Sunraysia Drainage Strategy

Volume 2 - Background and Issues Papers
Part 2 of 2

June 2002

Department of Natural Resources and Environment

GOULBURN-MURRAY WATER

SUNRAYSIA RURAL WATER AUTHORITY

mallee catchment management authority

SunRISE INC. Sunraysia Regional Initiative for a Sustainable Economy - 21st Century

First Mildura Irrigation Trust

Lower Murray Water

Mildura Rural City Council

EPA Victoria

Murray-Darling Basin Commission

Sunraysia Drainage Strategy

Excerpts from Issues Paper no.2 - Threats and Values

June 2002

Department of Natural Resources and Environment

GOULBURN-MURRAY WATER

SUNRAYSIA RURAL WATER AUTHORITY

LOWER MURRAY WATER

Mildura Rural City Council

EPA VICTORIA

MURRAY-DARLING BASIN COMMISSION

Contents

Document History and Status

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
Draft	1	Stakeholders		15 / 11 / 01	D. Sheehan	T. Dando
Draft	2	Stakeholders		11 / 01 / 02		D Sheehan
Final Draft	1	Stakeholders and Hardcopies	50	21/01/02	D.Sheehan	T.Dando
Final	2	Mildura Rural City Council	25	27/6/02	T.Dando	D.Sheehan

Printed:	20 June, 2002
Last Saved:	18 June, 2002
File Name:	I:\WCMS\Wc01738\REP01_05.22\Final_Version_June_2002\Paper_2.Doc
Project Manager:	David Sheehan
Name of Organisation:	Mildura Rural City Council
Name of Project:	Sunraysia Drainage Strategy And Urban Stormwater Quality Management Plan
Name of Document:	Excerpts from Volume 2 of Urban Stormwater Quality Management Plan Report - values and threats associated with receiving waters
Document Version:	Final 2
Project Number:	WC01738

1. Values of receiving environments

1.1 Values

The receiving environments have a range of values including ecological, social and cultural, recreational, and economic values.

1.1.1 Ecological values

Aquatic, terrestrial and groundwater ecosystems are complex systems with a range of ecological values. They support a diverse range of unique flora and fauna dependent on a range of ecological and hydrological processes and habitat. Interactions between aquatic, terrestrial and groundwater ecosystems are complex with each dependant on the other for healthy functioning. The protection of these ecosystems, the diversity of communities that inhabit them, and the ecological and hydrological processes that shape these systems is a critical requirement of stormwater and drainage management.

Threats to ecological values from stormwater and drainage include changes to hydrological regimes, increased sediment, nutrient and other contaminant inputs and loss of habitat value. In the Mallee region, irrigation drainage water poses a particular threat, as it is often high in dissolved salts and nutrients. These impacts threaten native flora and fauna and can lead to a loss of species diversity. The healthy functioning of aquatic, terrestrial and groundwater ecosystems are not only important from an ecological point of view but also underpin other values associated with those ecosystems, such as recreational and economic values.

1.1.2 Cultural and Heritage Values

There is a range of social and cultural values associated with receiving environments. Indigenous and non-indigenous people have strong cultural attachments with waterways, for spiritual and historical reasons. Many waterways and activities or events associated with that environment form part of the psyche of local communities. These aspects are valued highly by communities.

Current archaeological records for the Sunraysia region indicates continuous Aboriginal occupation of the riverine corridor spanning the last 21,500 years (Edmonds 1997). There is a diverse range of site types and site complexes, the location of which appears to be closely associated with features of the two main landforms in the study region, the Riverine Landform and the Mallee Dunefield (LCC 1987). The Riverine Landform comprises the Murray River and floodplain, the Mallee Dunefield is located above the Riverine Landform. Most archaeological sites are associated with the Riverine Landform, specifically riparian zones and waterbodies (Table 1-1 Predictive Model of Site Location and Archaeological Sensitivity by Micro-Environmental Context for the Riverine Plain Landform and Associated Sub-systems (after Edmonds 1999)).

