with salinity and ammonia concentrations in groundwater.

Rising head hydraulic conductivity tests were conducted on a number of wells to assess the horizontal hydraulic conductivity of the shallow floodplain aquifer. The results ranged from 0.01 m/day to 0.76 m/day, with a geometric mean of 0.06 m/day. Based on the steep hydraulic gradients present, the low groundwater levels reported in the centre of the site, and evidence of an evaporative sink, it is considered likely that the hydraulic conductivity of the shallow aquifer is low to very low allowing these hydraulic features can be maintained.

It is understood that the proposed development will be designed to prevent intersection of the marina waterways with the groundwater. Based on the current groundwater elevations, it is considered that the waterways will be above the groundwater with the exception of the reaches in the vicinity of MW5 and MW14. It is understood that the proponent is considering an engineered solution consisting of a low permeability clay liner, together with a permanent head of water in these areas to prevent saline groundwater from entering the marina waterways.

6. LIMITATIONS

Purpose

1. This report was prepared by Soil & Groundwater Consulting ('S&G') for the sole use of the client identified in the body of the report ('Client'), in relation to the property identified in the body of the report ('Site') and in accordance with the scope of work agreed between S&G and the Client.

Standard

2. This report was prepared by S&G generally in accordance with the usual and accepted practices and standards for consultants at the time it was prepared. The data referred to in this report was obtained between the dates as set out in the body of the report ('Data Collection Period').

3. S&G is not responsible for any inaccuracies or omissions in this report outside the scope of work and purpose set out in the report. There was no indication to S&G during the data collection period that any information contained in this report was false.

4. Opinions and recommendations contained in this report are based on data provided by representatives of the Client, information gained during site inspection and fieldwork, employee interviews and information provided from government authorities' records and other third parties, to the extent to which such information has been sought and obtained.

Variation in Conditions

5. This report presents the results of an investigation and assessment program to determine the distribution and nature of shallow groundwater at the Site.

6. This report is based on the conditions encountered and information available during the Data Collection Period.

7. Subsurface conditions may vary significantly between sampling locations and depth intervals and at locations other than where data collection was performed. Groundwater levels, salinity and contaminant concentrations may vary from day to day.

8. S&G does not accept any responsibility for any changes to the Site conditions that may have occurred after the Data Collection Period described in Clause 2 above, or for the impact of any such changes on this report.

Use of Report

9. This report must be read in its entirety.

10. This report may not be relied upon by any third party without the express written permission of S&G, which permission may be granted or withheld in S&G's absolute discretion.

11. No responsibility is accepted by S&G for use of this report, or any part of this report, in any context or for any purpose or for any party, other than the Client, and for the purpose identified in the body of the report.

12. The information in this report is considered to be accurate at the date of issue and is in accordance with conditions at the Site during the data collection period.

13. This report and the information contained in it should only be regarded as validly representing the Site conditions at the time of the data collection period unless otherwise explicitly stated in this report.

No third party warranties

14. No warranties, express or implied, are made to any third party in relation to the subject matter of this report, or the recommendations or conclusions expressed within it.

APPENDIX A

SUMMARY TABLES

CALCULATION OF SALINITY CORRECTED RELATIVE WATER LEVELS
MANNUM WATERS

Well ID	TOC (mAHD)	Total depth (m btoc)	Screen length (m)	Top of Screen (m btoc)	Bottom of screen (mbtoc)	RL Top of Screen	RL Bottom of Screen	RL Screen Midpoint	May06 SWL	May06 RWL	Is RWL above Screen	Hs-Hp	TDS	Ps	Ps-Pf	Corrected RWL
MW5	5.183	8.4	3	5.4	8.4	-0.217	-3.217	-1.717	5.281	-0.098	YES	1.619	18,000	1.0135	0.0135	-0.076
MW6	2.996	4.5	3	1.5	4.5	1.496	-1.504	-0.004	2.968	0.028	NO	0.766	3,100	1.0023	0.0023	0.030
MW7	4.004	6	3	3	6	1.004	-1.996	-0.496	4.263	-0.259	NO	0.869	4,200	1.0032	0.0031	-0.257
MW8	2.676	4.5	3	1.5	4.5	1.176	-1.824	-0.324	1.653	1.023	NO	1.424	2,900	1.0022	0.0022	1.026
MW9	1.535	4	3	1	4	0.535	-2.465	-0.965	2.105	-0.570	NO	0.948	5,600	1.0042	0.0042	-0.566
MW10	1.289	4	3	1	4	0.289	-2.711	-1.211	2.195	-0.906	NO	0.903	30,000	1.0225	0.0225	-0.886
MW11	1.057	4	3	1	4	0.057	-2.943	-1.443	3.103	-2.046	NO	0.449	3,600	1.0027	0.0027	-2.044
MW12	-0.009	5.5	3	2.5	5.5	-2.509	-5.509	-4.009	4.833	-4.842	NO	0.334	12,000	1.0090	0.0090	-4.839
MW13	-0.539	4	3	1	4	-1.539	-4.539	-3.039	4.392	-4.931	NO	0.196	17,000	1.0128	0.0128	-4.929
MW14	6.635	9.4	3	6.4	9.4	0.235	-2.765	-1.265	7.183	-0.548	NO	1.109	4,300	1.0032	0.0032	-0.545
MW15	-0.212	4.1	3	1.1	4.1	-1.312	-4.312	-2.812	2.391	-2.603	NO	0.855	31,000	1.0233	0.0233	-2.583
MW16	1.417	4	3	1	4	0.417	-2.584	-1.084	2.821	-1.405	NO	0.590	65,000	1.0488	0.0488	-1.376
MW17	1.375	6	3	3	6	-1.625	-4.625	-3.125	1.847	-0.472	YES	2.653	29,000	1.0218	0.0217	-0.415
MW18	14.976	17	3	14	17	0.976	-2.024	-0.524	15.09	-0.114	NO	0.955	17,000	1.0128	0.0128	-0.102

Based on equation 3.2 of Pavelic and Dillon (1993)

Hf = Hs + (Ps - Pf / Pf) x (Hs-Hp)

where Hf = equivalent freshwater head

Hs = Level of saline groundwater measured in well

HP = Relative level of midppoint between SWl and base of screen, or where screen is saturated, relative level of midpoint of screen

Pf = density of freshwater

Ps = density of saline groundwater = TDS x 7.5E-7 + 1

SUMMARY OF ALL FIELD RESULTS
MANNUM WATERS

Well ID	Date	Dissolved Oxygen	Temperature	Salinity	pH	Conductivity	Estimated TDS	Redox	Comments
		mg/L	C	g/L	pH units	mS/cm	mg/L	mV	
MW5	20-Nov-07	2.04	24.4	20.4	7.2	28	18,200	-62	Dry 8L
MW6	20-Nov-07	3.16	23.8	3.12	7.35	4.61	2,997	-42	Dry 8L
MW7	20-Nov-07	3.06	23.1	4.74	6.3	6.91	4,492	-100	grey water
MW8	20-Nov-07	1.85	27.3	3.48	6.33	4.9	3,185	-23	--
MW9	20-Nov-07	1.43	23.3	6.13	6.27	8.87	5,766	-88	Dry 15L, high turbidity, silty clay
MW10	00-Jan-00	1.58	23.4	28.6	5.93	33.4	21,710	-6	Dry 20L
MW11	20-Nov-07	7.09	24	4.15	7.03	6.13	3,985	-82	Dry 7L
MW12	20-Nov-07	3.48	-	12.3	6.74	17.33	11,265	-44	Dry 5L
MW13	20-Nov-07	2.16	24.6	16.41	7.13	22.72	14,768	-37	Dry 5L
MW14	20-Nov-07	5.11	23.7	5.2	7.73	7.57	4,921	29	brown water
MW15	20-Nov-07	2.39	22.9	-	6.48	38.3	24,895	-11	slow recharge
MW16	20-Nov-07	3.08	23.9	57.4	6.41	73.3	47,645	21	Dry 5L, very slow recharge
MW17	20-Nov-07	4.32	22.3	32.1	6.26	43	27,950	-56	Dry 11L, grey water
MW18	20-Nov-07	-	-	3.246	-	-	--	-	anomolous readings

SG071493
Mannum Waters

SUMMARY OF GROUNDWATER RESULTS
ALL RESULTS IN MG/L

			Nutrients					Biological		Anions / cations								Heavy Metals															
Sample	Batch	Total Dissolved Solids	Ammonia(N)	Nitrate (N)	Nitrite (N)	Total Kjeldahl Nitrogen (N)	Phosphate total (P)	E.Coli	Faecal Coliforms	Calcium	Potassium	Sodium	Magnesium	Chloride	Sulphate (S)	Bicarbonate Alkalinity-mg CaCO3/L	Carbonate Alkalinity-mg CaCO3/L	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Chromium (hexavalent)	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Tin	Zinc
EPP CRITERIA																																	
EPP Fresh aquatic ecosystem			0.5				0.5											0.5	0.5	-	0.002	-	0.0044 (CrVI)	-	0.01	0.005	0.0001	-	0.015	0.07	-	0.05
Dutch Intervention																		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPP Potable				10	1													0.003	0.007	-	0.002	-	0.05 (CrVI)	-	2	0.01	0.001	0.05	0.02	0.01	-	-
RESULTS																																	
MW05	MGT 218724	18,000	4	0.02						360	580	20	5,400	8,800	660	630	<10																
MW06	MGT 218669	3,100	3	<0.02	0.22	4.1	1.4	<2	2	100	21	880	110	1,200	100	470	<10	<0.005	0.32	<0.001	<0.0002	0.01	0.01	<0.001	<0.001	<0.001	<0.0001	<0.005	0.007	0.004	<0.005	0.006
MW07	MGT 218669	4,200	1.4	0.05	<0.02	8.4	0.03	11	180	280	<5	770	280	1,800	3	960	<10	<0.005	0.016	<0.001	<0.0002	0.011	0.011	0.027	0.002	<0.001	<0.0001	<0.005	0.027	0.01	<0.005	0.01
MW08	MGT 218669	2,900	1.2	<0.02	0.05	3.6	1.4	240	240	78	<5	830	88	1,100	52	580	<10	<0.005	0.071	<0.001	<0.0002	0.005	0.005	0.021	<0.001	<0.001	<0.0001	<0.005	0.045	0.005	<0.005	0.012
MW09	MGT 218669	5,600	1.1	0.06	<0.02	2.4	0.02	<2	<2	250	14	1,600	300	3,100	140	440	<10	<0.005	0.004	<0.001	<0.0002	0.002	0.002	0.006	0.002	<0.001	<0.0001	<0.005	0.007	0.011	<0.005	0.02
MW10	MGT 218724	30,000	3.3	<0.02						1,000	1,200	<5	7,200	15,000	830	310	<10																
MW11	MGT 218724	3,600	0.53	0.13						130	130	<5	800	1,000	300	460	<10																
MW12	MGT 218724	12,000	**13**	0.29						400	500	<5	3,200	5,600	250	580	<10																
MW13	MGT 218724	17,000	**45**	**260**						550	980	6	4,100	7,100	720	<10	<10																
MW14	MGT 218724	4,300	<0.05	2.6						100	110	<5	1,200	1,600	140	680	<10																
MW15	MGT 218724	31,000	**17**	<0.02						1,000	1,700	34	7,100	14,000	1,400	230	<10																
MW16	MGT 218724	65,000	**69**	0.22						1,200	4,100	82	15,000	33,000	1,900	1,200	<10																
MW17	MGT 218669	29,000	2	0.02						1,500	41	6,500	1,100	15,000	830	510	<10																
MW18	MGT 218724	17,000	<0.05	0.24						430	550	94	5,400	8,800	430	280	<10																
QA / QC																																	
MW06	MGT 218669	3,100	3	<0.02	0.22	4.1	1.4	<2	2	100	21	880	110	1,200	100	470	<10	<0.005	0.32	<0.001	<0.0002	0.01	0.01	<0.001	<0.001	<0.001	<0.0001	<0.005	0.007	0.004	<0.005	0.006
D1	dup of MW06	2,400	1	<0.02						81	<5	840	81	1,100	51	580	<10	<0.005	0.079	<0.001	<0.0002	0.009		0.024	<0.001	<0.001	<0.0001	<0.005	0.051	0.004	<0.005	0.007
RPD (%)		25%	**100%**	-						21%	-	5%	30%	9%	**65%**	21%	-	-	**121%**	-	-	11%		-	-	-	-	-	**152%**	0%	-	15%
MW14	MGT 218724	4,300	<0.05	2.6						100	110	<5	1,200	1,600	140	680	<10																
DupA	interlab of MW14	4,450								41.9	41	1400	60.8	1,810	421	743	<5																
RPD (%)		3%								**82%**	-	-	**181%**	12%	**100%**	9%	-																

