Upper South East Dryland Salinity and Flood Management Program – Catchment Risk Assessment for Water Quality

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FOREWORD

South Australia's unique and precious natural resources are fundamental to the economic and social wellbeing of the State. It is critical that these resources are managed in a sustainable manner to safeguard them both for current users and for future generations.

The Department of Water, Land and Biodiversity Conservation (DWLBC) strives to ensure that our natural resources are managed so that they are available for all users, including the environment.

In order for us to best manage these natural resources it is imperative that we have a sound knowledge of their condition and how they are likely to respond to management changes. DWLBC scientific and technical staff continues to improve this knowledge through undertaking investigations, technical reviews and resource modelling.

Rob Freeman
CHIEF EXECUTIVE
DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

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SUMMARY

The Catchment Risk Assessment for Water Quality was undertaken to give a better understanding of contaminants that could pose a threat to aquatic ecosystem health and to ensure that monitoring programs in the region are set up to target these contaminants.

This report provides an in-depth description of the risk assessment method, outlines the result of the risk assessment and provides recommendations for the future.

The risk assessment was undertaken for the 17 sub-catchments in the Upper South East and Dryland Salinity Project Area. Interviews were held with individual landholders in each of the sub-catchments and information gathered from these interviews was reinforced with water quality data where available.

The USE Catchment Risk Assessment is a component of the program's flow management system. The management program will direct the operation of structures controlling flows through the drainage/flooding network and environmental flows to wetlands and watercourses.

The Risk Assessment was conducted in several stages:

- Hazard Identification
- Risk Analysis and
- Risk Evaluation.

Hazards were combined into seven main risks to water quality:

- Nutrients
- Pesticides
- Organic Matter
- Turbidity
- Salinity
- Heavy Metals and
- Hydrocarbons.

The Risk Analysis consisted of calculating the Likelihood of a hazardous event (i.e. management/infrastructure failure) occurring and the Consequence that the event would have on the Environmental Value (Aquatic Ecosystem). Risks are expressed as Low, Moderate, High and Very High. A certainty level is associated to each of the results to reflect whether the analysis was conducted with detailed knowledge, data or limited knowledge.

Management options and recommendations were then proposed on the results from the Risk Analysis. The two main risk management options recommended are: Monitoring for expression; and Investigation/adaptive management programs. The USE&DS Program is already undertaking monitoring for expression of risk.

1. INTRODUCTION

Water quality management in the Upper South East (USE) is an important issue for the Coorong and wetland ecosystems. A Risk Assessment approach was implemented to identify potential hazards, and in some cases strategies, to mitigate significant risks to water quality within the Upper South East Catchment, as these relate to the USE Dryland Salinity and Flood Management (USEDS&FM) Program.

The USEDS&FM Catchment Risk Assessment will assist in the design of an appropriate monitoring program. It will also inform the timing, duration, and volume of releases to the Coorong. This program has been developed to include key stakeholders with an interest in the catchment area to be involved in the process, as well as to meet requirements for water resource protection consistent with national Water Quality Guidelines.

This Risk Assessment report includes the methods and results of the present study, as well as a discussion of the catchment Risk Assessment process, and offers further conclusions and recommendations.

1.1 BACKGROUND

The Upper South East Dryland Salinity and Flood Management Program (USEDS&FM) was developed in response to increasing salinisation, periodic flood events, and associated widespread and prolonged inundation of land in the USE region. The development of a drainage scheme through the landscape has been identified as a critical component of the integrated management strategies to reduce flooding and release saline groundwater from the landscape, whilst at the same time providing environmental flows to key wetland systems using an adaptive management approach for development and implementation.

As a result, a comprehensive environmental management system is required in addition to drain operation to ensure significant wetlands throughout the USE receive appropriate environmental flows. The southern lagoon of the Coorong is the receiving environment for the largely groundwater baseflow from the USE drainage system, as well as a proportion of surface water yield associated with significant rainfall events.

The USE Catchment Risk Assessment project area is shown in Figure 1. The project area captures the southern lagoon of the Coorong and the Upper South East region.

1.2 PURPOSE

The Catchment Risk Assessment for Water Quality was designed to identify sources of risk to water quality in the Upper South East region. The Risk Assessment process has provided a mechanism to identify and evaluate present and potential risk, define risk treatment options, and develop a monitoring program. The process has been implemented to focus investment and monitoring activities related to water quality pressures.

Ongoing monitoring within the USE will be conducted using an adaptive management approach for the management of regional drainage and environmental flows. The approach was based on an integrated hydrological, water quality, and ecological

monitoring and evaluation approach. A critical component of this monitoring is the development of an understanding of potential pollutants in the USE Catchment and their potential effect on the water quality of aquatic ecosystems.

It should be noted that the present Catchment Risk Assessment report considers only the water quality of aquatic ecosystems, and does not consider other environmental values such as potable water or agricultural production.

1.3 AIM AND OBJECTIVES

The aim of the project was to determine the level of risk to water quality in aquatic ecosystems of the USE Catchment and to identify potential measures to minimise the risk of impacts to aquatic ecosystems, in particular:

- To identify the nature and location of hazards within the USE Catchment that are a potential risk to the aquatic ecosystems
- To develop a qualitative understanding of catchment hazards using a Risk Assessment approach, supported by water quality and GIS (Geographic Information Systems) data including land use information
- Identify potential risk mitigation solutions including investigations, on-ground works, education, and monitoring.

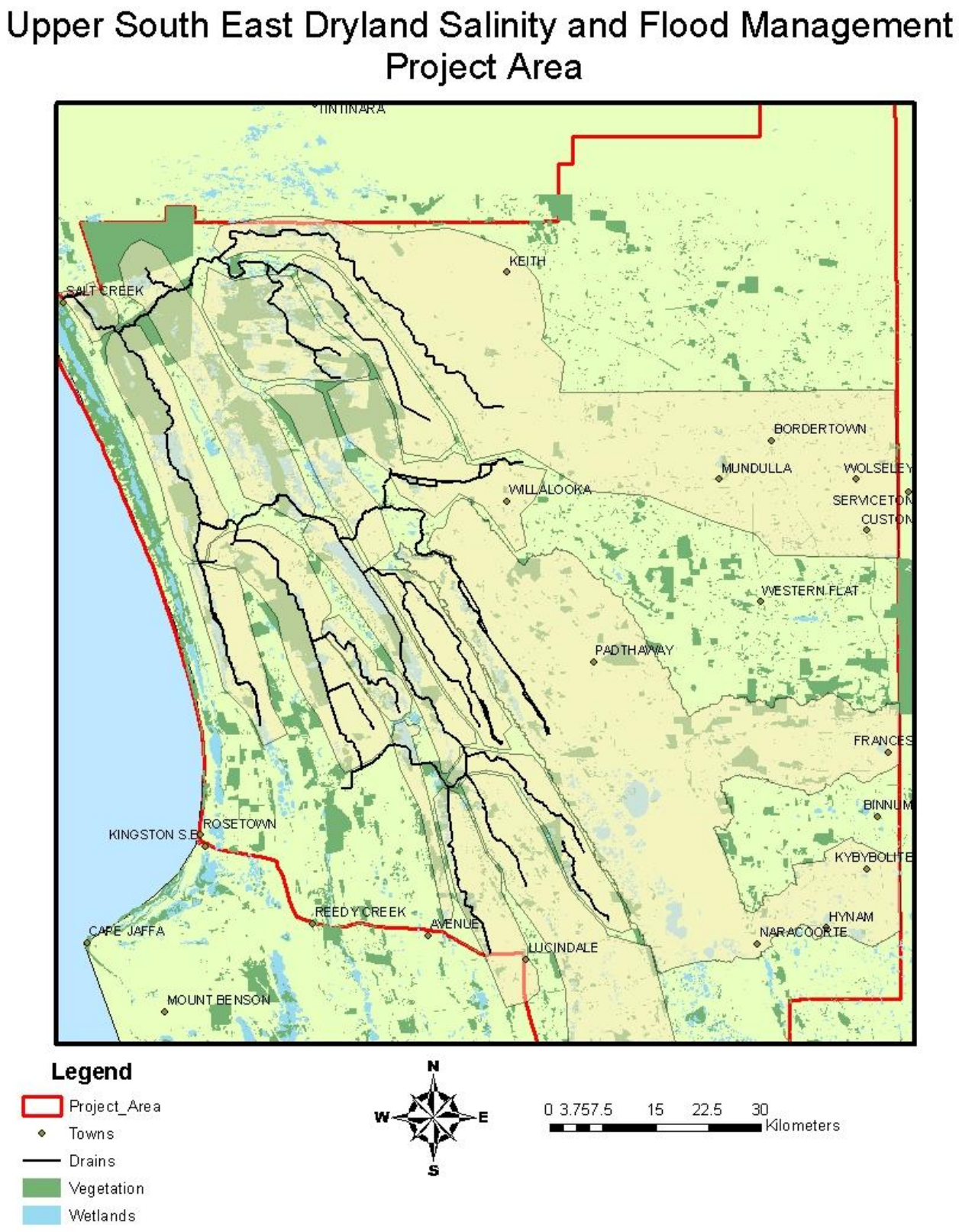


Figure 1. Upper South East Dryland Salinity and Flood Management Project area

2. RISK ASSESSMENT METHOD

2.1 INTRODUCTION

The USE Catchment Risk Assessment was developed and implemented in order to ascertain the potential hazards or threats, termed 'risks', to water quality and local wetlands (such as pollutants, land uses, flow). An assessment of possible risk management options subsequently identified related effects and possible mitigation strategies where necessary.