Currently, information regarding the context of archaeological sites located in the Mallee Dunefield land system is limited but it seems that all known sites occur on aeolian features, such as, dunes, ridges and lakeside sediments within 500 m of a fresh or saline water source (Table 1-2).

■ **Table 1-1 Predictive Model of Site Location and Archaeological Sensitivity by Micro-Environmental Context for the Riverine Plain Landform and Associated Sub-systems (after Edmonds 1999)**

*Micro-Environments	Expected Site Types	Archaeological Sensitivity
Riparian (Ffc2)	Shell middens on high banks/ scarred trees/isolated artefacts/hearths	Moderate
Lagoons, swamps and lake margins (Pf2 and Ffc2)	Shell middens/ scarred trees/ isolated artefacts/ hearths/ surface scatters	High
Floodplain (Ffc2)	Isolated hearths/ scarred trees/ isolated artefacts	Low
Box Plain (Ffc2, Pf2)	Scarred trees/ isolated hearths	Low
Sand Dunes (including lunettes) (PEfc2, Ffc2, Lfc2, Pf2)	Burials/ hearths/ surface scatters/ shell middens	High

*See LCC (1987) for key to sub-systems.

■ **Table 1-2 Predictive Model of Site Location and Archaeological Sensitivity by Micro-Environmental Context for the Mallee Dunefield Land System and Associated Sub-systems (after Edmonds 1999).**

*Micro-Environments	Expected Site Types	Archaeological Sensitivity
Dunes- in lakeside sediments or aeolian ridges within 500 m of a fresh or saline water source (PREfc12, RPEfc2)	Shell middens/ burials/surface scatters/ isolated artefacts/ isolated hearths	Moderate
Dunes-on plains adjacent to depressions (PEfc2)	Hearths/ isolated artefacts	Low-Moderate
Gypseous basins-adjacent dunes and margins (PYfz2)	Isolated artefacts/ isolated hearths	Low

*See LCC (1987) for key to sub-systems.

There are only two previous heritage studies that have involved field survey within the study area. These are Andrew C. Ward & Assoc. (1986), which sought to document sites for an LCC regional review, and Kenderdine (1994), which documented sites specifically related to shipping and trade along the Murray River. Neither study employed a systematic field methodology. Other studies (Bardwell 1980, Penney 1993) involved historical research only, but do assist in defining the main historical themes relating to the study area. These are:

- **Exploration** (1828-1840)
  Sites predicted: blazed trees, memorials & historical places (eg. camp sites & Aboriginal interaction sites).
- **Pastoral settlement and forest grazing** (1843+)
  Sites predicted: abandoned station sites, wells, weirs, stock yards, stock routes and cemeteries.
- **Aboriginal communities** (1840+)
  Sites predicted: former missions & reserves, 'contact' sites, scarred trees and campsites.
- **Surveying** (1840+)
  Sites predicted: blazed trees, survey markers
- **Land communications** (1852+)
  Sites predicted: abandoned hotel sites, mail and coach routes, telegraph lines, bridges and punt/ferry crossings.
- **The development of inland shipping and trade** (1853-1904)

Sites predicted: shipwrecks, wharves, slipways, docks, locks, custom house sites and navigation markers.

- **Timber getting** (1859+)
  Sites predicted: saw mills, charcoal kilns, transport relics, logging camps and stumps.
- **The development of rural industry and settlement** (1860+)
  Sites predicted: abandoned selections, boiling-down works, tanneries, abattoirs, flour mills, research stations, lime kilns, brick works, packing sheds and canneries.
- **Irrigation** (1888+)
  Sites predicted: channels, syphons, pumps, pump houses, locks, weirs, water storage facilities and construction camps.
- **Leisure and tourism** (1950+)
  Sites predicted: fishing sites, campsites, tourist attractions and monuments.