SG071493
Mannum Waters

SUMMARY OF GROUNDWATER RESULTS
ALL RESULTS IN MG/L

Sample	Batch	Polycyclic Aromatic Hydrocarbons																BTEX				TPH				
		Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH	Benzene	Ethylbenzene	Toluene	Xylenes(ortho,meta and para)	TRH C6-C9 Fraction by GC	TRH C10-C14 Fraction by GC	TRH C15-C28 Fraction by GC	TRH C29-C36 Fraction by GC	C10 - C36 Total
EPP CRITERIA																										
EPP Fresh aquatic ecosystem		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.003	0.3	-	-	-	-	-	-	-	-
Dutch Intervention		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6
EPP Potable		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00001	0.001	0.3	0.8	0.6	-	-	-	-	-
RESULTS																										
MW05	MGT 218724																									
MW06	MGT 218669	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.05	<0.1	<0.1	<0.25
MW07	MGT 218669	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.02	<0.05	<0.1	<0.1	<0.25
MW08	MGT 218669	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	<0.02	<0.05	<0.1	<0.1	<0.25
MW09	MGT 218669	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.05	<0.1	<0.1	<0.25
MW10	MGT 218724																										
MW11	MGT 218724																										
MW12	MGT 218724																										
MW13	MGT 218724																										
MW14	MGT 218724																										
MW15	MGT 218724																										
MW16	MGT 218724																										
MW17	MGT 218669																										
MW18	MGT 218724																										
QA / QC																										
MW06	MGT 218669	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.05	<0.1	<0.1	<0.25
D1	dup of MW06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.05	<0.1	<0.1	<0.25
RPD (%)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW14	MGT 218724																										
DupA	interlab of MW14																										
RPD (%)																											

SG071493
Mannum Waters

SUMMARY OF GROUNDWATER RESULTS
ALL RESULTS IN MG/L

Sample	Batch	Organochlorine Pesticides																					Cyanide (total)	Polychlorinated Biphenyls							
		4 4'-DDD	4 4'-DDE	4 4'-DDT	a-BHC	Aldrin	b-BHC	Chlordane	d-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor	Toxophene		Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Total PCB
EPP CRITERIA																							* free								
EPP Fresh aquatic ecosystem		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000004
Dutch Intervention		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPP Potable		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08*	-	-	-	-	-	-	-	-
RESULTS																															
MW05	MGT 218724																														
MW06	MGT 218669	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
MW07	MGT 218669	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
MW08	MGT 218669	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
MW09	MGT 218669	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
MW10	MGT 218724																														
MW11	MGT 218724																														
MW12	MGT 218724																														
MW13	MGT 218724																														
MW14	MGT 218724																														
MW15	MGT 218724																														
MW16	MGT 218724																														
MW17	MGT 218669																														
MW18	MGT 218724																														
QA / QC																															
MW06	MGT 218669	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
D1	dup of MW06	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	< 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01
RPD (%)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW14	MGT 218724																														
DupA	interlab of MW14																														
RPD (%)																															

SG071493
Mannum Waters

SUMMARY OF GROUNDWATER RESULTS
ALL RESULTS IN MG/L

Sample	Batch	Chlorinated Hydrocarbons																Phenols										
		1.2-Dichlorobenzene	1.2.3-Trichlorobenzene	1.2.3.4-Tetrachlorobenzene	1.2.3.5-Tetrachlorobenzene	1.2.4-Trichlorobenzene	1.2.4.5-Tetrachlorobenzene	1.3-Dichlorobenzene	1.3.5-Trichlorobenzene	1.4-Dichlorobenzene	Benzal chloride	Benzotrichloride	Benzyl chloride	Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachloroethane	Pentachlorobenzene	2-Chlorophenol	2-Methylphenol (o-Cresol)	2-Nitrophenol	2.4-Dichlorophenol	2.4-Dimethylphenol	2.4.6-Trichlorophenol	2.6-Dichlorophenol	3&4-Methylphenol (m&p-Cresol)	4-Chloro-3-methylphenol	Pentachlorophenol	Phenol
EPP CRITERIA																												
EPP Fresh aquatic ecosystem		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0002	0.05
Dutch Intervention		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPP Potable		1.5	-	-	-	-	-	-	-	0.04	-	-	-	-	0.0007	-	-	-	-	-	-	0.0003	-	-	-	-	-	0.00001	-
RESULTS																												
MW05	MGT 218724																											
MW06	MGT 218669	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
MW07	MGT 218669	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
MW08	MGT 218669	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
MW09	MGT 218669	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
MW10	MGT 218724																											
MW11	MGT 218724																											
MW12	MGT 218724																											
MW13	MGT 218724																											
MW14	MGT 218724																											
MW15	MGT 218724																											
MW16	MGT 218724																											
MW17	MGT 218669																											
MW18	MGT 218724																											
QA / QC																												
MW06	MGT 218669	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
D1	dup of MW06	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.005	<0.001
RPD (%)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW14	MGT 218724																											
DupA	interlab of MW14																											
RPD (%)																												

APPENDIX B

BORELOGS & WELL CONSTRUCTION DETAILS

GROUNDWATER WELL REPORT

WELL NUMBER: MW05

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 6/11/07
Date Completed: 6/11/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4 5 6 7 8 9		CI CH CH	**FILL** Sandy CLAY, pale brown, medium plasticity, fine to medium grained sand with some fine grained gravels **Sandy Silty CLAY** Pale brown, high plasticity, fine to medium grained **Sandy CLAY** Grey, high plasticity, fine to medium grained sand Groundwater well terminated at 8.4m	D M M				Standpipe PVC Casing Grout / Backfill Bentonite Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW06

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4 5		CI CI CH	**FILL** Silty Sandy CLAY, brown / grey brown, medium plasticity, fine to medium grained sand **Sandy CLAY** Dark brown, medium plasticity, fine to coarse grained sand **Silty CLAY** Brown, high plasticity [Soft] Groudnwater well terminated at 4.5m	M M W				Standpipe Bentonite PVC Casing Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW07

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1		Cl	**FILL** Sandy Silty CLAY, pale brown, medium plasticity, fine to coarse grained sand with some gravels	M				Standpipe Bentonite	
				Cl	**Silty CLAY** Dark grey, medium plasticity [Stiff]	M					
		2			**Silty CLAY** Brown, medium plasticity [Stiff, organic]					PVC Casing	
		3		Cl		M					
		4			**Silty CLAY** Brown, medium plasticity [Firm]					SWL at 4.0m	
		5		Cl		W				Sand pack PVC Screen	
		6			Groundwater well terminated at 6.5m					End cap	
		7									

GROUNDWATER WELL REPORT

WELL NUMBER: MW08

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4 5		Cl Cl CH	**FILL** Silty Sandy CLAY, brown / grey brown, medium plasticity, fine to medium grained sand **Sandy CLAY** Dark brown, medium plasticity, fine to medium grained sand **Silty CLAY** Grey, high plasticity]Soft] Groundwater well terminated at 4.5m	D M W				Standpipe Bentonite PVC Casing Sand pack SWL at 2.5m PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW09

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4		SC CI CH	**FILL** SAND, pale brown, fine to medium grained with some medium plasticity fine inclusions **Silty Sandy CLAY** Pale brown / dark brown, medium plasticity, fine to coarse grained sand **Silty CLAY** Grey, high plasticity [Soft] Groundwater well terminated at 4.0m	M D M				Standpipe Bentonite PVC Casing Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW10

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1		SC/GP	**FILL** SANDS / GRAVELS, orange / brown, fine to coarse grained sand, fine to coarse grained gravel	D				Standpipe	
				SC	**SAND** Pale orange / brown, fine to coarse grained	D				Bentonite	
				CI	**Silty CLAY** Dark grey / black, medium plasticity [Organic]	M				PVC Casing	
		2		CI	**Silty CLAY** Dark grey / brown, medium plasticity	M				SWL at 1.75m	
				CI	**Silty CLAY** Dark grey / brown, medium plasticity [Organic]	W				Sand pack	
		3			Grey / orange [High silt content]					PVC Screen	
		4			Groundwater well terminated at 4.0m					End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW11

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1		CI	**FILL** Sandy CLAY, pale brown, medium plasticity, fine to medium grained sand	M				Standpipe, Bentonite, PVC Casing	
				SC	**FILL** Clayey SAND, grey, fine to medium grained, medium plasticity fines	M					
		2			Pale grey					Sand pack	
		3		CH	**Sandy Silty CLAY** Pale brown, high plasticity, fine to medium grained sand	M				PVC Screen	
		4		CH	**Sandy CLAY** Grey, high plasticity, fine to medium grained sand	W				End cap	
					Groundwater well terminated at 4.0m						

GROUNDWATER WELL REPORT

WELL NUMBER: MW12

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4 5		SC Cl Cl	**FILL** Gravelly Clayey SAND, dark grey, fine to medium grained, medium plasticity, fine grained gravel with some silt fines **Sandy CLAY** Dark brown, medium plasticity, fine to medium grained sand **Silty CLAY** Dark brown, medium plasticity [Firm] Groundwater well terminated at 4.5m	D M M				Standpipe Bentonite PVC Casing Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW13

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4 5		Cl Cl Cl Cl	**FILL** Silty CLAY, dark grey mottled orange, medium plasticity **Silty CLAY** Grey mottled brown, medium plasticity [Firm] **Silty CLAY** Grey / brown, medium plasticity [Firm / stiff] **Silty CLAY** Grey, medium plasticity [Firm] Groundwater well terminated at 4.0m	D M M W				Standpipe Bentonite PVC Casing SWL at 1.8m Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW14

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Auger rockbit from 0.0 to 0.5m then Push tube from 0.5 to 12.0m		1 2 3 4 5 6 7 8 9 10 11 12 13		SC	**FILL** Gravelly SAND, pale grey / pale brown, fine to coarse grained, fine to medium grained gravel **Limestone** Pale grey / pale brown cuttings [High resistance] Lower resistance at 7.0m Groundwater well terminated at 12.0m	D D M				Standpipe Grout / Backfill PVC Casing Bentonite Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW15

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4		Cl CH CH	**FILL** Silty Sandy CLAY, grey / brown, medium plasticity, fine to medium grained sand [Firm, calcareous] **Silty CLAY** Orange / brown mottled grey, high plasticity with some sand Grey / brown Grey / brown mottled orange **Silty CLAY** Grey, high plasticity [Firm, stiff] Groudnwater well terminated at 4.1m	D M W			PVC Casing	Standpipe Bentonite SWL at 1.9m Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW16

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1		Cl	**FILL** Silty CLAY, grey, medium plasticity with some sand [Firm / stiff]	D				Standpipe Bentonite PVC Casing	
				Cl	**Silty CLAY** Dark grey / brown, medium plasticity [Firm]	D					
		2		Cl	**Silty CLAY** Grey / brown mottled blue, medium plasticity	M/W				SWL at 1.7m Sand pack	
		3		Cl	**Silty CLAY** Grey / brown, medium plasticity [Very soft]	W				PVC Screen	
		4			Groundwater well terminated at 4.0m					End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW17

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 25/10/07
Date Completed: 25/10/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Push tube		1 2 3 4		Cl	**FILL** Silty CLAY, dark brown, medium plasticity with some gravels **Silty CLAY** Dark grey / brown, medium plasticity [Firm] Pale grey / brown [Soft / firm] Groundwater well terminated at 4.0m	M				Standpipe Bentonite PVC Casing Sand pack PVC Screen End cap	

GROUNDWATER WELL REPORT

WELL NUMBER: MW18

First Floor 207 The Parade
NORWOOD SA 5067
T: + 61 8 8431 7113

Client: Tallwood
Project: Mannum Waters
Location: Mannum
Project No: SG071493
Date Commenced: 8/11/07
Date Completed: 8/11/07

Checked by: SMF
Datum: -
Easting: -
Northing: -
R.L. surface: -

Logged by: RAF
Contractor: In-depth
Operator: Lachlan
Machine: Rockmaster

SUBSURFACE PROFILE								SAMPLING			
Drilling Method	Water	Depth (m)	Graphic	USCS	Description	Moisture	Consistency	Recovery	Sampling	Well Construction Details	PID (ppm)
Auger Rockbit from 0.0 to 0.5m then Rotary air hammer from 0.5 to 21.0m		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22		GP	**FILL** Sandy GRAVEL, pale grey / pale brown, fine to medium grained, fine to coarse grained sand **Limestone** Pale grey / pale brown [High resistance] Yellow / brown Pale brown Groundwater well terminated at 21.0m	D M				Standpipe PVC Casing Bentonite PVC Screen Sand pack End cap	

GOVERNMENT OF SOUTH AUSTRALIA
DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137100
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5857/178
   Allotment 331 in Filed Plan 208707
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137099
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5857/178
   Allotment 331 in Filed Plan 208707
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137098
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5857/178
   Allotment 331 in Filed Plan 208707
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137092
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5871/733
   Allotment 61 in Deposited Plan 56840
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137091
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5871/733
   Allotment 61 in Deposited Plan 56840
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
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TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Date: 19/10/2007 Delegate of Minister for Environment and Conservation

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137090
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5871/733
   Allotment 61 in Deposited Plan 56840
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
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4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

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GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137089
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5871/733
   Allotment 61 in Deposited Plan 56840
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
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Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

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DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137088
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5977/589
   Allotment 500 in Deposited Plan 70381
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
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4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

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Melinda Kovac
COORDINATOR WATER LICENSING
Date: 19/10/2007 Delegate of Minister for Environment and Conservation

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137087
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5913/469
   Section 743
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
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4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

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Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137086
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5913/469
   Section 743
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
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6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137085
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5913/469
   Section 743
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

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GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137084
Expiry Date:	19/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5913/469
   Section 743
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

1. Under section 202(1)(b)(ii) of the Natural Resources Management Act 2004, you have a right of appeal to the Environment, Resources and Development Court against the imposition of any condition on this permit. The appeal must be instituted within six weeks of the date of permit issue. The appeal must also be served upon this department within that time.
2. This permit is not transferable.
3. This well construction permit is not an authorisation for a person to enter private property and prior authority must be obtained from the land owner in all circumstances.
4. The issue of this permit does not negate the requirement to comply with the provisions of other Acts that may impact on the activity undertaken pursuant to this permit.