The aims of the risk management phase of this project are to:

- Provide a transparent framework for the identification and assessment of potential risks to water quality in the catchment
- Involve stakeholders in the review process and implementation
- Develop a program to monitor potential water quality risks
- Identify agreed environmental values (EVs) and water quality guideline objectives at specific management control points throughout the drainage/wetlands network
- Find solutions to identified risks including investigation, on-ground action, and monitoring and investment requirements.

In the context of water quality, a risk is the chance that a hazardous event will occur which will have a consequent negative impact on the asset (or environmental value or EV), or more specifically, on the water quality objective. Risks can exist due to an event, action or lack of action, and the consequences can range from negligible to catastrophic (Standards Australia 2000).

The Catchment Risk Assessment framework (illustrated in Figure 2) has seven major components described below.

- Establishing the context –
    - Define the strategic, organisational, legislative and management context including the structure of the risk analysis and the criteria against which risks are assessed
    - Define stakeholders and their involvement as well as the communication and consultation strategies for the risk management process
    - Describe the intended management use of the catchment water.
- Know the catchment –
    - Describe the catchment, construct a schematic diagram, map the hydrological sub-catchments and develop a conceptual model
    - Define the environmental values (EVs), corresponding management goals and associated pressures
    - Define the Water Quality Guideline objectives
    - Screen the existing water quality data by comparing against interim Water Quality Guideline objectives to identify potential hazards.

- Hazard identification – Identify hazards and hazardous events that require management ; what, where and why they occur including the identification and potential impact of current control measures.
- Risk analysis – Risks are analysed in terms of likelihood and consequence of a contamination of water quality or effect on the EV.
- Risk evaluation – Comparing the estimated level of risk with the pre-determined criteria and deciding the significance of the risk to water quality.
- Treatment/mitigation of risks – Develop and implement a management plan for the risks to water quality.
- Monitoring and Review – Monitor and review the risks, the performance of the risk management system and any changes that may affect it.

Consultation with internal and external stakeholders as appropriate through each step of the risk management process was also identified as an essential aspect of the framework.

The framework used was adapted from the draft *Torrens Catchment Risk Assessment For Drinking Water Supply* (Billington et al. 2005) by SA Water, and the *River Murray and Lower Lakes Catchment Risk Assessment Project for Water Quality* (Bradley and Billington 2005; EPA 2006). The latter was developed by the River Murray Catchment Water Management Board (RMCWMB), SA Water and the Environment Protection Authority (EPA) as a cross-government approach to managing water quality impacts.

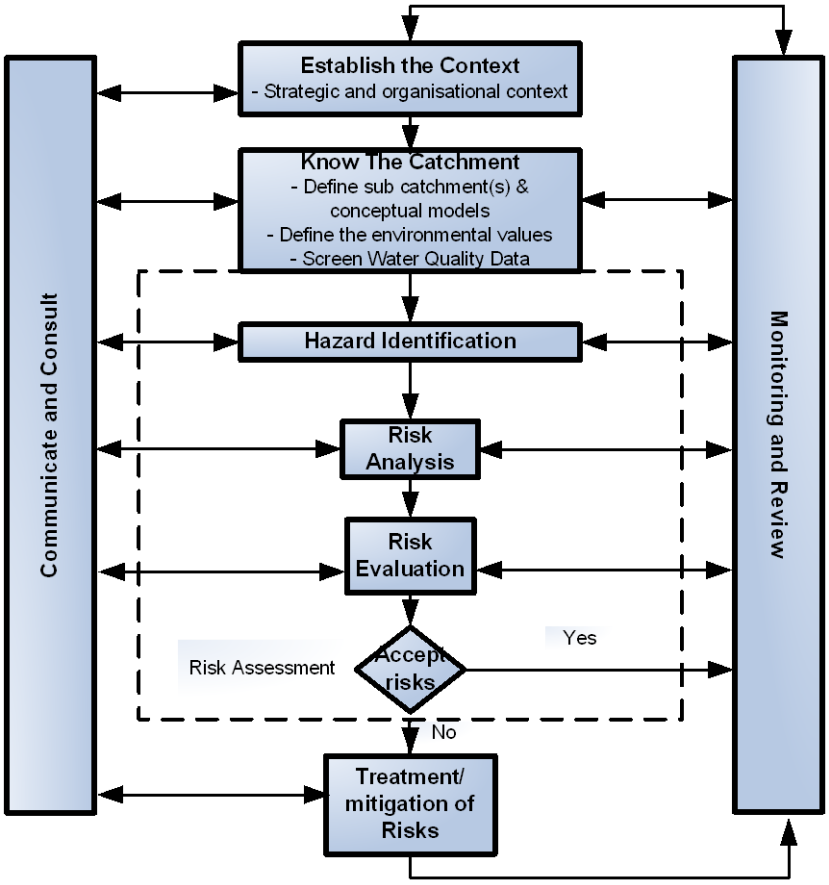


Figure 2. USE Risk Assessment framework

2.2 CONSULTATION AND COMMUNICATION

Consultation and communication was critical to the success of the Risk Assessment process at all stages (refer to Figure 2).

The consultation process throughout the Risk Assessment project included a variety of people with different expertise and knowledge of the catchment. State and regional government agency staff provided specialised technical knowledge and access to relevant data. Local community members and landholders provided critical land use information and knowledge of local hazards. Scientists and experts provided specialised knowledge, literature, and peer review of the results.

A project team who facilitated consultation and completed identifying, assessing and researching water quality risks in the USE region was formed of staff in the Department of Water, Land and Biodiversity Conservation (DWLBC). This team is referred to as the 'risk assessors' and were responsible for implementing the entire process and the final reporting.

A communication strategy was developed for the Risk Assessment with the objectives of:

- Documenting water quality information from the scientific and landholder community and government agencies on the location and nature of risks in the USE.
- Raising the awareness of water quality hazards in the USE Catchment and developing prevention/mitigation options.
- Targeting specific groups to develop an understanding of:
    - Risks to water quality in general, and within sub-catchments
    - Options to mitigate risks
    - Responsibilities and obligations for risk management
    - The benefits and objectives of risk management.

The communication and consultation strategy identified target groups to receive key messages. These target groups were divided into primary and secondary groups.

2.2.1 PRIMARY TARGET GROUP

The primary target group were those people who could assist in the identification or assessment of risk information and/or influence the secondary group (EPA 2006).

- State and Local Government: DWLBC, South East Natural Resources Management Board (SENRMB), EPA, Department for Environment and Heritage (DEH), South East Water Conservation and Drainage Board (SEWCDB) and local councils (Kingston SE, Naracoorte, Lucindale, Keith)
- Landholders: farmers (including irrigators, graziers, viticulturalists, foresters)
- Specific USE program groups/committees: USE Program Board; Environmental Management Advisory Group (EMAG), funding partners.

2.2.2 SECONDARY TARGET GROUP

The secondary target group were those people and/or organisations whose awareness in water quality issues could be increased.

- Community: general public, farmers
- Government: Government agency staff, council staff, Natural Resources Management (NRM) Board staff
- Ministers: Minister for Environment and Conservation.

2.2.3 KEY COMMUNICATION MESSAGES

The key communication messages for the project included:

- Government working with community to identify risks and target investment in the USE region
- Shared responsibility for hazards to water quality
- Industry, towns, farming and households effect water quality.

2.2.4 KEY COMMUNICATION TOOLS

Communication tools used for key target groups included:

- USE Newsletter
- Presentations to local community, government and stakeholder groups including EMAG and Program Board.

2.3 ESTABLISHING CONTEXT

2.3.1 STRATETIC AND OPERATIONAL CONTEXT

The USEDS&FM Program was established as a result of community concerns about salinity, flooding, and ecosystem fragmentation and degradation. Program activities including drainage, salt-land agronomy and wetland restoration were developed to address these concerns in an integrated manner. A specific legislative and policy framework provided the context within which activities for the USE Program were undertaken. The USE Program's risk management process was implemented to focus investment and monitoring related to water quality pressures.