In total, there are approximately 22 non-indigenous heritage sites/places listed on various registers and/or planning schemes within the study area (Edmonds 1999) including the Mildura Planning Scheme, the Register of the National Estate, the Register of Heritage Victoria, the Historic Buildings Register and the National Trust Register. Most of these sites are buildings that are located in urban/residential precincts, although the Mildura Weir and Lock 11 have been identified as historical sites of significant heritage value.

1.1.3 Amenity and recreational values

Waterways are valued for a their visual and landscape amenity and for a range of recreation activities from passive enjoyment of the environment to more active pursuits of swimming and water skiing.

Passive recreational activities are those that involve no contact with the water. They take place on land adjacent to the waterway and include picnicking, walking and visual enjoyment. Secondary contact recreational activities are those where the body is not immersed in the water but where some contact with water may occur. They include activities such as boating, canoeing, wading and fishing. Primary contact recreational activities are those where the whole body can become immersed in the water. These activities include swimming, diving and water skiing.

The Murray River and permanent wetlands on the floodplain are the focus for recreational activity in the study area including boating, fishing, skiing, camping, bird watching etc. Bird watching is also popular at some of the drainage basins where large numbers of waterbirds flock from time to time.

The type of recreational activity recommended for a particular waterbody depends on the quality of water. In Victoria, the EPA has specified the water quality objectives required for different types of recreational activities (Victorian Government 1988). Stormwater and drainage water can have a significant impact on reducing the quality of water in a waterway and severely impact upon the type of recreational activities suitable for that waterway. For example, stormwater can carry significant bacterial contamination at times and this can reduce the recreational value of the receiving waterway and highly saline inputs can impact on vegetation and reduce the aesthetic values and amenity of wetland areas.

1.1.4 Economic values

Receiving environments have a range of economic values. They have an intrinsic value as a provider of ecosystem services, for example, as a natural treatment system for the disposal of effluent and in providing drainage and flood mitigation services. They also have a range of more quantifiable economic values as a source of water for irrigation, industrial, stock and domestic supply purposes. Many waterways are also the focus of commercial industries such as fishing and tourism.

For the purposes of this study, economic values are considered those that relate to the suitability for water supply and the potential for re-use. The supply of high quality water for domestic, industrial and irrigation purposes is essential to the economy of the region, as is the protection of that supply from impacts that may reduce its economic value to downstream users. In the Sunraysia region there is potential for the re-use of good quality irrigation and stormwater on particular crops such as wood lots. In fact, most treated sewage effluent is now used to successfully irrigate wood lots. The challenge is in identifying suitable activities where re-use water can be used and in securing a sustainable supply of suitable quality.

The economic value to the region from tourism is considered under Amenity values while the protection of economic and environmental values to downstream users is considered under Drainage values.

1.1.5 Drainage values

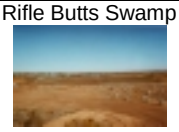
In the Sunraysia region, drainage basins provide an important function in preventing excess salt and nutrients in irrigation drainage water from entering the Murray River. Irrigation drainage water is pumped to evaporation basins where the water evaporates and leaves the salt behind. Other basins also receive saline groundwater from groundwater interception schemes aimed at preventing saline groundwater entering the Murray River. The operation of drainage basins in this manner is designed to protect a range of values including environmental, amenity and economic values within the region and downstream. Inflows to drainage basins is often the only source of water that supports habitat values in those basins. The hydraulic capacity of receiving waters is also important, adequate capacity to cope with inflows from storm events is necessary to prevent local flooding.

The economic values in terms of preventing excess salinity in the Murray River are very high. A credit system is currently in operation in the Murray-Darling Basin such that the prevention of saline water entering the Murray River generates EC credits. Evaporation basins are used to generate EC credits by providing an off river disposal site for saline drainage water and groundwater.

1.2 Specific values of receiving environments

This section identifies and summarises the values of environments receiving urban stormwater runoff and irrigation drainage in relation to the broad values listed above. Values have been identified from relevant literature including environmental investigations, water quality data and waterway condition, regional strategies and management plans and field inspections. Field inspections were conducted of all receiving environments and drainage outfall locations from 26-28 June 2001. The key values of environments receiving urban stormwater water runoff and irrigation drainage are summarised in Table 1-3.