TAKE NOTE that the permit holder, or a person acting on behalf of the permit holder, who contravenes or fails to comply with a condition of this permit is guilty of an offence, and such acts or omissions may result in the variation, suspension or revocation of the permit.

Melinda Kovac
COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 19/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137097
Expiry Date:	24/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CR 5267/641
   Section 770
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
4. If the well is considered unsatisfactory, it may be abandoned and a replacement well may then be constructed provided that the abandoned well is backfilled prior to the drill rig leaving the site.
5. Water samples are required from all wells drilled in respect of this permit.
6. Strata samples are not required.
7. The licensed well driller must forward with his report a plan obtained from the permit holder, who must mark thereon the location of all wells drilled in respect of this permit.
8. All wells must be drilled vertical unless written permission is obtained from the Minister.

NOTES:

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Melinda Kovac
COORDINATOR WATER LICENSING
Date: 24/10/2007 Delegate of Minister for Environment and Conservation

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

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Permit No:	137096
Expiry Date:	24/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CR 5267/641
   Section 770
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
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Melinda Kovac
COORDINATOR WATER LICENSING
Date: 24/10/2007 Delegate of Minister for Environment and Conservation

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137095
Expiry Date:	24/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CR 5267/641
   Section 770
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
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Melinda Kovac
COORDINATOR WATER LICENSING
Date: 24/10/2007 Delegate of Minister for Environment and Conservation

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137094
Expiry Date:	24/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CR 5267/641
   Section 770
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
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COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 24/10/2007

GOVERNMENT OF SOUTH AUSTRALIA

DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137093
Expiry Date:	24/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CR 5267/641
   Section 770
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
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Delegate of Minister for Environment and Conservation

Date: 24/10/2007

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RESOURCE ALLOCATION DIVISION
GPO Box 2834 Adelaide SA 5001
Ph: 8463 6875 Fax: 8463 6840

PERMIT to undertake a WATER AFFECTING ACTIVITY

pursuant to section 135 of the *Natural Resources Management Act 2004*

WELL PERMIT

Subject to full compliance with all the procedures, specifications and limitations contained or referred to, in the conditions set out below,

Permit No:	137284
Expiry Date:	16/10/2008

Permission is hereby granted to: SOIL AND GROUNDWATER CONSULTING
ACN 100 220 479
1ST FLOOR, 207 THE PARADE
NORWOOD SA 5067

To undertake the following water affecting activity:

Activity: Well Construction
Well Use: Investigation

CONDITIONS:

1. The activity authorised by this permit must only be undertaken on the land described below:

   CT 5792/113
   Allotment 2 in Deposited Plan 17430
   Hundred of Finniss

2. All work is to be carried out in accordance with the enclosed general specifications.
3. The well is not to penetrate beyond the base of the Morgan - Mannum limestone, ie not into the brown/black clays at the top of the Renmark beds.
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COORDINATOR WATER LICENSING
Delegate of Minister for Environment and Conservation

Date: 16/10/2007

APPENDIX C

LABORATORY CERTIFICATES & CHAIN OF CUSTODY DOCUMENTATION

mgt Environmental Consulting Pty. Ltd.

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

CERTIFICATE OF ANALYSIS

Soil and Groundwater Consulting
First Floor The Parade
Norwood
South Australia 5065
Site: SG071493 MANNUM MARINA

Report Number: 218669 Page 1 of 18
Order Number:
Date Received: Dec 6, 2007
Date Sampled: Dec 5, 2007
Date Reported: Dec 13, 2007
Contact: Adrian Webber

Methods

- USEPA 6020 Heavy Metals
- USEPA 8270C Phenols
- USEPA 8082 Polychlorinated Biphenyls
- USEPA 8121 Chlorinated Hydrocarbons
- USEPA 8081A Organochlorine Pesticides
- USEPA 8270C Polycyclic Aromatic Hydrocarbons
- USEPA 8260B - MGT 350A Monocyclic Aromatic Hydrocarbons
- MGT100A-GC Total Recoverable Hydrocarbons
- EML Method 3.3.4.14 E.coli – Subcontracted
- APHA 4500-Cl (Cl by FIA)
- USEPA 9010B Cyanide
- APHA 4500-NH3 Ammonia Nitrogen by FIA
- APHA 4500-NO3 Nitrate Nitrogen by FIA
- APHA 4500-NO2 Nitrite Nitrogen by FIA
- APHA 4500 TKN
- APHA 4500-P E. Phosphorous
- APHA 2540C Total Dissolved Solids
- APHA 4500-SO4 (SO4 by FIA)
- EML Method 3.3.3.10 Faecal Coliforms
- APHA 2320 Alkalinity by Titration

Comments

Please Note E.coli and Faecal Coliform results are from EML reference no 271630 and Nata Accreditation no 1247

Notes

1. The results in this report supersede any previously corresponded results.
2. All Soil Results are reported on a dry basis.
3. Samples are analysed on an as received basis.

ABBREVIATIONS
mg/kg : milligrams per kilograms, mg/L : milligrams per litre, ppm : parts per million,
LOR : Limit of Reporting
RPD : Relative Percent Difference
CRM : Certified Reference Material
LCS : Laboratory Control Sample

Authorised

Report Number: 218669

Michael Wright
Laboratory Manager
NATA Signatory

Rhonda Chouman
Client Manager
NATA Signatory

Orlando Scalzo
Chief Organic Chemist
NATA Signatory

Tammy Lakeland
Chief Inorganic Chemist

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited
Laboratory Number 1261
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced, except in full.

Environmental Laboratory Industry Group
Member

mgt Environmental Consulting Pty. Ltd.

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Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW08	MW06	MW07	MW09
	Lab Number		07-De02457	07-De02458	07-De02459	07-De02460
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**				
Heavy Metals						
Calcium	0.5	mg/L	78	100	280	250
Magnesium	0.5	mg/L	88	110	280	300
Potassium	0.5	mg/L	< 5	21	< 5	14
Sodium	0.5	mg/L	830	880	770	1600
E.Coli	1	org/100mL	240	< 2	11	< 2
Faecal Coliforms	1	org/100mL	240	2.0	180	< 2
Total Recoverable Hydrocarbons						
TRH C6-C9 Fraction by GC	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH C10-C14 Fraction by GC	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28 Fraction by GC	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36 Fraction by GC	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Monocyclic Aromatic Hydrocarbons						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.005	< 0.001
Toluene	0.001	mg/L	< 0.002	< 0.001	< 0.005	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.005	< 0.001
Xylenes(ortho.meta and para)	0.001	mg/L	< 0.002	< 0.001	< 0.005	< 0.001
Fluorobenzene (surr.)	1	%	66	56	105	60
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(b)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

COMMENTS:

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Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW08	MW06	MW07	MW09
	Lab Number		07-De02457	07-De02458	07-De02459	07-De02460
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**				
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PAH	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene-d12 (surr.)	1	%	126	126	135	133
2-Fluorobiphenyl (surr.)	1	%	124	122	138	133
Organochlorine Pesticides						
4.4'-DDD	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
4.4'-DDE	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
4.4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldrin	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
b-BHC	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chlordane	0.0005	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
d-BHC	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dieldrin	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan I	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan II	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin aldehyde	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin ketone	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
g-BHC (Lindane)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor epoxide	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Methoxychlor	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001

COMMENTS:

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW08	MW06	MW07	MW09
	Lab Number		07-De02457	07-De02458	07-De02459	07-De02460
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**				
Toxophene	0.0005	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibutylchlorendate (surr.)	1	%	62	86	85	97
Tetrachloro-m-xylene (surr.)	1	%	52	50	52	55
Chlorinated Hydrocarbons						
1.2-Dichlorobenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
1.2.3-Trichlorobenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
1.2.3.4-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1.2.3.5-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1.2.4-Trichlorobenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
1.2.4.5-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1.3-Dichlorobenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
1.3.5-Trichlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
1.4-Dichlorobenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzal chloride	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzotrichloride	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Benzyl chloride	0.0001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Hexachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorobutadiene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorocyclopentadiene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachloroethane	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Pentachlorobenzene	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dibutylchlorendate (surr.)	1	%	62	86	85	97
Tetrachloro-m-xylene (surr.)	1	%	52	50	52	55
Polychlorinated Biphenyls						
Aroclor-1016	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Aroclor-1221	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Aroclor-1232	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Aroclor-1242	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Aroclor-1248	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW08	MW06	MW07	MW09
	Lab Number		07-De02457	07-De02458	07-De02459	07-De02460
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**				
Aroclor-1254	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Aroclor-1260	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PCB	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Dibutylchlorendate (surr.)	1	%	62	86	85	97
Tetrachloro-m-xylene (surr.)	1	%	52	50	52	55
Phenols						
2-Chlorophenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Methylphenol (o-Cresol)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Nitrophenol	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
2.4-Dichlorophenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2.4-Dimethylphenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2.4.6-Trichlorophenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2.6-Dichlorophenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
3&4-Methylphenol (m&p-Cresol)	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
4-Chloro-3-methylphenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pentachlorophenol	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Phenol	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenol-d6 (surr.)	1	%	64	53	77	58
Ammonia(N)	0.05	mg/L	1.2	3.0	1.4	1.1
Chloride	0.01	mg/L	1100	1200	1800	3100
Cyanide (total)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nitrate (N)	0.02	mg/L	< 0.02	< 0.02	0.05	0.06
Nitrite (N)	0.02	mg/L	0.05	0.22	< 0.02	< 0.02
Phosphate total (P)	0.01	mg/L	1.4	1.4	0.03	0.02
Sulphate (S)	1	mg/L	52	100	2.7	140
Total Dissolved Solids	10	mg/L	2900	3100	4200	5600
Total Kjeldahl Nitrogen (N)	0.1	mg/L	3.6	4.1	8.5	2.4
Alkalinity						

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW08	MW06	MW07	MW09
	Lab Number		07-De02457	07-De02458	07-De02459	07-De02460
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**				
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	580	470	960	440
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10	< 10	< 10
Heavy Metals						
Antimony	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Arsenic	0.001	mg/L	0.071	0.32	0.016	0.004
Beryllium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.005	0.010	0.011	0.002
Cobalt	0.001	mg/L	0.021	< 0.001	0.027	0.006
Copper	0.001	mg/L	< 0.001	< 0.001	0.002	0.002
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.045	0.007	0.027	0.007
Selenium	0.001	mg/L	0.005	0.004	0.010	0.011
Tin	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.001	mg/L	0.012	0.006	0.010	0.020