The USE Catchment Risk Assessment is a component of the Program's flow management system. This system predominately involves the management of water resources within the catchment to maximise benefits to agricultural production and aquatic ecosystems. The risk management process will aim to identify and characterise potential hazards in the catchment, which may impact the aquatic ecosystems. The management program will direct the operation of structures controlling flows through the drainage/flooding network and environmental flows to wetlands and watercourses.

The legislation influencing this function includes the Upper South East Dryland Salinity and Flood Management Act 2002, Water Resources Act 1997, Natural Resource

Management Act 2004, South Eastern Water Conservation and Drainage Act 1992, and the Environment Protection (Water Quality) Policy 2003 (refer to Appendix 1 for the legislative framework relevant to this project).

2.3.1 ASSEMBLING A TEAM

A list of appropriately skilled people from within DWLBC, the USE Program and from the USE region was developed for specific stages of the Risk Assessment process. The knowledge and experience of the individuals identified was a key to the successful ranking of risks and the credibility of this report. This group included the key stakeholder representatives in the communication/consultation plan who provided input into the identification of hazards and hazardous events, and the determination of consequence on the environmental values when determining risk. Input from these individuals was achieved through one-on-one meetings.

2.3.2 INTENDED USE OF CATCHMENT WATER

The 'intended use' of the catchment water in this context relates to its delivery into a number of wetland receiving environments varying from fresh to saline in nature, and as such the risk considerations of this assessment focused on aquatic ecosystem values.

2.3.3 DEFININGTHE CATCHMENT AND SUB-CATCHMENTS

The geographic scope of the Risk Assessment was defined as the USE Project area (refer to Figure 1), however this was limited in the northwest to the end point of the Morella Basin regulator. Salt Creek and the Coorong are therefore not included in this Risk Assessment.

The study area was divided into 18 sub-catchments defined by topography, drains and regulation points in the system. The sub-catchments are generally connected and drain towards Morella Basin, the end point of the system

2.3.4 CONSTRUCTING A SCHEMATIC DIAGRAM

A schematic diagram has been developed for the USE Program to identify drains, wetland storages, flow regulation and decision points in the system. The schematic provides a visualisation of where the controlled and uncontrolled water movement occurs in the system. Each decision point has a 'purpose and function statement'; which documents the hydrological connectivity of the system. The 'purpose and function statements' will provide a useful tool when assessing the transport mechanisms and fate of contaminants in the future. This schematic can be produced on request from the SEWCDB.

2.3.5 CONCEPTUAL MODEL(S)

A conceptual model of the USE was developed to show the relationship between the land uses, wetlands, and water quality in the region (refer to Figures 3 through 5).

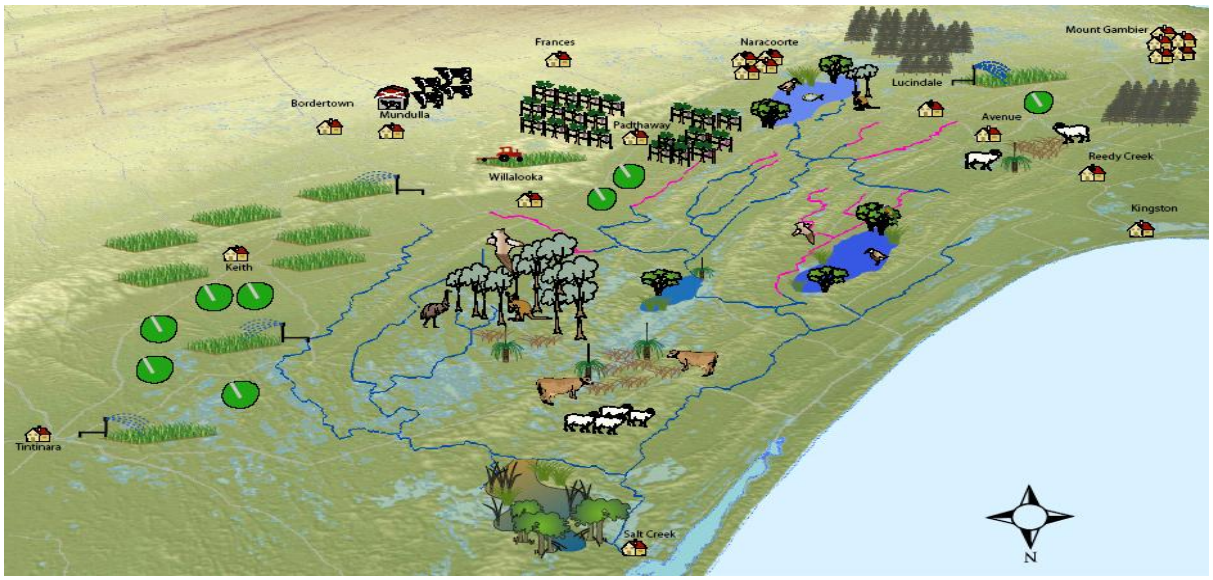


Figure 3. Conceptual model of the land uses, wetlands and water quality in the USE

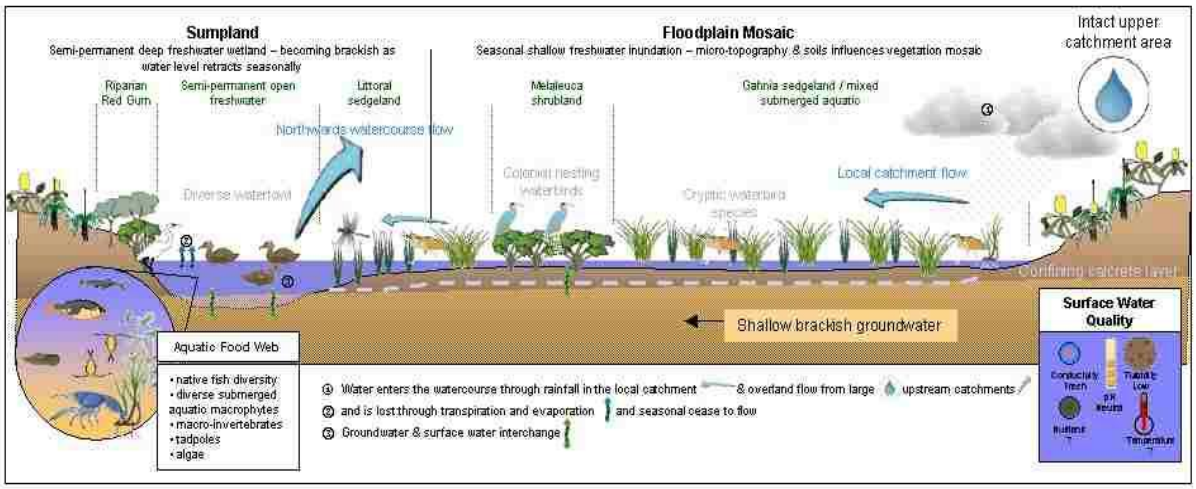


Figure 4. Conceptual model of natural/historical watercourse

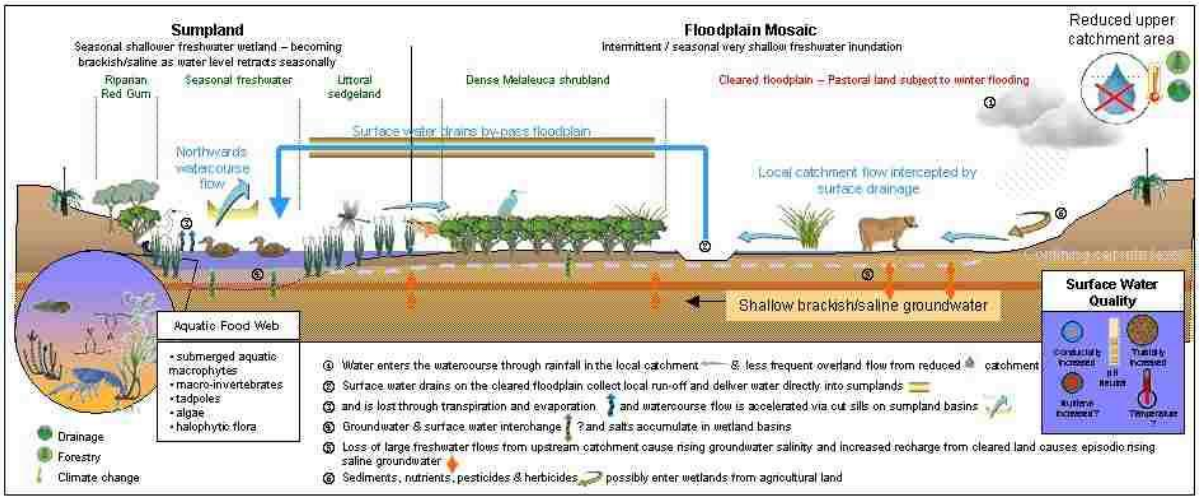


Figure 5. Conceptual model of managed watercourse

2.3.2 ENVIRONMENTAL VALUES, MANAGEMENT GOALS AND WATER QUALITY OBJECTIVES

USE Catchment environmental values (EVs) are based upon the delivery of water to wetland receiving environments. The management requirements and intended use of the water resources is for aquatic ecosystems. The determination of water quality objectives for aquatic ecosystems including wetlands was defined within each of the sub-catchments and used the method outlined in the National Water Quality Management Strategy (NWQMS).