■ Table 1-3 Summary of key values of high value environments receiving urban stormwater and irrigation drainage

Receiving Environment	Key values
Significant environments receiving urban stormwater runoff	
Murray River 	▪ The Murray River above and below Lock 11 provides significant instream and riparian habitat values. A range of threatened species are supported by the river and floodplain environments and parts of this system are listed on the Register of the National Estate and the Directory of Important Wetlands in Australia. ▪ The Murray River environment is also significant for its cultural and heritage values and there are numerous archaeological sites highlighting the links with indigenous cultures. ▪ The River environment is highly valued for its recreational, tourism and amenity values. ▪ The region is highly dependent on the River as a source of high quality water for irrigation, domestic and industrial use.
Kings Billabong 	▪ As with the Murray River, Kings Billabong has significant instream and riparian values. There is a long record of indigenous contact with the area as well as more recent non-indigenous heritage values associated with irrigation development in the region. ▪ Kings Billabong is listed on the Directory of Important Wetlands in Australia and supports a range of threatened flora and fauna. ▪ The wetlands is a popular for recreational activities including swimming, boating fishing and camping and provides high landscape amenity to rural residential development along the west shoreline. ▪ Water is pumped from the Murray River to Kings Billabong from where it is then pumped into the FMIT irrigation supply system.
Basin 12 	▪ Basin 12 provides habitat values for a range of bird species and offers visual amenity for residential areas, however more active recreational opportunities are low. ▪ Basin 12 is used for irrigation and urban stormwater drainage, however inflows appear to be declining due to improved irrigation practices.
Rifle Butts Swamp 	▪ Rifle Butts Swamp provides a moderate level of habitat for birds. ▪ If managed appropriately, Rifle Butts Swamp offers high amenity values to the community as urban development expands around the wetland. ▪ By directing urban stormwater to Rifle Butts Swamp, inputs to the Murray River are reduced. ▪ The values associated with Rifle Butts Swamp are maintained by stormwater inputs.
Lake Ranfurly 	▪ Lake Ranfurly provides significant habitat for many bird species, including species listed under State Government threatened species legislation. It is listed on the Directory of Important Wetlands in Australia for its significant bird habitat. ▪ While the area around the Lake Ranfurly is degraded, there are opportunities for improved amenity for local residential communities. ▪ By directing urban stormwater to Lake Ranfurly, inputs to the Murray River are reduced.
Lake Hawthorn 	▪ Lake Hawthorn provides habitat for birds and some fish species ▪ Lake Hawthorn also provides some recreational opportunities and visual amenity for surrounding residents. ▪ By directing stormwater runoff the Lake Hawthorn, salt and nutrient inputs to the Murray River are reduced.
Significant environments receiving irrigation drainage water	
Cardross Lakes 	▪ Cardross Lakes are significant for supporting one of the most diverse small native fish populations in the State, and in particular the endangered Purple Spotted Gudgeon. ▪ Inflows to Cardross Lakes are declining and reduced water levels in the lakes pose a threat to the native fish species present.
Wargan Basins 	▪ Wargan basins provide significant habitat for a range of bird species and offer a range of passive recreational activities such as bird watching and nature conservation. ▪ The basins are listed on the Directory of Important Wetlands in Australia and support populations of waterbird listed under international migratory bird agreements.

In accordance with the requirements of the Victorian Stormwater Committee guidelines, values have been ranked as low, moderate, high and very high. In order to adequately determine realistic values for each environment, a set of criteria were developed (Table 1-4). Using these criteria, specific values for each receiving environment were ranked. In addition to current values, an assessment of potential values was also conducted. This assessment was based on the potential change in values of particular environments depending on future management scenarios. These values have been discussed and confirmed with the Project Steering Committee, Reference Group and Working Group and confirmed by the Mildura Rural City Council.