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Soil and Groundwater Consulting	Client Sample ID		D1	MW17
First Floor The Parade	Lab Number		07-De02461	07-De02766
Norwood	Matrix		Water	Water
South Australia 5065	Sample Date		Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**		
Heavy Metals				
Calcium	0.5	mg/L	81	1500
Magnesium	0.5	mg/L	81	1100
Potassium	0.5	mg/L	< 5	41
Sodium	0.5	mg/L	840	6500
Total Recoverable Hydrocarbons				
TRH C6-C9 Fraction by GC	0.02	mg/L	< 0.02	-
TRH C10-C14 Fraction by GC	0.05	mg/L	< 0.05	-
TRH C15-C28 Fraction by GC	0.1	mg/L	< 0.1	-
TRH C29-C36 Fraction by GC	0.1	mg/L	< 0.1	-
Monocyclic Aromatic Hydrocarbons				
Benzene	0.001	mg/L	< 0.001	-
Toluene	0.001	mg/L	< 0.001	-
Ethylbenzene	0.001	mg/L	< 0.001	-
Xylenes(ortho.meta and para)	0.001	mg/L	< 0.001	-
Fluorobenzene (surr.)	1	%	70	-
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	0.001	mg/L	< 0.001	-
Acenaphthylene	0.001	mg/L	< 0.001	-
Anthracene	0.001	mg/L	< 0.001	-
Benz(a)anthracene	0.001	mg/L	< 0.001	-
Benzo(a)pyrene	0.001	mg/L	< 0.001	-
Benzo(b)fluoranthene	0.001	mg/L	< 0.001	-
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	-
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	-
Chrysene	0.001	mg/L	< 0.001	-
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	-
Fluoranthene	0.001	mg/L	< 0.001	-
Fluorene	0.001	mg/L	< 0.001	-
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	-
Naphthalene	0.001	mg/L	< 0.001	-

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Soil and Groundwater Consulting **First Floor The Parade** **Norwood** **South Australia 5065**	**Client Sample ID**		**D1**	**MW17**
	Lab Number		**07-De02461**	**07-De02766**
	Matrix		**Water**	**Water**
	Sample Date		**Dec 5, 2007**	**Dec 5, 2007**
Analysis Type	**LOR**	**Units**		
Phenanthrene	0.001	mg/L	< 0.001	-
Pyrene	0.001	mg/L	< 0.001	-
Total PAH	0.001	mg/L	< 0.001	-
Chrysene-d12 (surr.)	1	%	130	-
2-Fluorobiphenyl (surr.)	1	%	136	-
Organochlorine Pesticides				
4.4'-DDD	0.0001	mg/L	< 0.0001	-
4.4'-DDE	0.0001	mg/L	< 0.0001	-
4.4'-DDT	0.0001	mg/L	< 0.0001	-
a-BHC	0.0001	mg/L	< 0.0001	-
Aldrin	0.0001	mg/L	< 0.0001	-
b-BHC	0.0001	mg/L	< 0.0001	-
Chlordane	0.0005	mg/L	< 0.001	-
d-BHC	0.0001	mg/L	< 0.0001	-
Dieldrin	0.0001	mg/L	< 0.0001	-
Endosulfan I	0.0001	mg/L	< 0.0001	-
Endosulfan II	0.0001	mg/L	< 0.0001	-
Endosulfan sulphate	0.0001	mg/L	< 0.0001	-
Endrin	0.0001	mg/L	< 0.0001	-
Endrin aldehyde	0.0001	mg/L	< 0.0001	-
Endrin ketone	0.0001	mg/L	< 0.0001	-
g-BHC (Lindane)	0.0001	mg/L	< 0.0001	-
Heptachlor	0.0001	mg/L	< 0.0001	-
Heptachlor epoxide	0.0001	mg/L	< 0.0001	-
Hexachlorobenzene	0.0001	mg/L	< 0.0001	-
Methoxychlor	0.0001	mg/L	< 0.0001	-
Toxophene	0.0005	mg/L	< 0.001	-
Dibutylchlorendate (surr.)	1	%	98	-
Tetrachloro-m-xylene (surr.)	1	%	71	-

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		D1	MW17
	Lab Number		07-De02461	07-De02766
	Matrix		Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**		
Chlorinated Hydrocarbons				
1.2-Dichlorobenzene	0.001	mg/L	< 0.001	-
1.2.3-Trichlorobenzene	0.001	mg/L	< 0.001	-
1.2.3.4-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	-
1.2.3.5-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	-
1.2.4-Trichlorobenzene	0.001	mg/L	< 0.001	-
1.2.4.5-Tetrachlorobenzene	0.0001	mg/L	< 0.0001	-
1.3-Dichlorobenzene	0.001	mg/L	< 0.001	-
1.3.5-Trichlorobenzene	0.0001	mg/L	< 0.0001	-
1.4-Dichlorobenzene	0.001	mg/L	< 0.001	-
Benzal chloride	0.0001	mg/L	< 0.0001	-
Benzotrichloride	0.0001	mg/L	< 0.0001	-
Benzyl chloride	0.0001	mg/L	< 0.001	-
Hexachlorobenzene	0.0001	mg/L	< 0.0001	-
Hexachlorobutadiene	0.0001	mg/L	< 0.0001	-
Hexachlorocyclopentadiene	0.0001	mg/L	< 0.0001	-
Hexachloroethane	0.0001	mg/L	< 0.0001	-
Pentachlorobenzene	0.0001	mg/L	< 0.0001	-
Dibutylchlorendate (surr.)	1	%	98	-
Tetrachloro-m-xylene (surr.)	1	%	71	-
Polychlorinated Biphenyls				
Aroclor-1016	0.001	mg/L	< 0.001	-
Aroclor-1221	0.001	mg/L	< 0.001	-
Aroclor-1232	0.001	mg/L	< 0.001	-
Aroclor-1242	0.001	mg/L	< 0.001	-
Aroclor-1248	0.001	mg/L	< 0.001	-
Aroclor-1254	0.001	mg/L	< 0.001	-
Aroclor-1260	0.001	mg/L	< 0.001	-
Total PCB	0.01	mg/L	< 0.01	-

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		D1	MW17
	Lab Number		07-De02461	07-De02766
	Matrix		Water	Water
	Sample Date		Dec 5, 2007	Dec 5, 2007
Analysis Type	**LOR**	**Units**		
Dibutylchlorendate (surr.)	1	%	98	-
Tetrachloro-m-xylene (surr.)	1	%	71	-
Phenols				
2-Chlorophenol	0.001	mg/L	< 0.001	-
2-Methylphenol (o-Cresol)	0.001	mg/L	< 0.001	-
2-Nitrophenol	0.005	mg/L	< 0.005	-
2.4-Dichlorophenol	0.001	mg/L	< 0.001	-
2.4-Dimethylphenol	0.001	mg/L	< 0.001	-
2.4.6-Trichlorophenol	0.001	mg/L	< 0.001	-
2.6-Dichlorophenol	0.001	mg/L	< 0.001	-
3&4-Methylphenol (m&p-Cresol)	0.002	mg/L	< 0.002	-
4-Chloro-3-methylphenol	0.001	mg/L	< 0.001	-
Pentachlorophenol	0.005	mg/L	< 0.005	-
Phenol	0.001	mg/L	< 0.001	-
Phenol-d6 (surr.)	1	%	55	-
Ammonia(N)	0.05	mg/L	1.0	2.0
Chloride	0.01	mg/L	1100	15000
Cyanide (total)	0.005	mg/L	< 0.005	-
Nitrate (N)	0.02	mg/L	< 0.02	0.02
Sulphate (S)	1	mg/L	51	830
Total Dissolved Solids	10	mg/L	2400	29000
Alkalinity				
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	580	510
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10
Heavy Metals				
Antimony	0.005	mg/L	< 0.005	-
Arsenic	0.001	mg/L	0.079	-
Beryllium	0.001	mg/L	< 0.001	-

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Soil and Groundwater Consulting **First Floor The Parade** **Norwood** **South Australia 5065**	**Client Sample ID**		**D1**	**MW17**
	Lab Number		**07-De02461**	**07-De02766**
	Matrix		**Water**	**Water**
	Sample Date		**Dec 5, 2007**	**Dec 5, 2007**
Analysis Type	**LOR**	**Units**		
Cadmium	0.0002	mg/L	< 0.0002	-
Chromium	0.001	mg/L	0.009	-
Cobalt	0.001	mg/L	0.024	-
Copper	0.001	mg/L	< 0.001	-
Lead	0.001	mg/L	< 0.001	-
Mercury	0.0001	mg/L	< 0.0001	-
Molybdenum	0.005	mg/L	< 0.005	-
Nickel	0.001	mg/L	0.051	-
Selenium	0.001	mg/L	0.004	-
Tin	0.005	mg/L	< 0.005	-
Zinc	0.001	mg/L	0.007	

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Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	RPD	MW08	Method blank
	Lab Number	BATCH	07-De02457	Batch
	QA Description		Spike % Recovery	
	Matrix	Water	Water	Water
	Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units		% Recovery	mg/L
Chloride		< 1	-	< 0.01
Phosphate total (P)		8.9	85	< 0.01
Sulphate (S)		< 1	99	< 1
Monocyclic Aromatic Hydrocarbons				
Benzene		2.0	88	< 0.001
Toluene		4.0	89	< 0.001
Ethylbenzene		15	99	< 0.001
Xylenes(ortho.meta and para)		15	95	< 0.001
Fluorobenzene (surr.)		-	105	90
Polycyclic Aromatic Hydrocarbons				
Acenaphthene		< 1	100	< 0.001
Acenaphthylene		< 1	102	< 0.001
Anthracene		< 1	87	< 0.001
Benz(a)anthracene		< 1	79	< 0.001
Benzo(a)pyrene		< 1	113	< 0.001
Benzo(b)fluoranthene		< 1	112	< 0.001
Benzo(g.h.i)perylene		< 1	92	< 0.001
Benzo(k)fluoranthene		< 1	94	< 0.001
Chrysene		< 1	71	< 0.001
Dibenz(a.h)anthracene		< 1	82	< 0.001
Fluoranthene		< 1	87	< 0.001
Fluorene		< 1	99	< 0.001
Indeno(1.2.3-cd)pyrene		< 1	82	< 0.001
Naphthalene		< 1	100	< 0.001
Phenanthrene		< 1	100	< 0.001
Pyrene		< 1	88	< 0.001
Total PAH		< 1	-	< 0.001
Chrysene-d12 (surr.)		-	93	93
2-Fluorobiphenyl (surr.)		-	110	72

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First Floor The Parade
Norwood

South Australia 5065

Client Sample	MW08	MW08	MW08	MW08	Method blank
Lab Number	07-De02457	07-De02457	07-De02457	07-De02457	Batch
QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
Matrix	Water	Water	Water	Water	Water
Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Phenols						
2-Chlorophenol		-	-	< 1	120	< 0.001
2-Methylphenol (o-Cresol)		-	-	< 1	86	< 0.001
2-Nitrophenol		-	-	< 1	99	< 0.005
2.4-Dichlorophenol		-	-	< 1	96	< 0.001
2.4-Dimethylphenol		-	-	< 1	71	< 0.001
2.4.6-Trichlorophenol		-	-	< 1	81	< 0.001
2.6-Dichlorophenol		-	-	< 1	112	< 0.001
3&4-Methylphenol (m&p-Cresol)		-	-	< 1	90	< 0.002
4-Chloro-3-methylphenol		-	-	< 1	93	< 0.001
Pentachlorophenol		-	-	< 1	75	< 0.005
Phenol		-	-	< 1	114	< 0.001
Phenol-d6 (surr.)		-	-	-	132	75
Heavy Metals						
Antimony		< 0.005	< 0.005	< 1	107	< 0.005
Arsenic		0.071	0.076	7.0	105	< 0.001
Beryllium		< 0.001	< 0.001	< 1	106	< 0.001
Cadmium		< 0.0002	< 0.0002	< 1	88	< 0.0002
Calcium		-	-	10	74	< 0.5
Chromium		0.005	0.006	18	100	< 0.001
Cobalt		0.021	0.023	7.8	101	< 0.001
Copper		< 0.001	< 0.001	< 1	92	< 0.001
Lead		< 0.001	< 0.001	< 1	92	< 0.001
Magnesium		-	-	< 1	78	< 0.5
Mercury		-	-	< 1	86	0.0002
Molybdenum		< 0.005	< 0.005	< 1	74	< 0.005
Nickel		0.045	0.049	7.6	98	< 0.001
Potassium		-	-	< 1	112	< 0.5
Selenium		0.005	0.005	11	101	< 0.001

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Soil and Groundwater Consulting
First Floor The Parade
Norwood

South Australia 5065

Client Sample	MW08	MW08	MW08	MW08	Method blank
Lab Number	07-De02457	07-De02457	07-De02457	07-De02457	Batch
QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
Matrix	Water	Water	Water	Water	Water
Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units		% RPD	% Recovery	mg/L
Heavy Metals					
Sodium	-	-	< 1	-	< 0.5
Tin	< 0.005	< 0.005	< 1	94	< 0.005
Zinc	0.012	0.011	15	86	< 0.001
Alkalinity					
Bicarbonate Alkalinity-mg CaCO3/L	-	-	< 1	-	< 10
Carbonate Alkalinity-mg CaCO3/L	-	-	< 1	-	< 10