Environmental values are not a measurable indicator in isolation. This process specifically links the EVs, management goals, and causal pressures. Indicators can then be developed for the causal pressures. The matricies in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped intro like catchments (in terms of wetland character and water quality management goals).

The first column of the matrix groups sub-catchments with similar management goals. This resulted in the 18 sub-catchments being reduced to eight groups. All wetlands in the USE region are considered slightly to moderately disturbed systems, and therefore the level of species protection was set at 95% (ANZECC 2000). The management goals for individual wetlands within each sub-catchment were difficult to define as there are hundreds of wetlands (with sub-components) in the region. Therefore, the highest value wetland systems were identified and the management goals defined broadly or specifically as necessary. The high value ranking system was developed by Harding (2006a) for prioritising activities in the Upper South East region.

The water quality objectives were drawn from the Water Quality Guidelines developed by the Australia and New Zealand Environment Conservation Council (ANZECC 2000), and Environmental Protection Policies (EPA 2003) as applicable. This enabled the qualitative management goals to be translated into quantitative water quality objectives, which were then used in the screening Risk Assessment.

2.3.3 SCREENING WATER QUALITY DATA

A screening risk analysis was conducted using existing water quality data derived from the Water Quality Monitoring Program (Everingham 2007) to identify actual pollutants within the sub-catchments. This provided a further understanding of contaminants in the catchment (where data existed) to flag hazards for the Risk Assessment. The screening risk analysis was conducted before commencing the Risk Assessment and utilised monitoring data collected between June 1999 and December 2006 at 18 sites along the USE drainage network and one site in Morella Basin (Martins Washpool Conservation Park), the end point of the USE drainage system. The extent of data for each of these 18 sites is variable due to the differing drain construction dates. Of the 18 sites, nine sites are still currently monitored.

The screening risk analysis involved comparing the available water quality data to the water quality objectives (see section 2.3.2) to identify historical exceedences. The screening process flagged the potential pollutants in the sub-catchments. Water quality data was available for only nine of the sub-catchments, the rest were based on landholder and local community consultation (refer to Table 1).

Table 1. Data sources for study sites

Sub-catchment	Data source
Martin's Washpool	monitoring, limited local consultation
Tilley Swamp	monitoring, limited local consultation
Taratap	landholder consultation only
Watervalley Wetlands	monitoring, limited local consultation
West Avenue	landholder consultation
Winpinmerit	limited local consultation
Keilira	limited local consultation
East Avenue	landholder consultation
Bakers Range	landholder consultation
Fairview	landholder consultation
Marcollat	extensive landholder and local government consultation
Wongawilli	monitoring, landholder consultation
Gum Lagoon	monitoring, limited local consultation
Rosemary Downs	limited local consultation
Mt Charles	monitoring, landholder consultation
Bunbury	limited monitoring data, landholder consultation
Taunta Hut	limited monitoring data, landholder consultation
Watervalley	limited monitoring data, limited local consultation

2.4 HAZARD IDENTIFICATION

Hazards are a source of 'potential harm' that can cause loss or adverse impact to an environmental value (adapted from Standards Australia 1999, 2004). The hazard identification process described the hazard, including its source and surrounding environment, but impacts of the hazard were not considered at this stage of the project. Hazard identification for the Catchment Risk Assessment was determined from land use and land management activities in relation to high value wetlands in the system. For example, pesticide application may present a hazard in relation to a local high value wetland ecosystem and/or the end point of the system, Morella Basin.

Potential hazards to the identified EVs in the USE Catchment were identified by examining available water quality data (where possible) and by consulting with local landholders and local government. For a detailed description of hazards identified in the Catchment Risk Assessment for the USE refer to Table 2.

Table 2. Hazards identified in the Catchment Risk Assessment for the USE Catchment

HAZARD	DESCRIPTION
Construction works	Construction of infrastructure such as drains
Contaminated sites – Historical	Sites which have been contaminated with heavy metals and hydrocarbons in the past, may or may not have been rehabilitated
Contaminated sites – Present	Sites that are currently contaminated with heavy metals and hydrocarbons

Dead animal pad	An area, possibly a hole, used to place dead animals in; generally used for stock that has died during transport; generally clay lined
Deep ripping	A farming practice where the soil is dug past the normal cultivation layer to break soil compaction and improve drainage
Dredging waterways	Clearing silt, debris from waterways including drains
Effluent ponds – Abattoir	A pond for the storage of liquid waste
Effluent ponds – Dairy	A pond for the storage of liquid waste
Effluent ponds – Feedlot	A pond for the storage of liquid waste
Effluent ponds – Industrial	A pond for the storage of liquid waste
Effluent ponds – Sewage	A pond for the storage of liquid waste
Effluent ponds – Stockyards	A pond for the storage of liquid waste
Effluent ponds – Stormwater	A pond for the storage of liquid waste
Fertiliser application	The application of fertilisers via any process
Fuel storage	An area and/or container used for fuel storage
Landfills	An area of land used to house waste; either private or public
Limestone/clay spreading	The spreading of clay or limestone to stabilise, improve drainage, and reduce the acidity of soil
Management/infrastructure failure	A failure of infrastructure such as drains collapsing or becoming blocked; and/or human failure such as a bad or uninformed decision-making; and/or spillage/accidents with pesticides etc.
Pesticide application	The application of pesticides via any process
Removal of native vegetation	The removal of native vegetation
Salinity	An increase in the amount of salts in water and/or soil
Septic tank overflow	The overflow or leakage of unsealed underground sewage-disposal tanks
Stock grazing near watercourses	Stock grazing in or around watercourses including drains
Stormwater infrastructure	Infrastructure used to divert stormwater away from townships, such as gutters and drains
Transport route	The route along which fuel, stock and waste is transported; includes potential fuel/oil runoff from roads in general
Wash down bays	An area where stock trucks containing faecal material are washed out;also refers to an area where small aircraft, potentially carrying pesticides, are washed out
Waste transfer station	A location where waste such as household waste is transferred from truck to truck, and possibly held for a short time, for transport to another location

Any potential hazard actually requires an event or process to create a risk exposure (Billington 2005). It is therefore critical to define the hazard as well as the potential exposure process/event in order to determine the context for assessing likelihood and consequence. A description of hazardous events identified in the USE Catchment Risk Assessment is provided in Table 3.

Table 3. Hazardous events identified in the USE Catchment Risk Assessment

HAZARD EVENT	DESCRIPTION
Discharge (general discharge)	The process of water moving through the soil and discharging into groundwater and/or drains, wetlands and waterways
Event discharge (during rainfall events)	The process of water moving through the soil and discharging into groundwater and/or drains, wetlands and waterways during rainfall
Event drift	The process of sprayed chemicals such as pesticides being caught by the wind and drifting into wetlands, waterways and other properties etc.
Leakage (subsurface into watertable or aquatic environment)	The process of elements such as pesticides and nutrients moving through the soil into groundwater and/or drains, wetlands and waterways.
Management/infrastructure failure	The failure of infrastructure such as drains collapsing or becoming blocked, and/or human failure such as a bad decision or spillage/accidents with pesticides etc
Salinity	A process in which the amount of salts in water and/or soil increases
Sediment disturbance	The process of sediment becoming disturbed such as construction works and stock grazing in the drainage system etc.
Stock excretion discharge	The process of stock excretions moving into wetlands, drains and waterways etc

2.5 RISK ANALYSIS

Risk analysis determined the likelihood or probability of the hazard occurring and determined the consequence of that impact on the EVs. A combination of the likelihood and the consequence (L x C) provides an index of the level of risk. This enables major risks to be distinguished from minor risks.

The risk analysis defined the likelihood of a land use related hazardous event having an impact on high value wetlands in the system, and then defined the consequence of such an event as a combined risk index.

Appendix 3 includes the proposed likelihood, consequence, risk, and certainty level matrices (adapted from Standards Australia 1999;2004). These matrices have been taken directly from the *River Murray and Lower Lake Catchment Risk Assessment Project for Water Quality* (Billington 2005, EPA 2006), which is consistent with the leading approaches currently evolving at the national level.

The River Murray and Lower Lakes Catchment Risk Assessment Project (Billington 2005, EPA 2006 incorporates a ‘certainty level’ matrix which defines the confidence level of information/data used in determining the risk index. For example, subjective judgements made without supporting data are ranked 1, while data that is available and readily agreed on by experts is ranked 5. The certainty level matrix is presented below in Table 4.