A summary of the current values for all receiving environments is shown in Table 1-5. Generally, all values associated with the Murray River and Kings Billabong are very high. The smaller terminal evaporation basins generally have low environmental value due to highly saline water and reduced volumes whereas the larger terminal basins with a greater water volume have high to very high environmental values because of their significance as habitat for rare and threatened waterbirds. All basins have high drainage value, particularly those that are used to prevent saline and nutrient rich water from entering the Murray River. The highest amenity values are associated with the Murray River, however there is the potential to improve the amenity of many of the drainage basins by revegetation and enhancement of their conservation values. High economic values are associated with the Murray River and with the potential for the re-use of water from some basins depending on the ability to guarantee the quality and quantity of water.

■ **Table 1-4 Criteria for determining values associated with environments that receive urban stormwater runoff and irrigation drainage water**

Ranking	Environmental **Instream flora & fauna** **Ecological processes** **Riparian vegetation**	Cultural **Indigenous cultural sites** **Non-indigenous heritage sites**	Amenity **Tourism** **Recreation** **Education**	Economic **Water supply** **Re-use opportunities**	Drainage **Flood prevention** **Nutrient removal** **Salt interception**
Very high	• Flora & fauna species listed under State or Commonwealth legislation • High biodiversity • Critical habitat or ecological communities listed under State or Commonwealth legislation • Habitat listed on Directory of Important Wetlands in Australia • Sites listed on the Register of the National Estate as 'Natural'	• Archaeological sites listed on the Aboriginal Affairs Victoria register • Sites listed on the Register of the National Estate as 'Historic'	• Important for regional tourism • Activities include Primary Contact Recreation eg swimming • Very high scenic values • Used for educational activities eg nature awareness,	• Water supply for domestic, industrial & irrigation • Re-use opportunities	• High capacity for nutrient stripping • Contributes to EC credits • Flooding prevention • Asset protection
High	• Regionally significant habitat or flora/fauna species • Drought refuge	• High probability of archaeological sites given landform • Sites of local historical significance	• Important for local tourism • Activities include Secondary Contact Recreation eg fishing • High scenic values • Some educational activities	• Water supply for irrigation • Re-use opportunities • Commercial fisheries	• Moderate capacity for nutrient stripping & EC credits • Flood prevention & asset protection
Moderate	• Some habitat values • Locally significant habitat or species	• Low probability of archaeological sites given landform • Minor historical significance	• Limited recreational values • Limited visual amenity	• Water supply for stock • Limited re-use opportunities	• Flood prevention & asset protection
Low	• Low habitat values • No significant flora/fauna • Degraded habitat condition	• No sites	• No recreational values	• Not suitable for water supply	• No capacity for nutrient stripping • No hydraulic capacity

■ **Table 1-5 Summary of current values of environments receiving urban stormwater and irrigation drainage**

Receiving Environment	Environmental		Cultural		Amenity			Eco-nomic	Drainage	
	Instream	Riparian	Indigenous	Non-indigenous	Recreational	Amenity	Tourism	Water Supply	Flood reductions	Salt & nutrient reductions to Murray River
Environments receiving urban stormwater runoff (& irrigation drainage)										
Murray River	V high	V high	V high	V high	V high	V high	V high	V high	High	Low
Kings Billabong	V high	V high	V high	V high	V high	V high	V high	High	Low	Mod.
Basin 12	High	High	Mod.	Low	Mod.	Mod.	Low	Low	High	V high
Rifle Butts Swamp	Mod.	Mod.	Mod.	Low	Low	Mod.	Low	Low	High	Mod.
Lake Ranfurly East	V high	V high	High	Low	Low	High	Low	Low	High	V high
Lake Hawthorn	V high	V high	Mod.	Low	High	High	Mod.	Low	V high	V high
Environments receiving irrigation drainage										
Cardross Lakes	V high	V high	Low	Low	Low	Low	Low	Low	Mod.	Mod.
Koorlong Basins	Low	Mod.	Mod.	Low	Low	Low	Low	Low	Mod.	V high
Lamberts Swamp	Low	Low	Low	Low	Low	Low	Low	Low	Low	V high
Lake Ranfurly West	V high	V high	High	Low	Low	Low	Low	Low	Low	V high
Wargan Basins	V high	V high	Mod.	Low	Mod.	High	Low	Low	V high	V high
Psyche Bend Lagoon	Low	Low	Mod.	Low	Low	Low	Low	Low	Mod.	V high