COMMENTS:

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW07	MW07	MW07	MW07	Method blank
	Lab Number	07-De02459	07-De02459	07-De02459	07-De02459	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
	Matrix	Water	Water	Water	Water	Water
	Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Cyanide (total)		< 0.005	< 0.005	< 1	74	< 0.005
Total Recoverable Hydrocarbons						
TRH C6-C9 Fraction by GC		-	-	< 1	-	< 0.02
TRH C10-C14 Fraction by GC		-	-	< 1	129	< 0.05
TRH C15-C28 Fraction by GC		-	-	< 1	-	< 0.1
TRH C29-C36 Fraction by GC		-	-	< 1	-	< 0.1

COMMENTS:

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Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW09	MW09	MW09	MW09	Method blank
	Lab Number	07-De02460	07-De02460	07-De02460	07-De02460	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
	Matrix	Water	Water	Water	Water	Water
	Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Ammonia(N)		1.1	1.1	1.0	103	< 0.05
Nitrate (N)		0.06	0.05	6.0	111	< 0.02
Nitrite (N)		< 0.02	< 0.02	< 1	115	< 0.02
Total Kjeldahl Nitrogen (N)		2.4	2.0	5.2	68	< 0.1

COMMENTS:

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Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
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Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	RPD	D1	Method blank
	Lab Number	BATCH	07-De02461	Batch
	QA Description		Spike % Recovery	
	Matrix	Water	Water	Water
	Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units		% Recovery	mg/L
Organochlorine Pesticides				
4.4'-DDD		< 1	94	< 0.0001
4.4'-DDE		< 1	98	< 0.0001
4.4'-DDT		< 1	78	< 0.0001
a-BHC		< 1	100	< 0.0001
Aldrin		< 1	94	< 0.0001
b-BHC		< 1	110	< 0.0001
Chlordane		< 1	96	< 0.001
d-BHC		< 1	124	< 0.0001
Dieldrin		< 1	107	< 0.0001
Endosulfan I		< 1	102	< 0.0001
Endosulfan II		< 1	94	< 0.0001
Endosulfan sulphate		< 1	104	< 0.0001
Endrin		< 1	108	< 0.0001
Endrin aldehyde		< 1	84	< 0.0001
Endrin ketone		< 1	99	< 0.0001
g-BHC (Lindane)		< 1	99	< 0.0001
Heptachlor		< 1	78	< 0.0001
Heptachlor epoxide		< 1	95	< 0.0001
Methoxychlor		< 1	80	< 0.0001
Toxophene		< 1	-	< 0.001
Chlorinated Hydrocarbons				
1.2-Dichlorobenzene		< 1	75	< 0.001
1.2.3-Trichlorobenzene		< 1	89	< 0.001
1.2.3.4-Tetrachlorobenzene		< 1	75	< 0.0001
1.2.3.5-Tetrachlorobenzene		< 1	-	< 0.0001
1.2.4-Trichlorobenzene		< 1	-	< 0.001
1.2.4.5-Tetrachlorobenzene		< 1	92	< 0.0001
1.3-Dichlorobenzene		< 1	-	< 0.001

COMMENTS:

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Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting
First Floor The Parade
Norwood

South Australia 5065

Client Sample	RPD	D1	Method blank
Lab Number	BATCH	07-De02461	Batch
QA Description		Spike % Recovery	
Matrix	Water	Water	Water
Sample Date	Dec 5, 2007	Dec 5, 2007	Dec 5, 2007
Analysis Type	Units	% Recovery	mg/L
Chlorinated Hydrocarbons			
1.3.5-Trichlorobenzene	< 1	115	< 0.0001
1.4-Dichlorobenzene	< 1	74	< 0.001
Benzal chloride	< 1	98	< 0.0001
Benzotrichloride	< 1	94	< 0.0001
Benzyl chloride	< 1	-	< 0.001
Hexachlorobenzene	< 1	91	< 0.0001
Hexachlorobutadiene	< 1	84	< 0.0001
Hexachlorocyclopentadiene	< 1	75	< 0.0001
Hexachloroethane	< 1	79	< 0.0001
Pentachlorobenzene	< 1	88	< 0.0001
Polychlorinated Biphenyls			
Aroclor-1016	< 1	-	< 0.001
Aroclor-1221	< 1	-	< 0.001
Aroclor-1232	< 1	-	< 0.001
Aroclor-1242	< 1	-	< 0.001
Aroclor-1248	< 1	-	< 0.001
Aroclor-1254	< 1	-	< 0.001
Aroclor-1260	< 1	-	< 0.001
Total PCB	< 1	-	< 0.01
Dibutylchlorendate (surr.)	-	89	120
Tetrachloro-m-xylene (surr.)	-	98	58

COMMENTS:

CHAIN OF CUSTODY DOCUMENTATION

First Floor 202 The Parade Norwood SA 5067 · PO Box 3195 Norwood SA 5067
T: +61 8 8431 7113 · F: +61 8 8431 7115
ACN 100 220 479 · ABN 62 100 220 479

CLIENT: Tallwood Group	LABORATORY: MGT	LABORATORY BATCH NO.:
PROJECT: Mannum Marina	COC Reference #: 1038	SAMPLERS: RAF/RCP
SEND REPORT TO: S&G	SEND INVOICE TO: S&G	PHONE: 08 8431 7113 FAX: 08 8431 7115
DATA NEEDED BY: 5 day t/a	REPORT NEEDED BY: 5 day t/a	REPORT FORMAT: HARD: YES FAX: NO E-MAIL: YES
PROJECT ID: 4G071493	QUOTE NO.:	

RELINQUISHED BY:		RECEIVED BY		
NAME: Rosa Fitzgerald [signature]	DATE: 5/12/07	NAME: Dianq 218669	DATE 6/12/07	METHOD OF SHIPMENT: Overnight
OF: S&G	TIME:	OF:	TIME:	CONSIGNMENT NOTE NO.
NAME:	DATE:	NAME:	DATE:	
OF:	TIME:	OF:	TIME:	TRANSPORT CO. NAME

P.O. NO.:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Please forward results and invoice to:
labresults@soilandgroundwater.com.au

FOR LAB USE ONLY
COOLER SEAL
Yes ...... No ......
broken ...... intact ......
COOLER TEMP. deg.C

ANALYSES REQUIRED

SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH field	TDS/ Anions/ Cations	Vic EPA Screen	Nutrients	Biological Parameters
MW08	water	5/12/2007		P, N, 2 VC, S, BS, C, O	3	y	x	x	x	x
MW06	water	5/12/2007		P, N, 2 VC, S, BS, C, O	3	y	x	x	x	x
MW07	water	5/12/2007		P, N, 2 VC, S, BS, C, O	3	y	x	x	x	x
MW09	water	5/12/2007		P, N, 2 VC, S, BS, C, O	3	y	x	x	x	x
MW17	water	5/12/2007		P & C P	1	y	x			
01	water	5/12/2007		P, N, 2 VC, S, BS, C, O	3	y	x	x		
						TOTAL	6	5	4	4

Totals for the remaining analysis columns: 0 0 0 0 0 0 0 0 0 0 0 0

Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Plastic Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

NOTES

Biological parameters - E coli & faecal coliforms

Nutrients - ammonia, nitrate, nitrite, TKN, Total P

mgt Environmental Consulting Pty. Ltd.

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Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

CERTIFICATE OF ANALYSIS

Soil and Groundwater Consulting
First Floor The Parade
Norwood
South Australia 5065
Site: MANNUM SG071493

Report Number: 218724 Page 1 of 8
Order Number:
Date Received: Dec 8, 2007
Date Sampled: Dec 7, 2007
Date Reported: Dec 12, 2007
Contact: Adrian Webber

Methods

- USEPA 6020 Heavy Metals
- APHA 4500-Cl (Cl by FIA)
- APHA 4500-NH3 Ammonia Nitrogen by FIA
- APHA 4500-NO3 Nitrate Nitrogen by FIA
- APHA 2540C Total Dissolved Solids
- APHA 4500-SO4 (SO4 by FIA)
- APHA 2320 Alkalinity by Titration

Comments

Notes

1. The results in this report supersede any previously corresponded results.
2. All Soil Results are reported on a dry basis.
3. Samples are analysed on an as received basis.

ABBREVIATIONS
mg/kg : milligrams per kilograms, mg/L : milligrams per litre, ppm : parts per million,
LOR : Limit of Reporting
RPD : Relative Percent Difference
CRM : Certified Reference Material
LCS : Laboratory Control Sample

Authorised

Report Number: 218724

Michael Wright
Laboratory Manager
NATA Signatory

Rhonda Chouman
Client Manager
NATA Signatory

Tammy Lakeland
Chief Inorganic Chemist

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited
Laboratory Number 1261
The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced, except in full.

Environmental Laboratory Industry Group
Member

Environmental Consulting Pty. Ltd.

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Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID		MW5	MW10	MW11	MW12
	Lab Number		07-De02767	07-De02768	07-De02769	07-De02770
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	**LOR**	**Units**				
Heavy Metals						
Calcium	0.5	mg/L	360	1000	130	400
Magnesium	0.5	mg/L	580	1200	130	500
Potassium	0.5	mg/L	20	< 5	< 5	< 5
Sodium	0.5	mg/L	5400	7200	800	3200
Ammonia(N)	0.05	mg/L	4.0	3.3	0.53	13
Chloride	0.01	mg/L	8800	15000	1000	5600
Nitrate (N)	0.02	mg/L	0.02	< 0.02	0.13	0.29
Sulphate (S)	1	mg/L	660	830	300	250
Total Dissolved Solids	10	mg/L	18000	30000	3600	12000
Alkalinity						
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	630	310	460	580
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10	< 10	< 10

COMMENTS:

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Soil and Groundwater Consulting

First Floor The Parade
Norwood
South Australia 5065

	Client Sample ID		MW13	MW14	MW15	MW16
	Lab Number		07-De02771	07-De02772	07-De02773	07-De02774
	Matrix		Water	Water	Water	Water
	Sample Date		Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	**LOR**	**Units**				
Heavy Metals						
Calcium	0.5	mg/L	550	100	1000	1200
Magnesium	0.5	mg/L	980	110	1700	4100
Potassium	0.5	mg/L	5.6	< 5	34	82
Sodium	0.5	mg/L	4100	1200	7100	15000
Ammonia(N)	0.05	mg/L	45	< 0.05	17	69
Chloride	0.01	mg/L	7100	1600	14000	33000
Nitrate (N)	0.02	mg/L	260	2.6	< 0.02	0.22
Sulphate (S)	1	mg/L	720	140	1400	1900
Total Dissolved Solids	10	mg/L	17000	4300	31000	65000
Alkalinity						
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	680	230	1200
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10	< 10	< 10

COMMENTS:

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Soil and Groundwater Consulting

First Floor The Parade
Norwood
South Australia 5065

	Client Sample ID		**MW18**
	Lab Number		**07-De02775**
	Matrix		**Water**
	Sample Date		**Dec 7, 2007**
Analysis Type	**LOR**	**Units**	
Heavy Metals			
Calcium	0.5	mg/L	430
Magnesium	0.5	mg/L	550
Potassium	0.5	mg/L	94
Sodium	0.5	mg/L	5400
Ammonia(N)	0.05	mg/L	< 0.05
Chloride	0.01	mg/L	8800
Nitrate (N)	0.02	mg/L	0.24
Sulphate (S)	1	mg/L	430
Total Dissolved Solids	10	mg/L	17000
Alkalinity			
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	280
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10

COMMENTS:

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
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Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW13	MW13	MW13	MW13
	Lab Number	07-De02771	07-De02771	07-De02771	07-De02771
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery
	Matrix	Water	Water	Water	Water
	Sample Date	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	Units			% RPD	% Recovery
Total Dissolved Solids		17000	18000	-	-

COMMENTS:

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
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Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW14	MW14	MW14	MW14	Method blank
	Lab Number	07-De02772	07-De02772	07-De02772	07-De02772	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
	Matrix	Water	Water	Water	Water	Water
	Sample Date	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Ammonia(N)		< 0.05	< 0.05	< 1	102	< 0.05
Nitrate (N)		2.6	2.7	3.0	111	< 0.02

COMMENTS:

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Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW16	MW16	MW16	MW16	Method blank
	Lab Number	07-De02774	07-De02774	07-De02774	07-De02774	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
	Matrix	Water	Water	Water	Water	Water
	Sample Date	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Heavy Metals						
Calcium		1200	1100	10	74	< 0.5
Magnesium		4100	4100	< 1	78	< 0.5
Potassium		82	82	< 1	112	< 0.5
Sodium		15000	-	< 1	-	< 0.5