Table 4. Certainty level matrix used for information/data in the USE Risk Assessment (source: Billington 2005, EPA 2006)

Level of Confidence or Certainty	Description
1	Perception only, no information or knowledge forms the basis of the opinion
2	Perception based, some information on process but not directly relevant to region, or information at a regional level has significant limitations
3	Limited information is known, expert knowledge would lead to this outcome – may be some differences in opinion
4	Information known; process has been described and documented at a regional level, experts can verify this position
5	Information is known and well represents the specific nature of the process; described and documented at a regional level and experts would agree on this position

The catchment risk analysis for the USE used quantitative and qualitative information in the assessments. The use of qualitative and quantitative methods differed with each sub-catchment as the available data varied significantly. Initially, the qualitative Risk Assessment was conducted and the hazards identified were verified using water quality data (where available). This strengthened the understanding of whether a perceived hazard would result in an impact to water quality.

2.6 RISK EVALUATION

Risk evaluation is the process of determining whether or not to accept a risk or whether a treatment/mitigation strategy is required. Through this process the managers and stakeholders will be in a position to determine levels of acceptable or unacceptable risk, based on the recommendations of relevant specialists and key stakeholders.

2.7 RISK TREATMENT/MITIGATION

Risk treatment or mitigation refers to the selection and implementation of appropriate options for dealing with identified risks (Standards Australia 1999; 2004). This can include avoiding or reducing risks, reducing the likelihood or consequence of occurrence, as well as transferring or retaining the risk. The treatment of risks includes developing and implementing a management plan, a monitoring program, and incident response protocols for breaches to accepted thresholds. The decision-making process for mitigating risks requires the Risk Assessment information to be considered in parallel with social and economic information.

3. RESULTS AND DISCUSSION

3.1 UPPER SOUTH EAST CATCHMENT

This section summarises the survey and data results obtained for the entire USE Catchment during this study.

3.1.1 LAND USE

The dominant land use in the USE Catchment is 'grazing modified pastures'. This land use is implemented across 65% of the total catchment area. Other dominant land uses included 'cropping', 'nature conservation', 'grazing native vegetation', 'irrigated cropping', and 'plantation forestry' (Figure 6).

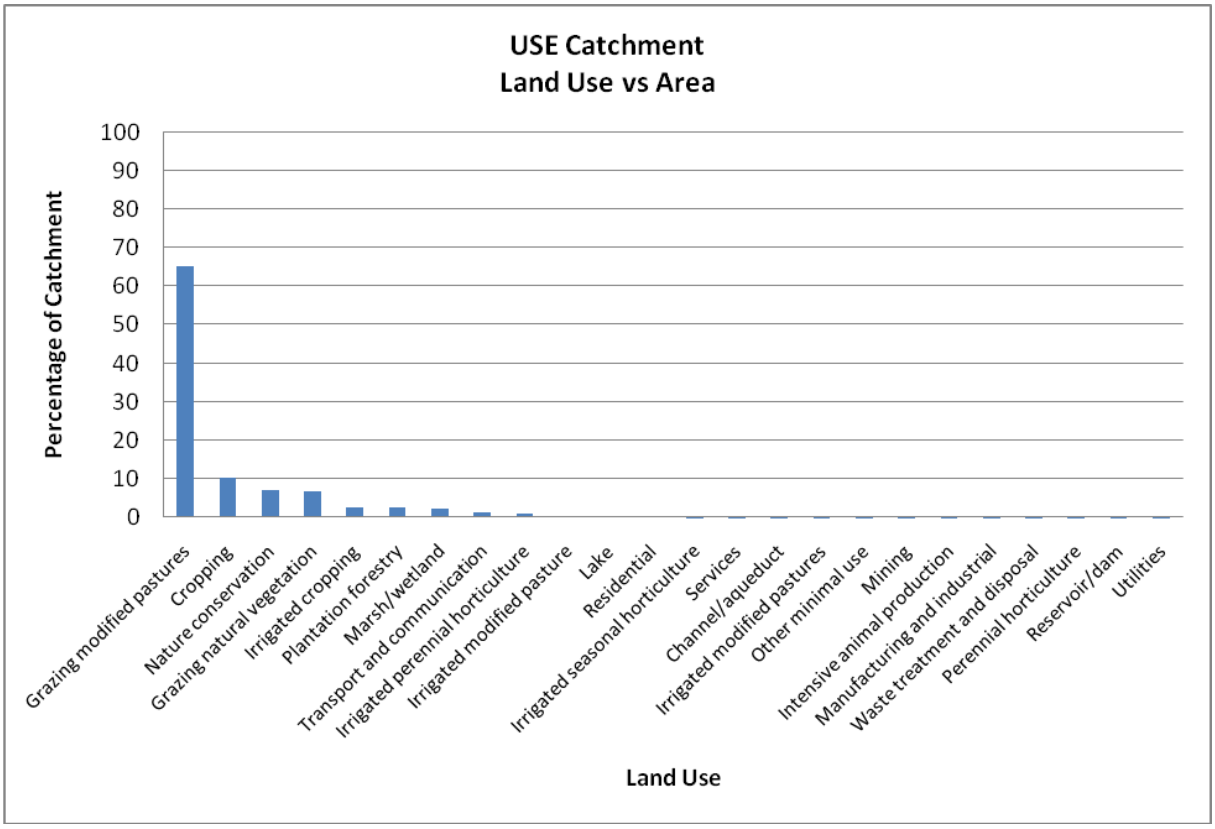


Figure 6. Land uses versus area in the USE Catchment

3.1.2 ENVIRONMENTAL VALUES

The environmental values (EVs) of aquatic ecosystemes considered in this assessment, their management goals, and associated pressures are described in Appendix 2.

3.1.3 HAZARD IDENTIFICATION PROCESS

The hazard identification process was based on water quality data (where available) and consultation with landholders, local government, and representatives from DWLBC and EPA in individual interviews. The process identified the nature and location of potential hazards to water quality.

3.1.4 RISK TO WATER QUALITY

A total of 27 hazards and 14 land uses were identified in the Upper South East Catchment. Eight hazard events were also described. These hazards posed 926 risks of varied intensity ('low', 'moderate' or 'high') to water quality. No 'very high' risks were identified in the Upper South East Catchment.

Table 5. Risk matrix used in the USE Catchment Risk Assessment
(adapted from Standards Australia 1999; 2004, EPA 2006)

Likelihood	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
5 (almost certain)	Low	Moderate	High	Very high	Very high
4 (likely)	Low	Moderate	High	Very high	Very high
3 (possible)	Low	Moderate	High	Very high	Very high
2 (unlikely)	Low	Low	Moderate	High	Very high
1 (rare)	Low	Low	Moderate	High	High

The level of risk that a hazard demonstrates (even in the same sub-catchment) can be largely determined by land use. For example, the hazard 'stock grazing near watercourses' had a higher nutrient risk level in the land use 'channel/aqueduct' than in 'grazing natural vegetation' because the likelihood of excrement discharging into the watertable was much higher due to the proximity of the stock to an open water source.

This section describes risk in the context of the entire USE Catchment. It outlines the broad scale (multiple sub-catchment) 'low' level and some 'moderate' level risks, with the more pertinent and unusual risks identified under each sub-catchment.

The percentage of 'high', 'moderate' and 'low' risk in the Upper South East Catchment is presented in Table 6 showing risk categories (or parameter types). These risk categories are described in more detail in the following sections. Parameter types are discussed below.