2. Threats from stormwater and drainage water

2.1 Threats

There is a range of threats to receiving environments from stormwater and irrigation drainage discharge in the study area. These threats and the values they impact upon are summarised below. The impact stormwater threats have on receiving environments is summarised in Table 2.1, specific threats in the study area summarised in Table 2-2.

2.1.1 Sediment

Sediment and soil particles are highly elevated in stormwater and rural surface runoff. Sediment can enter the stormwater system via a number of pathways. Runoff from bare and disturbed ground (eg construction sites, development areas, uncontained stockpiles, carparks and paved areas) carries significant quantities of sediment that are washed in to the stormwater system. Sediment can also wash and fall off vehicles; this deposited sediment builds up on road surfaces and subsequently washes into the stormwater system. Erosion of waterways, drains and unsealed roads also results in increased sedimentation and turbidity.

Excess sediment poses a threat to aquatic ecosystems by smothering benthic surfaces and the organisms that inhabit those surfaces. Fine sediment contributes to turbidity that reduces light penetration. Fine particles suspended in the water column can block fish gills. In addition, nutrients - particularly phosphorus, heavy metals and other contaminants can be strongly bound to sediment particles and hence these pollutants enter waterways attached to sediment particles where they can threaten aquatic ecosystem health and other beneficial values.

Sub-surface drainage water is generally low in suspended material as it has percolated through the soil however, particulate material can become entrained in flow through open earthen channels and where excess surface runoff enters the sub-surface drainage system as a result of flood irrigation practices or rainfall events.

2.1.2 Nutrients

The concentration of the nutrients nitrogen and phosphorus are highly elevated in stormwater and drainage water. There are several key pathways by which nutrients enter stormwater. As indicated above, phosphorus binds to soil and sediment particles and can enter stormwater via erosion, deposition from the atmosphere and runoff from construction sites. Nutrients can also enter the drainage system via fertiliser in runoff from irrigated areas, parks, gardens and recreational areas, particularly golf courses. Sullage and septic tank effluent can contribute significant nutrient loads to stormwater and receiving waterways. Activities such as washing vehicles in the street and allowing the detergent to drain to the stormwater system can also contribute nutrients to waterways. Dog faeces, particularly where they are deposited near to waterways (eg. along foreshores of rivers and lakes) may also contribute excess nutrients.

Excess nutrients in runoff can contribute to excessive algal and plant growth which create eutrophic conditions that can threaten aquatic ecosystem values. Excessive algal and plant growth also threatens other values by increasing the cost of water treatment and restricting recreational activity. The development of toxic blue-green algal blooms can threaten stock and human health.

2.1.3 Salinity

In the Sunraysia region, saline drainage water poses a significant threat to many values and is managed to prevent it from entering the Murray River and contributing to elevated groundwater levels. Elevated salinity levels threatens aquatic communities and degrades vegetation. Agricultural production is impacted upon where saline groundwater is located

near to the soil surface. Elevated salinity in water supply increases the cost of treatment or renders it unsuitable for some applications.

2.1.4 Litter

Litter in stormwater can impact on the visual amenity of a waterway, threaten instream fauna and impact on recreational activities and human health. The main sources of litter entering the stormwater system are around shopping centres and schools where rubbish bins overflow or litter is discarded in the street and subsequently washes into the stormwater system. Litter can also be generated in residential areas, particularly where open 'tub' type recycling bins are used as litter can blow out of these bins, and around construction sites where waste management is often poor.