COMMENTS:

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Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Soil and Groundwater Consulting First Floor The Parade Norwood South Australia 5065	Client Sample ID	MW18	MW18	MW18	MW18	Method blank
	Lab Number	07-De02775	07-De02775	07-De02775	07-De02775	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	
	Matrix	Water	Water	Water	Water	Water
	Sample Date	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007	Dec 7, 2007
Analysis Type	Units			% RPD	% Recovery	mg/L
Chloride		8800	8700	< 1	-	< 0.01
Sulphate (S)		430	430	< 1	106	< 1
Alkalinity						
Bicarbonate Alkalinity-mg CaCO3/L		-	-	< 1	-	< 10
Carbonate Alkalinity-mg CaCO3/L		-	-	< 1	-	< 10

COMMENTS:

First Floor 207 The Parade Norwood SA 5067 · PO Box 3166 Norwood SA 5067
T: +61 8 8431 7113 · F: +61 8 8431 7115
ACN 100 220 479 · ABN 62 100 220 479

S&G

AIN OF CUSTODY DOCUMENTATION

T: Tallwood	LABORATORY: MGT	LABORATORY BATCH NO.:
ECT: Mannum	COC Reference #: 1041	SAMPLERS: NGB/NDP
REPORT TO: S&G	SEND INVOICE TO: S&G	PHONE: 08 8431 7113 FAX: 08 8431 7115
NEEDED BY: 5 day t/a	REPORT NEEDED BY: 5 day t/a	REPORT FORMAT: HARD:YES FAX: NO E-MAIL: YES
ECT ID: SG071493	QUOTE #:	

	RELINQUISHED BY: Nick Byrne	RECEIVED BY		METHOD OF SHIPMENT: Overnight
: Nick Byrne	DATE: 7/12/07	NAME: Rhonda Chouman	DATE: 8/12/07	CONSIGNMENT NOTE NO.
S&G	TIME: PM	OF:	TIME: 10:00 A.M.	
E: [signature]	DATE:	NAME: [signature]	DATE:	TRANSPORT CO. NAME.
	TIME:	OF:	TIME:	

NO.:

LAB USE ONLY

LER SEAL

..... No ......

en ...... Intact ......

LER TEMP: deg.C

COMMENTS/SPECIAL HANDLING/STORAGE OR DIPOSAL:

Please forward results and invoice to:
labresults@soilandgroundwater.com.au

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

ANALYSIS REQUIRED

SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH field	ANIONS	CATIONS	TDS	NOTES
5	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
10	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
11	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
12	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	LESS SAMPLE - WILL DO AS MUCH ANALYSIS AS POSSIBLE RC 8/12/07
/13	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
/14	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
/15	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	LESS SAMPLE - WILL DO AS MUCH ANALYSIS AS POSSIBLE
/16	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
~~/17~~	~~Water~~	~~7/12/2007~~	~~AM~~	~~1N, 1P~~	~~2~~	~~y~~		X		
/18	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	
pA	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X	**Please forward dupA to labmark**

TOTAL: 10 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0

[signature] 8/12/07
#218724

LabMark

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

ilac-MRA NATA Accreditation No. 13542

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

AQIS
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SYDNEY License No. N0356.

Quarantine Approved Premises criteria 5.1 for quarantine containment level 1 (QCI) facilities. Class five criteria cover premises utilised for research, analysis and testing of biological material, soil, animal, plant and human products.

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No: E035436
Client Name: Soil and Groundwater Pty Ltd
Client Reference: Mannum
Contact Name: Nick Byrne
Chain of Custody No: 1041
Sample Matrix: WATER

Cover Page 1 of 3
plus Sample Results

Date Received: 12/12/2007
Date Reported: 17/12/2007

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occured within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy:	matrix spike:	1 in first 5-20, then 1 every 20 samples
	lcs, crm, method:	1 per analytical batch
	surrogate spike:	addition per target organic method
Precision:	laboratory duplicate:	1 in first 5-10, then 1 every 10 samples
	laboratory triplicate:	re-extracted & reported when duplicate RPD values exceed acceptance criteria
Holding Times:	soils, waters:	Refer to LabMark Preservation & THT table VOC's 14 days water / soil VAC's 7 days water or 14 days acidified VAC's 14 days soil SVOC's 7 days water, 14 days soil Pesticides 7 days water, 14 days soil Metals 6 months general elements Mercury 28 days
Confirmation:	target organic analysis:	GC/MS, or confirmatory column
Sensitivity:	EQL:	Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy:	spike, lcs, crm surrogate:	general analytes 70% - 130% recovery phenol analytes 50% - 130% recovery organophosphorous pesticide analytes 60% - 130% recovery phenoxy acid herbicides, organotin 50% - 130% recovery
	anion/cation bal:	+/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)
Precision:	method blank:	not detected >95% of the reported EQL
	duplicate lab RPD (metals):	0-30% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)
	duplicate lab RPD:	0-50% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)

QUALITY CONTROL ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy:	spike, lcs, crm surrogate:	analyte specific recovery data <3xsd of historical mean
Uncertainty:	spike, lcs:	measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

Data Quality Objective	s:	matrix spike recovery	p:	pending	bcs: batch specific lcs
Data Quality Indicator	d:	laboratory duplicate	lcs:	laboratory control sample	bmb: batch specific mb
Estimated Quantitation Limit	t:	laboratory triplicate	crm:	certified reference material	
not applicable	r:	RPD relative % difference	mb:	method blank	

David Burns
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Geoff Weir
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Simon Mills
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NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.

B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.

C. Laboratory QA/QC samples are specific to this project.

D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.

E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.

F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.

G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomolous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.

H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.

I. LabMark shall maintain an official copy of this Certificate of Analysis for all tracable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

A. SRN issued to client upon sample receipt & login verification.

B. Preservation & sampling date details specified on COC and SRN, unless noted.

C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

A. NATA accreditation held for each in-house method and sample matrix type reported, unless noted below (Refer to subcontracted test reports for NATA accreditation status).

B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.

C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

Reported by Sydney Analytical Laboratories, NATA accreditation No.1884.

4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **WATER**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Chloride	1	0	0%	0	0	0%
2	Sulphate	1	0	0%	0	0	0%
3	Major cations	1	0	0%	0	0	0%
4	Alkalinity (CO3, HCO3, OH)	1	0	0%	0	0	0%
5	Total Dissolved Solids (TDS)	1	1	100%	0	0	0%

GLOSSARY:

#d	number of discrete duplicate extractions/analyses performed.
%d-ratio	NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t	number of triplicate extractions/analyses performed.
#s	number of spiked samples analysed.
%s-ratio	USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

5. ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535., unless indicated below.
B. The following test was conducted by Sydney Analytical Laboratories, NATA accreditation No.1884. :- SAL 20098. Results issued for TDS on 15/12/07.
C. Sample received and analysed outside Technical Holding Time for Alkalinity (CO3, HCO3, OH)), Lab ID #131528, at clients request.

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

Laboratory Report No: E035436
Client Name: Soil and Groundwater Pty Ltd
Contact Name: Nick Byrne
Client Reference: Mannum SG071493

Page: 1 of 5
plus cover page
Date: 17/12/07
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		**131528**	**lcs**	**mb**							
Sample Identification		DupA	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		7/12/07	--	--							
Laboratory Extraction (Preparation) Date		12/12/07	12/12/07	12/12/07							
Laboratory Analysis Date		12/12/07	12/12/07	12/12/07							
Method : E033.1/E045.1/E047.1											
Chloride	**EQL**										
Chloride	1	1810	101%	<1							

Results expressed in mg/l unless otherwise specified

Comments:

E033.1/E045.1/E047.1: Determination by colour and/or by Ion Chromatography. Sample filtered through a 0.45um filter prior to analysis.

Laboratory Identification		**131528**	**lcs**	**mb**							
Sample Identification		DupA	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		7/12/07	--	--							
Laboratory Extraction (Preparation) Date		12/12/07	12/12/07	12/12/07							
Laboratory Analysis Date		12/12/07	12/12/07	12/12/07							
Method : E042.1/E045.1/E056.1											
Sulphate	**EQL**										
Sulphate	2	421	101%	<2							

Results expressed in mg/l unless otherwise specified

Comments:

E042.1/E045.1/E056.1: Determination by colour and/or by Ion Chromatography. Sample filtered through 0.45um prior to analysis.

Laboratory Identification		**131528**	**lcs**	**mb**							
Sample Identification		DupA	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		7/12/07	--	--							
Laboratory Extraction (Preparation) Date		12/12/07	12/12/07	12/12/07							
Laboratory Analysis Date		13/12/07	13/12/07	13/12/07							
Method : E020.1/E030.1											
Major cations	**EQL**										
Calcium	0.1	41.9	105%	<0.1							
Magnesium	0.1	60.8	105%	<0.1							
Sodium	0.1	1400	94%	<0.1							
Potassium	0.1	41.0	97%	<0.1							

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: Sample directly analysed by Flame AAS and/or ICP-OES.

Laboratory Identification		**131528**	**lcs**	**mb**							
Sample Identification		DupA	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		7/12/07	--	--							
Laboratory Extraction (Preparation) Date		12/12/07	12/12/07	12/12/07							
Laboratory Analysis Date		12/12/07	12/12/07	12/12/07							
Method : E035.1											
Alkalinity (CO3, HCO3, OH)	**EQL**										
Carbonate	5	<5	--	<5							
Bicarbonate	5	743	112%	<5							
Hydroxide	5	<5	--	<5							

Results expressed in mg/l unless otherwise specified

Comments:

E035.1: Determination by colour and/or by titration, followed by calculation. Results expressed as CaCO3.

Laboratory Report No: E035436
Client Name: Soil and Groundwater Pty Ltd
Contact Name: Nick Byrne
Client Reference: Mannum SG071493

Page: 5 of 5
plus cover page
Date: 17/12/07
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		**131528**	**131528d**	**131528r**	**mb**						
Sample Identification		DupA	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		7/12/07	--	--	--						
Laboratory Extraction (Preparation) Date		14/12/07	14/12/07	--	14/12/07						
Laboratory Analysis Date		15/12/07	15/12/07	--	15/12/07						
Method : APHA 2540C											
Total Dissolved Solids (TDS)	**EQL**										
TDS	1	4450	4420	1%	<1						

Results expressed in mg/l unless otherwise specified

Comments:

APHA 2540C: Determined gravimetrically.

Quality, Service, Support

Report Date : 12/12/2007
Report Time : 1:18:18PM

Sample **Receipt** Notice (SRN) for **E035436**

Client Details		Laboratory Reference Information	
Client Name:	Soil and Groundwater Pty Ltd	**Please have this information ready when contacting Labmark.**	
Client Phone:	08 8431 7113		
Client Fax:	08 8431 7115	**Laboratory Report:**	**E035436**
Contact Name:	Nick Byrne	**Quotation Number:**	- Not provided, standard prices apply
Contact Email:	labresults@soilandgroundwater.com.au	**Laboratory Address:**	Unit 1, 8 Leighton Pl. Asquith NSW 2077
Client Address:	PO Box 3166 Norwood SA 5067	**Phone:**	61 2 9476 6533
		Fax:	61 2 9476 8219
Project Name:	Mannum	**Sample Receipt Contact:**	Jakleen El Galada
Project Number:	SG071493	**Email:**	jakleen.galada@labmark.com.au
CoC Serial Number:	1041	**Reporting Contact:**	Jyothi Lal
Purchase Order:	- Not provided -	**Email:**	jyothi.lal@labmark.com.au
Surcharge:	No surcharge applied (results by 6:30pm on due date)		
Sample Matrix:	WATER		
Date Sampled (earliest date):	07/12/2007	**NATA Accreditation:**	13542
Date Samples Received:	12/12/2007	**TGA GMP License:**	185-336 (Sydney)
Date Sample Receipt Notice issued:	12/12/2007	**APVMA License:**	6105 (Sydney)
Date Preliminary Report Due:	17/12/2007	**AQIS Approval:**	NO356 (Sydney)
		AQIS Entry Permit:	200521534 (Sydney)

Reporting Requirements: Electronic Data Download required: No

Invoice Number: 29602

Sample Condition: COC received with samples. Report number and lab ID's defined on COC.
Samples received in good order .
Samples received with cooling media: Ice bricks .
Samples received chilled.
Security seals not used .
Sample container & chemical preservation suitable .

Comments: TDS subcontracted out to SAL. Samples received outside of THT for Anions analysis.

Holding Times: Date received allows for insufficient time to meet Technical Holding Times.
Note: There are Samples within this batch that have been received by the laboratory 3 day(s) after Technical Holding Times expire. LabMark cannot guarantee THT compliance, refer to the extraction dates detailed in the sample grid for confirmation.