Table 6. Frequency of identified risk to water quality in the USE Catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	116	113	64	38	3	193	10	19	**556**	**57**
Moderate (2)	97	67	20	7	5	119	1	43	**359**	**37**
High (3)	6	2	0	17	0	14	0	18	**57**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**219**	**182**	**84**	**62**	**8**	**326**	**11**	**80**	972	
Percentage	**23**	**19**	**9**	**6**	**1**	**34**	**1**	**8**	**100**	

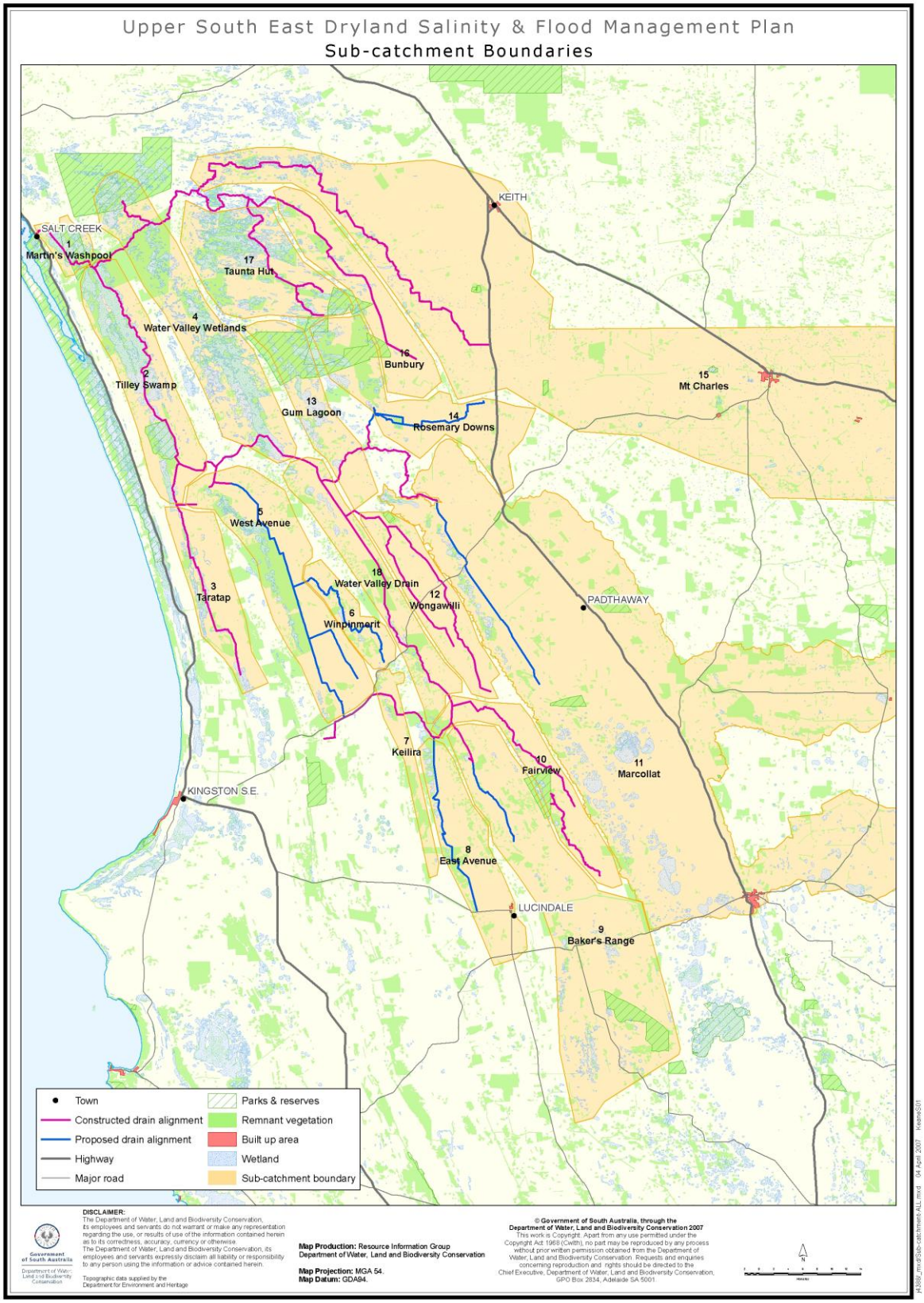


Figure 7. Map of the USE Catchment and sub-catchment areas

3.1.5 NUTRIENTS

In 14 of the 18 sub-catchment—East Avenue, Bakers Range, Marcollat and Mount Charles being the exceptions—the nutrient risk (both nitrogen [N] and phosphorous [P]) was classified as 'low' and 'moderate'.

The 'low' risks were attributed to three main hazards: 'effluent ponds' (all types), 'fertiliser application' and 'stock grazing near watercourses'.

'Fertiliser application' and 'stock grazing near watercourses' were the main hazards responsible for 'moderate' level risk.

'High' level nutrient risks were identified in East Avenue, Bakers Range, Marcollat, and Mount Charles sub-catchments. These are discussed individually in 3.9.4, 3.10.4, 3.12.4, and 3.16.4, respectively. 'Irrigated cropping' was the land use associated with 'high' level risk in all these sub-catchments, and 'waste treatment and disposal' was associated in the latter two catchments.

3.1.5.1 ORGANIC MATTER

In the Upper South East Catchment all sub-catchments with the exception of Morella Basin had at least one organic matter risk. This risk was common and classified as 'high' in every sub-catchment where it presented. This risk was attributed to the hazard 'stock grazing near watercourses' and was common to all sub-catchments as it is a hazard relating to the drainage system.

This common 'high' risk was the only organic matter risk for 15 out of the 18 sub-catchments. Morella Basin was the exception, as it is a protected area and stock is strictly excluded from the area – this was verified using available water quality data. The sub-catchments of Marcollat and Mount Charles had a significant number of organic matter risks which are described in sections 3.12.4.2 and 3.16.4.2 respectively.

3.1.5.2 SALINITY

Salinity is a major environmental concern in the USE Catchment. The USE was formed under an oceanic environment creating inherently salty soils. The same process produced a flat landscape that was subject to relatively high rainfall providing frequently wet conditions. Salinity was a natural phenomenon that was kept concealed by deep-rooted perennial native vegetation in some form of hydrological balance. The historical removal of native vegetation cover and the planting of shallow rooted species allowed for the mobilisation of salts under wet conditions. After flooding, salts expressed in the root zone of agricultural land and leached through the soil profile to watertables. Saline conditions are present in every sub-catchment in the USE.

Highly saline conditions present problems to agriculture and to the natural environment. However, it is important to note that this report describes salinity risk in reference to aquatic ecosystems and not agricultural production. Salt can enter aquatic ecosystems in the USE Catchment in several ways: saline water can enter wetlands through the drainage system; salt can be leached from the soil profiles within a wetland; salt can express at the surface via direct groundwater discharge; or it can enter wetlands through interflow.

Interflow is the flow of water below the surface, but above the watertable and is also responsible for salt entering otherwise fresh surface water drains. During high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

In areas of the catchment where water is specifically harvested for use in wetlands (such as Tilley Swamp and Taratap) salinity becomes a bigger issue. In low to medium flow years salts can sit in the system and become harmful to the aquatic ecosystems. In medium to high flow years, the salts are continuously flushed and diluted, decreasing the risk of saline waters entering the aquatic ecosystems. Following several years of low-flow, two to three years of above average flow may be needed before these salts are flushed from the system.

'Management/infrastructure failure' is a major cause for salinity risk in the USE Catchment. Many older drains (pre-2000) mix salty groundwater with fresh surface water that results in water quality that is not suitable for aquatic environments.

Many 'management/infrastructure failures' are manageable. Regulators can be closed and water can be directed elsewhere, however as mentioned before, this may mean that in low rainfall/low-flow conditions wetlands may not see water for several years.

Irrigation may also cause an increase in salinity due to over-irrigating, or by irrigating with saline water. Unused water can cause the watertable to rise, which may bring salts to the surface. Some irrigation methods such as flood irrigation can cause an increase in salinity, as the method can incur high evaporative losses of water leaving salts on the soil surface.

3.1.5.3 TURBIDITY

All turbidity risk in the USE Catchment was classed in the 'low' and 'moderate' categories. Turbidity refers to the cloudiness or haziness of water, caused by individual particles that are too small to be seen with magnification. Turbidity risk attributed to nine percent of total risk in the USE Catchment. 'Construction works' and maintenance of the drainage system was the hazard responsible for the majority of turbidity risk, and this included 'removal of native vegetation' and 'dredging of waterways'. Risks in the 'moderate' category were almost all accounted to 'stock grazing near watercourses'. These risks were common to the entire USE Catchment.

3.1.5.4 HEAVY METALS AND HYDROCARBONS

Heavy metal risk and hydrocarbon risk combined account for only two percent of the entire risk for the USE Catchment. No risk at all was identified in 16 out of the 18 sub-catchments, with sub-catchments Marcollat and Mount Charles exhibiting a significant number of risks.

Heavy metal and hydrocarbon risks in Marcollat sub-catchment are discussed in sections 3.12.4.4 and 3.12.4.5 respectively. Mount Charles sub-catchment risks in these categories are discussed in sections 3.16.4.4 and 3.16.4.5 respectively.

3.1.5.5 PESTICIDE APPLICATION

'Pesticide application' is the highest contributor to total risk in the USE Catchment, at 34%. Many sub-catchments have 'high' level pesticide risks and all have 'low' and 'moderate' risks. All but two risks identified were attributed to 'pesticide application', these were 'stormwater infrastructure' and 'contaminated sites' in sub-catchments Marcollat and Mount Charles respectively (described in more detail in sections 3.12.4.6 and 3.16.4.6 respectively).

Risks in the 'low' category accounted for 59% of the 'pesticide application' risk. There were four hazard events responsible for this risk: 'event discharge (during rainfall events)'; 'event drift'; 'leakage (subsurface into watertable or aquatic environment)'; and 'management/infrastructure failure'.