2.1.5 Organic material

Excessive organic material, including leaves and grass clippings, can enter the stormwater system in runoff. As organic material decomposes it can cause a decline in the oxygen concentration of the water column. A decline in oxygen can negatively impact on aquatic fauna, particularly fish.

2.1.6 Microbiological contamination

Microbiological contamination, namely bacteria, viruses and other pathogens, pose a significant threat to human health, recreational activity and water supply. Microbiological contamination can enter stormwater and waterways via sullage and septic tank discharges in unsewered residential areas. Runoff containing faecal material from sale yards and domestic stock can also contribute to microbiological contamination, as can accidental and emergency overflows from sewerage systems. Infiltration of contaminated stormwater to groundwater aquifers can threaten values associated with groundwater.

2.1.7 Heavy metals and other contaminants

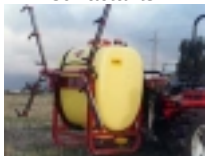
Heavy metals and other contaminants such as pesticides, surfactants, oils and grease can all enter stormwater systems in runoff and from accidental and deliberate discharges. All urban land use areas have the potential to contribute heavy metals and other contaminants however, runoff from industrial areas and major roads are the most likely source of these types of contaminants. In agricultural areas pesticides can enter the drainage system via drift and accidental and deliberate spills.

Heavy metals, oils and grease often become bound in sediments and can threaten aquatic ecosystems. Oil and grease scums impact on visual amenity and recreational values.

2.1.8 Other threats

Other threats from stormwater include impacts on visual amenity by pipes and other stormwater infrastructure. Construction of new stormwater infrastructure, such as pipes and retarding basins, can impact on cultural sites. Inadequate stormwater system capacity can contribute to flooding and health problems. Increases in the area of impervious pavement result in more runoff generation than would be experienced under natural conditions, thus most urban waterways carry a greater flow during storm events than non-urban streams with similar catchment areas. Increased flow can scour stream beds and banks creating erosion and turbidity problems. Poor infrastructure maintenance or design can result in erosion around pipe outfalls and channels.

■ Table 2.1 Summary of effect of stormwater threats on receiving environments.

Key pollutants	Effect on receiving environment
Sediments 	• Excess sediment can smother benthic surfaces and the organisms that inhabit those surfaces. • Fine sediment contributes to turbidity that reduces light penetration. • Fine particles suspended in the water column can block fish gills. • Contaminants such as nutrients and heavy metals can be strongly bound to sediment particles. • Excess sediment can block pipes increasing the risk of flooding.
Nutrients 	• Excess nutrients in runoff can contribute to excessive algal and plant growth. • Excessive algal and plant growth also threatens other values by increasing the cost of water treatment and restricting recreational activity. • The development of toxic blue-green algal blooms can threaten stock and human health. • Excessive algal growth can be aesthetically unpleasing and impact on recreational and public amenity values.
Salinity 	• Saline drainage water and groundwater can negatively impact on many ecological values • High levels kill vegetation and render land unproductive • Detrimental to intolerant fish and vegetation species • Contributes to economic loss through loss of productive land and quality of water supply • Impacts upon amenity and tourism potential
Litter 	• Litter can impact on the visual amenity of a waterway, threaten instream fauna and impact on recreational activities and human health. • Excess litter can block pipes increasing the risk of flooding.
Organic material 	• As organic material decomposes it can cause a decline in the oxygen concentration of the water column and contribute to offensive odours. • A decline in oxygen can negatively impact on aquatic fauna, particularly fish.
Pathogens 	• Microbiological contamination, namely bacteria, viruses and other pathogens, pose a significant threat to human health, recreational activity and water supply.
Heavy metals, oils and grease 	• Heavy metals, oils and grease often become bound in sediments and can threaten aquatic ecosystems. • Oil and grease scums impact on visual amenity and recreational values.
Pesticides and surfactants 	• Pesticides and surfactants can negatively impact on instream flora and fauna values. In particular, surfactants are considered a risk to many amphibian and fish species. • Pesticides can pose a significant threat to human health and impact on recreational values. • Excess pesticides and surfactants can significantly increase the cost of water treatment for water supply purposes.
Flow / Erosion 	• Increased discharge and velocity can scour stream beds and banks causing erosion, sedimentation and high turbidity. • Inadequate capacity in the stormwater systems can contribute to flooding. • Poorly constructed pipe outlets can contribute to erosion.