Preservation: Chemical preservation of samples satisfactory for requested analytes.

Important Notes:

LabMark shall responsibly dispose of spent customer soil and water samples which includes the disintegration of the sample label. A sample disposal fee of $1.00 is applicable on all samples received by the laboratory regardless of whether they have undergone analytical testing. Sample disposal of environmental samples shall be 31 days (water) and 3 months (soil, HN03 preserved samples) after laboratory receipt, unless otherwise requested in writing by the client. Samples requested to be held in non-refrigerated storage shall incur $5.00/ sample/ 3 months. Additional refrigerated storage shall incur $30/ sample/ 3 months. Combination prices apply only if requested. Transfer of report ownership from LabMark to the client shall occur once full and final payment has been settled and verified. All report copies may be retracted where full payment does not occur within the agreed settlement period.

Analysis comments:

Subcontracted Analyses:

Reported by Sydney Analytical Laboratories, NATA accreditation No.1884.

Thank you for choosing Labmark to analyse your project samples.

Additional information on www.labmark.com.au

Report Date : 12/12/2007
Report Time : 1:18:18PM

Quality, Service, Support

Sample **Receipt** Notice (SRN) for **E035436**

The table below represents LabMark's understanding and interpretation of the customer supplied sample COC request (refer to SRN comments section on first page for external subcontracting method details). Please confirm that your COC request has been entered correctly. Due to THT and TAT requirements, testing shall commence immediately as per this table, unless the customer intervenes with a correction prior to testing.

GRID REVIEW TABLE

				Requested Analysis																		
No.	**Date**	**Depth**	**Client Sample ID**	Major cations	Alkalinity (CO_3, HCO_3, OH)	Chloride	PREP Not Reported	Sulphate	External Total Dissolved Solids (TDS)													
131528	07/12		DupA	●	●	●	●	●	●													
			Totals:	1	1	1	1	1	1													

'PREP Not Reported' refers to an internal laboratory instruction - client confirmation of this parameter is not required.

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

CHAIN OF CUSTODY DOCUMENTATION

First Floor 207 The Parade Norwood SA 5067 · PO Box 3166 Norwood SA 5067
T: +61 8 8431 7113 · F: +61 8 8431 7115
ACN 100 220 479 · ABN 62 100 220 479

S&G

CLIENT: Tallwood	LABORATORY: MGT	LABORATORY BATCH NO.:	
PROJECT: Mannum	COC Reference #: 1041	SAMPLERS: NGB/NDP	
SEND REPORT TO: S&G	SEND INVOICE TO: S&G	PHONE: 08 8431 7113 FAX: 08 8431 7115	
DATA NEEDED BY: 5 day t/a	REPORT NEEDED BY: 5 day t/a	REPORT FORMAT: HARD:YES FAX: NO E-MAIL: YES	
PROJECT ID: SG071493	QUOTE #:		
	RELINQUISHED BY: Nick Byrne	RECEIVED BY	METHOD OF SHIPMENT: Overnight
NAME: Nick Byrne	DATE: 7/12/07	NAME: IAN DOUGLAS DATE:	CONSIGNMENT NOTE NO.
OF: S&G	TIME:PM	OF: LABMARK 11/12/07 TIME: 8:30am	
NAME:	DATE:	NAME: DATE:	TRANSPORT CO. NAME.
OF:	TIME:	OF: TIME:	
P.O. NO.:	COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:	ANALYSIS REQUIRED	

FOR LAB USE ONLY
COOLER SEAL
Yes ..... No .....
Broken ..... Intact .....
COOLER TEMP: deg.C

Please forward results and invoice to: E0355436
labresults@soilandgroundwater.com.au

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

SAMPLE DATA				CONTAINER DATA			ANIONS	CATIONS	TDS												'NOTES
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH field															
MW5	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW10	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW11	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW12	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW13	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW14	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW15	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
MW16	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
~~MW17~~	~~Water~~	~~7/12/2007~~	~~AM~~	~~1N, 1P~~	~~2~~	~~y~~		X													
MW18	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												
DupA 131528	Water	7/12/2007	AM	1N, 1P	2	y	X	X	X												Please forward dupA to labmark
						TOTAL	10	11	10	0	0	0	0	0	0	0	1	0	0	0	0	0	

FAXED 11/12/07 8:30AM

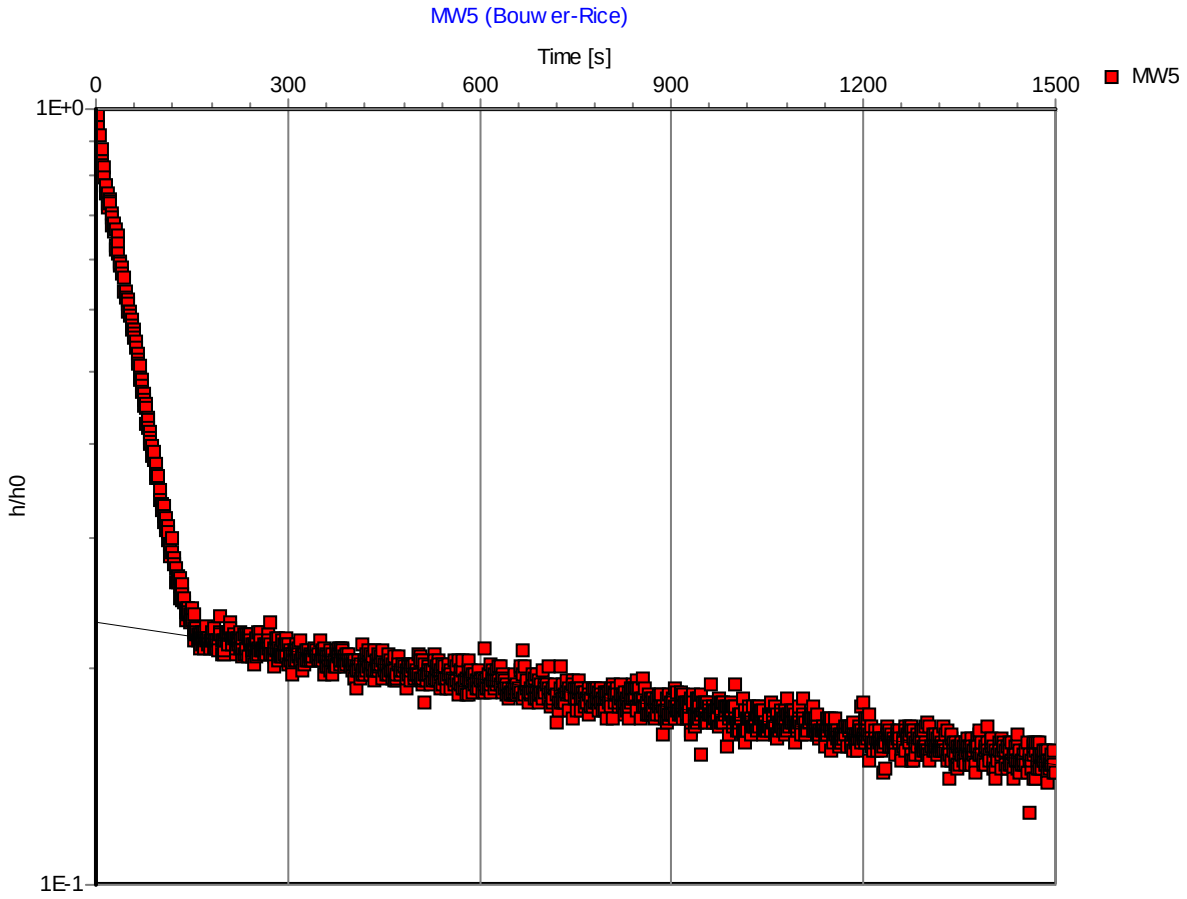
APPENDIX D

RISING HEAD HYDRAULIC CONDUCTIVITY TEST ANALYSES

Soil and Groundwater
First Floor 207 The Parade
Norwood, SA 5067
Phone: 08 8431 7113

Slug Test Analysis Report

Project:	Mannum Waters
No:	SG071493
Client:	Tallwood Pty Ltd



Test name: **MW5**

Analysis method: **Bouwer-Rice**

Analysis results:

Conductivity: 1.84E-7 [m/s]

Test parameters:

Test well:	MW5	Aquifer thickness:	10 [m]
Screen radius:	0.065 [m]	Gravel pack Porosity (%)	25
Screen length:	3 [m]		
Casing radius:	0.025 [m]		
r(eff):	0.039 [m]		

Comments:

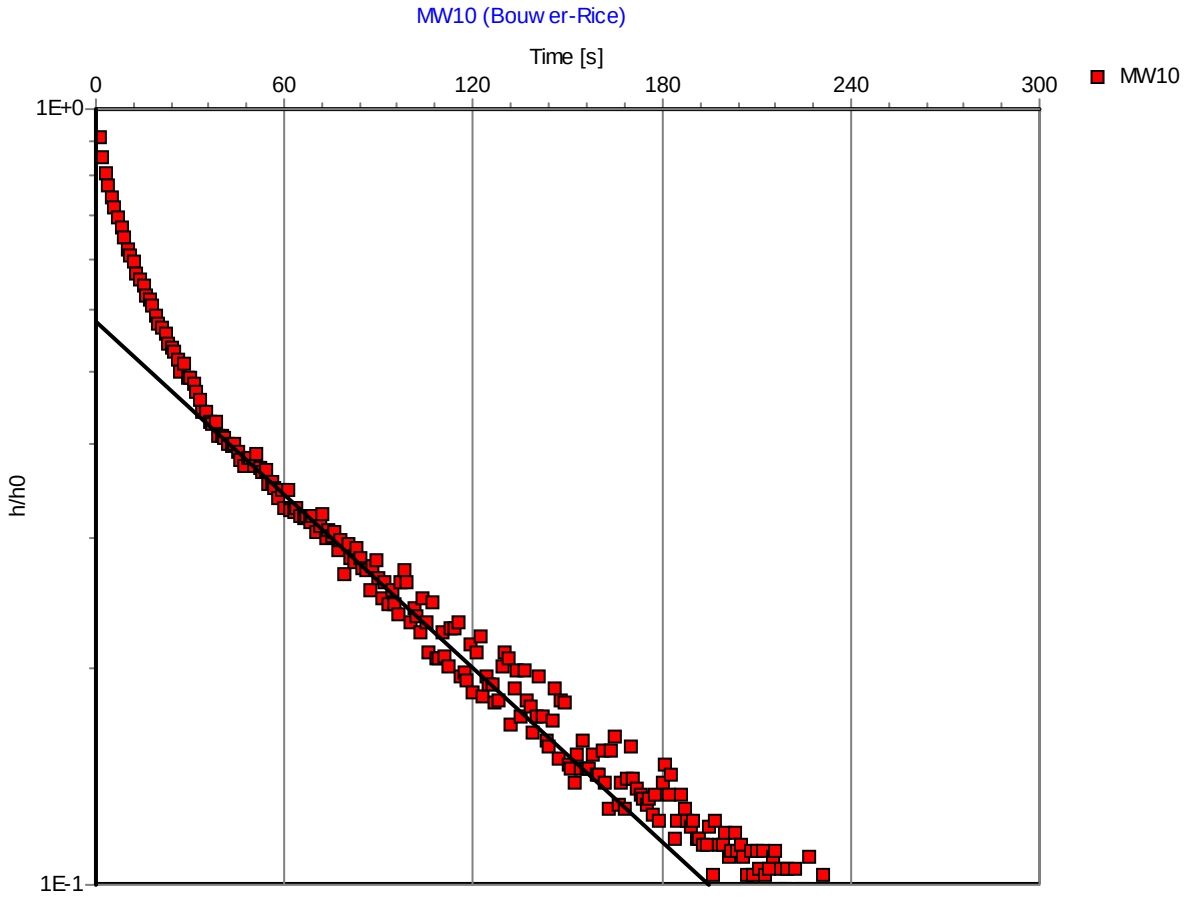
Evaluated by: DJN

Date: 21/01/2008

Soil and Groundwater
First Floor 207 The Parade
Norwood, SA 5067
Phone: 08 8431 7113

Slug Test Analysis Report

Project:	Mannum Waters
No:	SG071493
Client:	Tallwood Pty Ltd



Test name: **MW10**

Analysis method: **Bouwer-Rice**

Analysis results:

Conductivity: 4.94E-6 [m/s]

Test parameters:

Test well:	MW10	Aquifer thickness:	10 [m]
Screen radius:	0.065 [m]	Gravel pack Porosity (%)	25
Screen length:	3 [m]		
Casing radius:	0.025 [m]		
r(eff):	0.039 [m]		