'Event discharge' and 'leakage (subsurface into watertable or aquatic environment)' also presented as 'moderate' risks in the land uses 'cropping' and 'irrigated cropping'. This is because pesticide application is likely to occur in high rainfall months and more frequently in these land uses than others such as 'grazing natural vegetation' and 'nature conservation'.

'Event drift' is also classed as a 'moderate' risk in all sub-catchments with the land use 'grazing modified pastures'. This is because pesticide in this land use is generally applied consistently (i.e. every year) and is applied via spraying. Therefore, the likelihood of pesticide reaching the watercourse and/or EV is higher than if a pesticide was applied on an as-needed basis.

'Event drift' was also identified as a 'high' risk in many sub-catchments (this will be discussed in more detail in their individual sections).

'Management/infrastructure failure' was classed as a 'moderate' pesticide risk in all sub-catchments. This is because if a 'management/infrastructure failure' (such as an accidental spillage) were to occur it would have a high impact on the environmental value due to the high quantity of pesticide that would be released into the soil and water resources. This hazard risk was classed as 'low' in land uses such as 'irrigated perennial horticulture' and 'services', as vineyards have very strict operating procedures and such failure is less likely to occur; in regards to 'services' (such as roadside spraying for weeds), the quantity (and potency) of pesticide used is very low and as such, the consequence of the impact on the EV is also low.

3.2 MORELLA BASIN (MARTINS WASHPOOL) SUB-CATCHMENT 1

3.2.1 DESCRIPTION OF THE AREA

The Martins Washpool Conservation Park or Morella Basin sub-catchment is the terminal wetland in the Upper South East Program area. Morella Basin was a partially grazed property until 2005 before it was declared a Nature Conservation Park and extensively revegetated. It now functions as an important refuge for aquatic birds.

As well as a refuge, Morella Basin is used as a water storage facility. Water is stored in Morella Basin until November/December/January each year when it is released into the

Coorong, except under extreme drought conditions. This release of water from Morella Basin provides relief for the biota of the Coorong from hyper-saline conditions, ensures capacity is available in Morella Basin for spring/winter flows, and reduces the potential of flooding summer migratory bird water habitat in the southern lagoon of the Coorong.

The Morella Basin is connected (either primarily or secondarily) to all other sub-catchments in the USE via the drainage system. This places the sub-catchment into a vulnerable position, as hazards that may not pose a 'high' risk further up the catchment may be compounded as they reach Morella Basin.

For the purposes of Risk Assessment, two land uses—'nature conservation' and 'grazing modified pastures'—dominate the Morella Basin sub-catchment, and these land uses combined make up 95% of the total area. Figure 8 shows a breakdown of the land uses in the Morella Basin sub-Catchment.

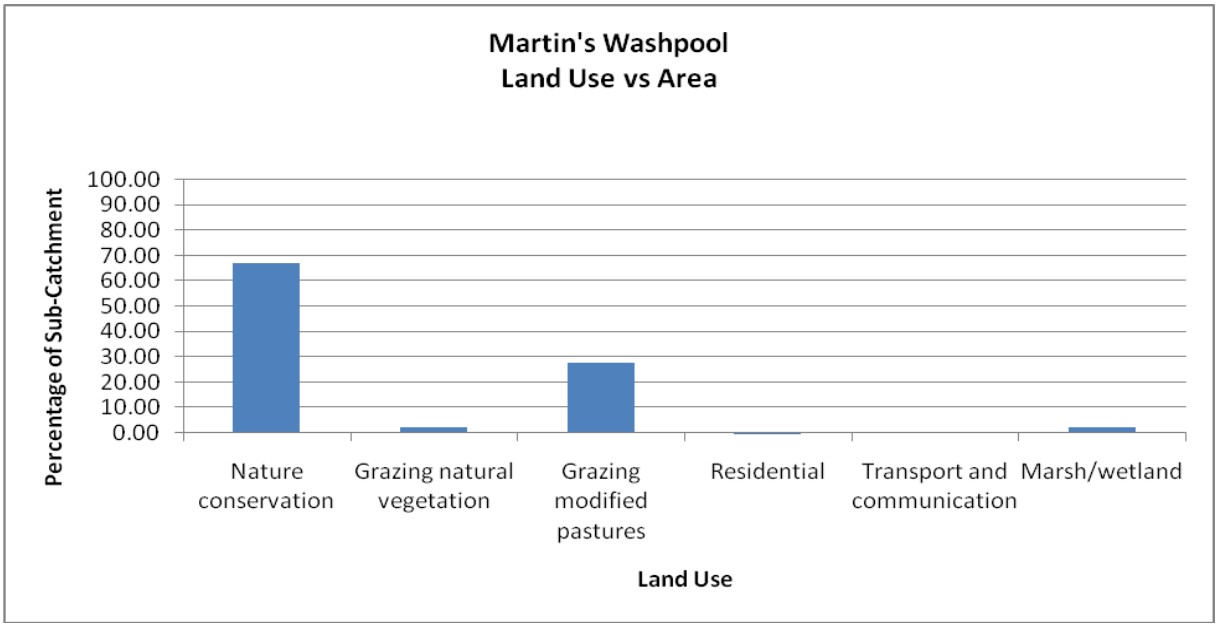


Figure 8: Land uses versus area in Morella Basin sub-catchment

3.2.2 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Morella Basin sub-catchment are to:

- Preserve and enhance seasonal wetlands
- Protect and enhance submerged aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance the Small Mouth Hardyhead population
- Protect and enhance macroinvertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators, which are listed in Appendix 2.

3.2.3 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Morella Basin sub-catchment was based on data collected via the Water Quality Monitoring Program and some local.

3.2.4 RISKS TO WATER QUALITY

3.2.4.1 SALINITY

Several specific salinity risks were identified in the Morella Basin sub-catchment, one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which, as mentioned earlier, is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Morella Basin sub-catchment (shown in Table 7) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