2.2 Specific stormwater threats

An assessment of the specific stormwater threats in the study area is summarised in Table 2-2. These threats are grouped according to landuse and particular catchment activities. Specific examples or locations of threats within the region are identified along with the impact expected on receiving environments. As with values, threats have been assigned a ranking according to their significance ie. Very high, High Moderate, Low. This ranking is based on the potential pollutants or impacts on the values of receiving environments. Where a particular threat is not present it has not been given a ranking.

■ **Table 2-2 Threats to receiving environments from stormwater and rural drainage (na: threat not applicable to that environment).**

	Stormwater & Irrigation Receiving Environment							Irrigation drainage Receiving Environments					
Activity/landuse threat	**Murray River below Lock 11**	**Murray River above Lock 11**	**Kings Billabong**	**Basin !2**	**Rifle Butts Swamp**	**Lake Ranfurly East**	**Lake Hawthorn**	**Psyche Bend Lagoon**	**Cardross Lakes**	**Koolong Basins**	**Lamberts Swamp**	**Lake Ranfurly West**	**Wargan Basins**
Residential runoff	V high	V high	High	High	V high	V high	High	Low	Low	Low	Low	Low	na
Industrial runoff	Mod.	V high	na	Mod.	Mod.	High	Low	na	na	na	na	Na	na
Commercial / institutional runoff	Mod.	V high	na	Mod.	High	V high	Low	na	na	na	na	Na	na
Construction sites – lot	High	High	High	Mod.	High	High	High	na	na	na	Low	Low	na
Development sites	High	High	High	Low	V high	V high	V high	na	na	na	na	Low	na
Major highways, arterial & rural road runoff	High	V high	Mod	High	High	V high	High	na	Low	Low	Low	Low	na
Sullage and septic tank overflows	High	High	V high	High	Mod.	Mod.	High	Low	High	High	High	Low	na
Sewer overflows	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	na
Open spaces, parks and recreational areas	Mod.	High	Mod.	High	High	High	High	Low	Low	Low	Low	Low	na
Upstream inflows	High	High	High	na	na	na	na	na	na	na	na	Na	V high
Irrigation drainage	V high	V high	High	V high	Mod.	V high	V high	High	V high	V high	V high	V high	Mod.
Rural surface runoff	V high	V high	High	V high	Low	High	V high	Mod	V high	V high	V high	V high	High
Unstable & degraded waterways	Mod.	High	High	Mod.	Mod.	Mod.	Mod.	High	Mod.	Low	Low	Mod.	Low

The greatest threats from stormwater and drainage water in the study area are due to:

- Excess nutrients in stormwater runoff from residential and industrial areas entering the Murray River;
- Runoff from roads;
- Septic tank effluent;
- Litter in stormwater runoff from commercial areas;
- Poor sediment control on development and construction sites; and,
- Damage to cultural sites, riverbanks, riparian vegetation and wetland areas through degradation by changed flow, erosion, uncontrolled vehicle access, vandalism and rubbish dumping.

Irrigation drainage and runoff from agricultural lands also pose a significant threat to the values of receiving environments. Agricultural runoff can carry nutrients, sediment, salt and pesticides. In the Mildura area most irrigation drainage and urban stormwater drainage systems are separate, although the receiving environments suffer from the combined impacts of stormwater and irrigation drainage water. Although irrigation drainage has been identified as a threat to values of receiving environments, measures to address irrigation drainage and runoff from other agricultural areas are outside the scope of strategies developed in this plan.