Comments: Early data thought to be associated with gravel pack and developed zone

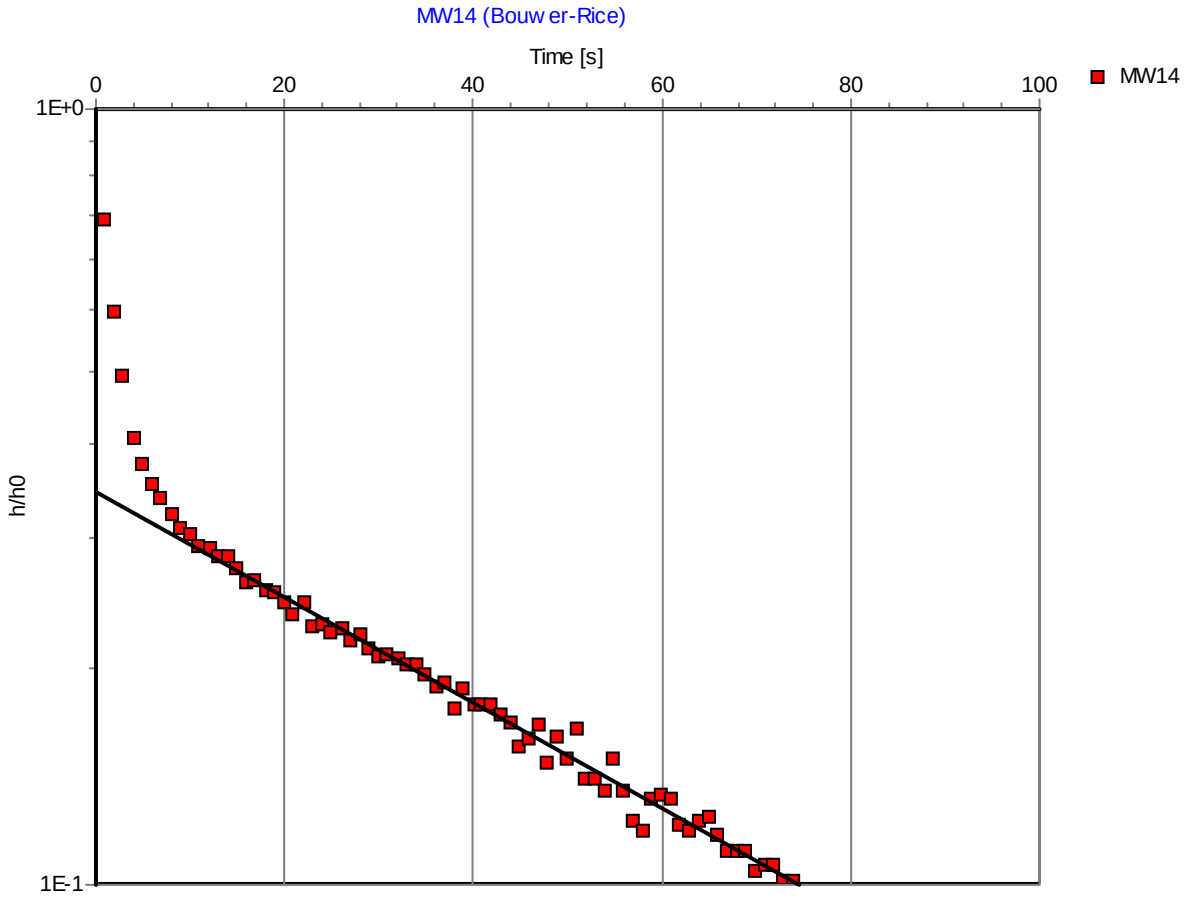
Evaluated by: DJN

Date: 21/01/2008

Soil and Groundwater
First Floor 207 The Parade
Norwood, SA 5067
Phone: 08 8431 7113

Slug Test Analysis Report

Project:	Mannum Waters
No:	SG071493
Client:	Tallwood Pty Ltd



Test name: **MW14**

Analysis method: **Bouwer-Rice**

Analysis results:

Conductivity: 8.82E-6 [m/s]

Test parameters:

Test well:	MW14	Aquifer thickness:	10 [m]
Screen radius:	0.065 [m]	Gravel pack Porosity (%)	25
Screen length:	3 [m]		
Casing radius:	0.025 [m]		
r(eff):	0.039 [m]		

Comments:

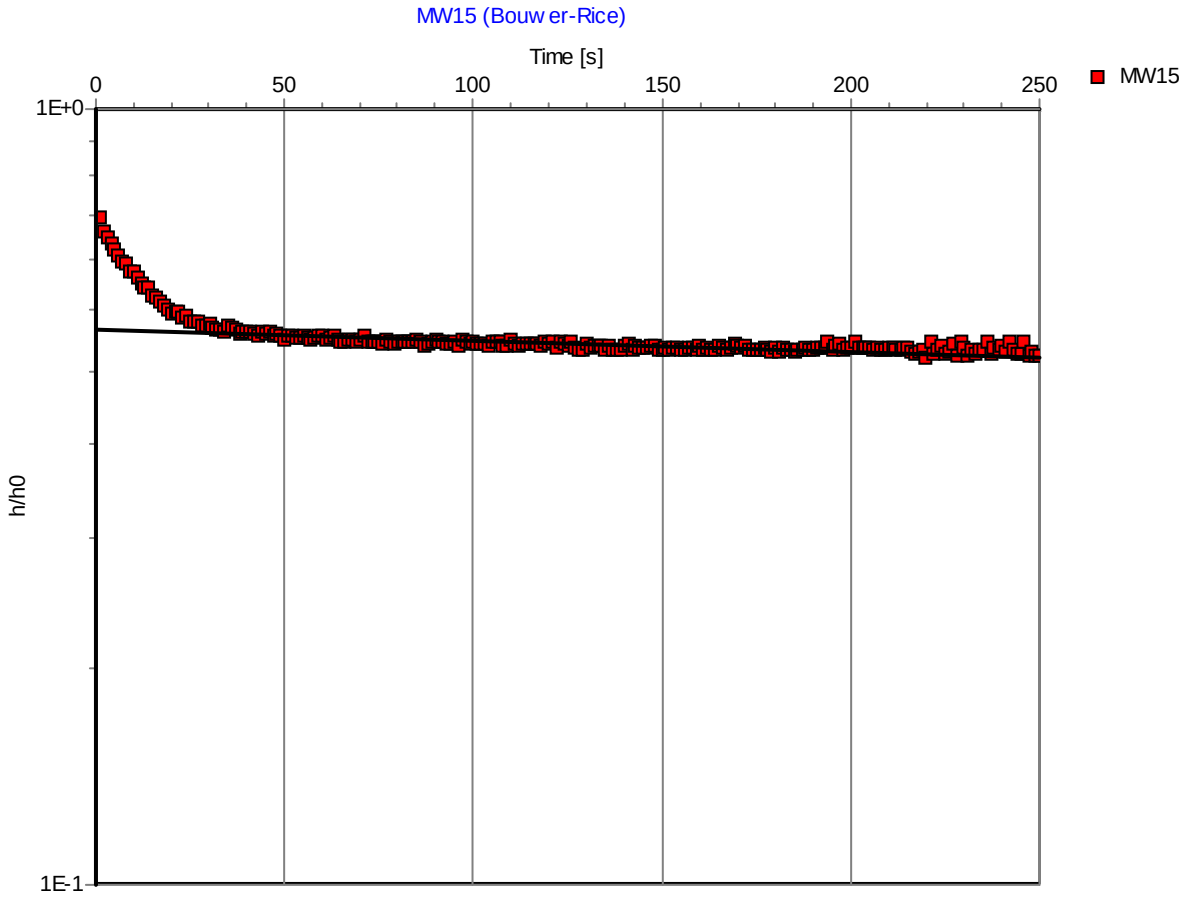
Evaluated by: DJN

Date: 21/01/2008

Soil and Groundwater
First Floor 207 The Parade
Norwood, SA 5067
Phone: 08 8431 7113

Slug Test Analysis Report

Project:	Mannum Waters
No:	SG071493
Client:	Tallwood Pty Ltd



Test name: **MW15**

Analysis method: **Bouwer-Rice**

Analysis results:

Conductivity: 1.83E-7 [m/s]

Test parameters:

Test well:	MW15	Aquifer thickness:	10 [m]
Screen radius:	0.065 [m]	Gravel pack Porosity (%)	25
Screen length:	3 [m]		
Casing radius:	0.025 [m]		
r(eff):	0.039 [m]		

Comments:

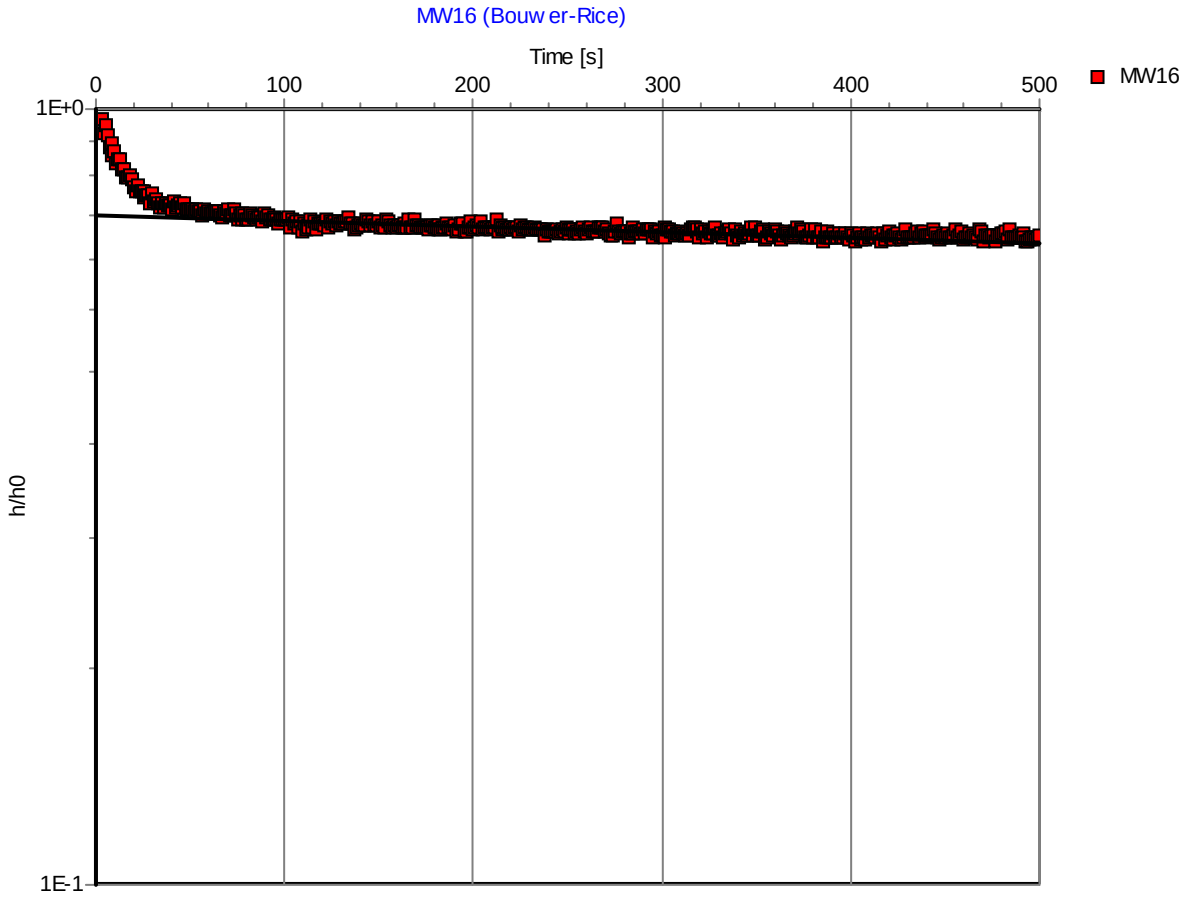
Evaluated by: DJN

Date: 21/01/2008

Soil and Groundwater
First Floor 207 The Parade
Norwood, SA 5067
Phone: 08 8431 7113

Slug Test Analysis Report

Project:	Mannum Waters
No:	SG071493
Client:	Tallwood Pty Ltd



Test name: **MW16**

Analysis method: **Bouwer-Rice**

Analysis results:

Conductivity: 8.69E-8 [m/s]

Test parameters:

Test well:	MW16	Aquifer thickness:	10 [m]
Screen radius:	0.065 [m]	Gravel pack Porosity (%)	25
Screen length:	3 [m]		
Casing radius:	0.025 [m]		
r(eff):	0.039 [m]		

Comments:

Evaluated by: DJN

Date: 21/01/2008