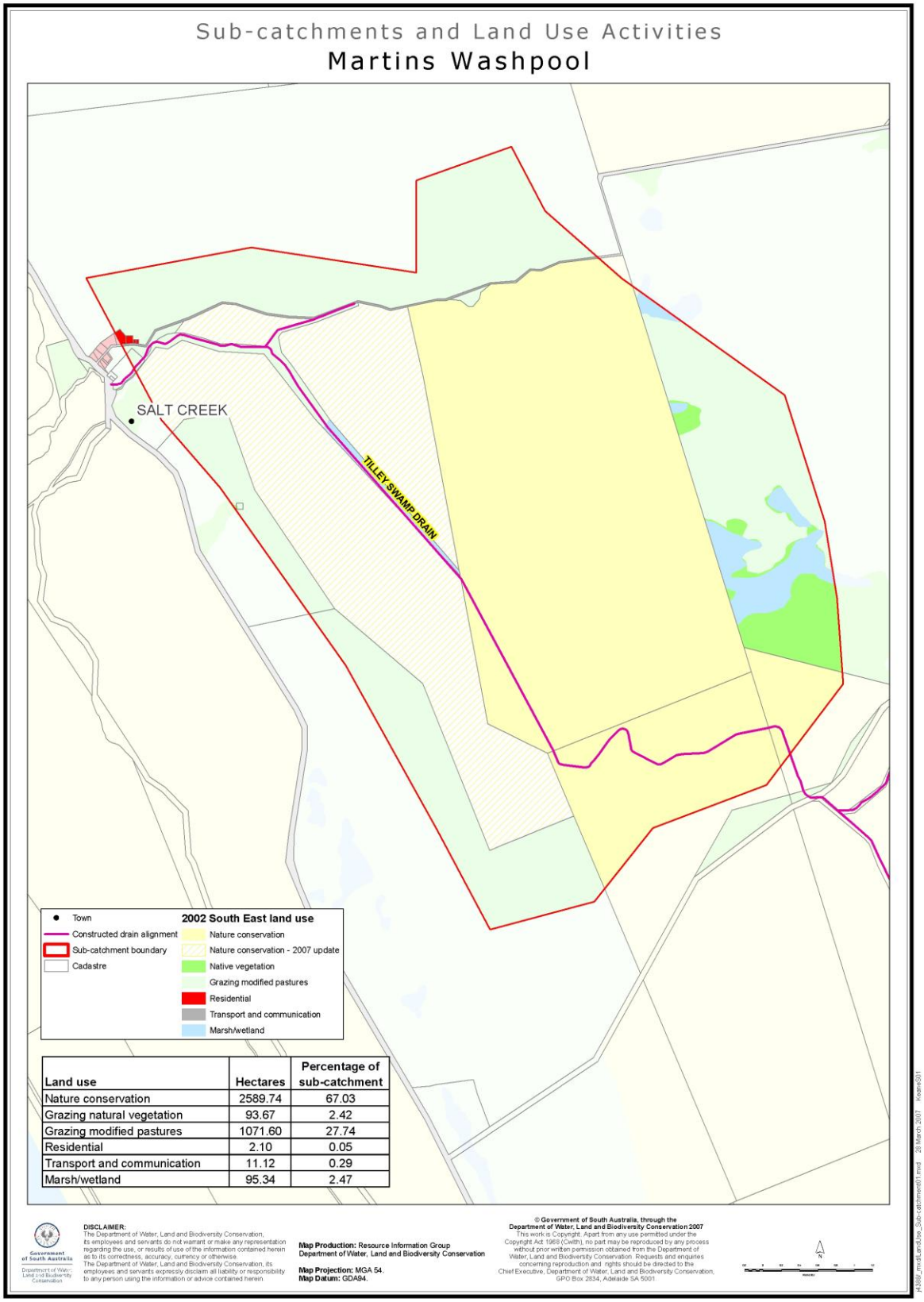


Figure 9: Map of the Morella Basin sub-catchment area

Table 7. Frequency of identified risk to water quality in Morella Basin sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	2	4	3	0	0	11	0	1	**21**	**68**
Moderate (2)	3	1	0	0	0	3	0	2	**9**	**29**
High (3)	0	0	0	0	0	0	0	1	**1**	**3**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**5**	**5**	**3**	**0**	**0**	**14**	**0**	**4**	31	
Percentage	**16**	**16**	**10**	**0**	**0**	**45**	**0**	**13**	**100**	

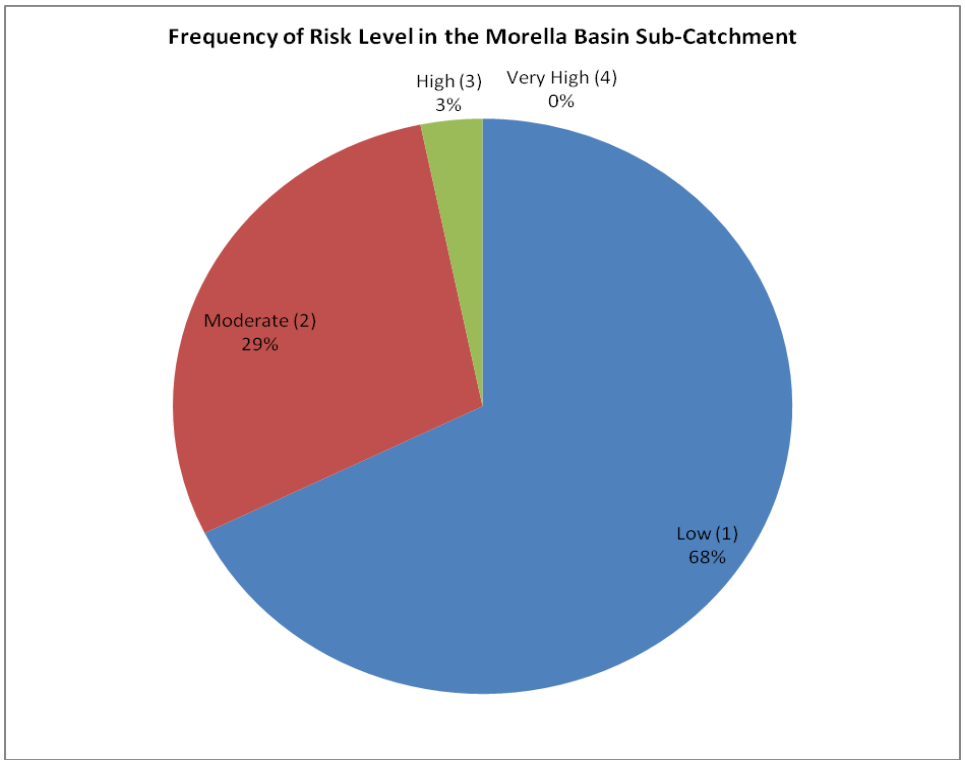


Figure 10. Frequency of risk levels identified in Morella Basin sub-catchment

3.2.5 DATA RESULTS

The Risk Assessment of Morella Basin sub-catchment was based on 38 samples, collected between March 2000 and December 2006.

Water quality data has been collected in Morella Basin since early 2000. Between 2000 and 2005 samples were collected and analysed at least quarterly, and in 2006 samples were taken monthly.

Table 8 below presents the parameters found to exceed ANZECC guidelines (refer to Appendix 4).

Quantitative and qualitative information was used in the assessment of Morella Basin. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified

using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

Table 8. Parameters exceeding Water Quality Guidelines in Morella Basin sub-catchment

METALS	NUTRIENTS
Aluminium (total and soluble)	Ammonia (as N and NH_3)
Arsenic (inorganic)	
Cadmium (total)	
Chromium (total)	
Copper (total)	
Iron (total)	
Lead (total)	
Mercury (total)	
Nickel (total)	
Silver (total)	
Zinc (total and soluble)	

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the limit of reporting (LOR). The parameters which have been screened out for Morella Basin are displayed in Table 9. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 9. Parameters screened from the Risk Assessment of Morella Basin sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No guideline, limited data
Pesticide	AMPA	No guideline, limited data

Metal	Antimony (sol)	No guideline, no data
Metal	Antimony (total)	Limited data
Pesticide	Atrazine	Limited data
Metal	Arsenic (sol)	No guideline, no data
Anions	Bicarbonate	No guideline
Metal	Cadmium (sol)	No guideline, no data
Cation	Calcium	No exceedences
Derived Data	Hardness	No exceedences
Derived Data	Carbonate Hardness	No exceedences
Pesticide	Chlordane A	All lower than Limit of Reporting
Pesticide	Chlordane G	No guideline, all lower than Limit of Reporting
Anion	Chloride	No guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No data
Metal	Copper (sol)	No data
Pesticide	DDD	No guideline, all lower than Limit of Reporting
Pesticide	DDT	No guideline, all lower than Limit of Reporting
Pesticide	DDE	No guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No guideline, all lower than Limit of Reporting

Pesticide	Endosulfan Sulphate	No guideline, all lower than Limit of Reporting
Pesticide	Endrin	No exceedences
Anion	Fluoride	No guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All lower than Limit of Reporting
Pesticide	Heptachlor	No exceedences
Pesticide	Heptechlor Epoxide	No guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No guideline, all lower than Limit of Reporting. Limited data
Pesticide	Hexazinone	No guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No guideline
Derived Data	Langler Index	No guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No data
Pesticide	Lindane	No exceedences
Cation	Magnesium	No guideline
Derived Data	Magnesium hardness	No guideline
Pesticide	Malthion	No exceedences
Metal	Mercury (sol)	No data
Pesticide	Methoxychlor	No guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No data
Nutrients	Nitrate as NO_3	No guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No exceedences
Nutrients	Phosphorus Total	No exceedences
Cation	Potassium	No guideline, all lower than Limit of

		Reporting
Nutrients	Silica Reactive	No guideline
Metal	Silver (sol)	No data
Pesticide	Simazine	No exceedences
Cation	Sodium	No guideline
Derived Data	Sodium Adsorption Ration	No guideline
Derived Data	Sodium /Total Cations Ratio	No guideline
Anion	Sulphate	No guideline
Physical	Suspended Solids	No guideline
Physical	Temperature	No guideline
Nutrient	TKN	No guideline
Derived Data	Total Chlorides as NaCl	No guideline
Physical	TDS by EC	No guideline
Physical	TDS by Evaporation	No guideline
Derived Data	Total Hardness ($CaCO_3$)	No guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No exceedences
Pesticide	Trifluran	No exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.2.6 DISCUSSION

Many metals found in Morella Basin exceeded ANZECC guidelines, and these metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the limit of reporting (LOR) could be higher than the actual guideline itself.

Ammonia as both N and NH_3 exhibited exceedences in Morella Basin. These exceedences may be explained by the high pH of the system, generally caused by a high salinity level. The Ammonia as NH_3 value is derived using the pH value, and the measure of pH will vary depending on the ionic solution with which the pH sensor is calibrated, and the salinity of the water being measured. Therefore, if the pH level has been artificially forced up (due to calibration of the pH sensor in fresh water rather than saline water) then this will in turn cause an inflated level of Ammonia as NH_3 (Everingham 2007))

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences and/or values which were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however

the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, hence this is also an issue for further investigation.

3.2.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE MORELLA BASIN SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Morella Basin and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended that an investigation be conducted into the correct analysis of pH and consequent analysis of Ammonia as NH_3. This could include investigation of a method of accurately measuring pH in highly saline conditions.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers.

It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable (such as the above recommendations for a metals analysis and pH/ammonia relationship).

3.3 TILLEY SWAMP SUB-CATCHMENT 2

3.3.1 DESCRIPTION OF THE AREA

Like the Martins Washpool sub-catchment, a large area of the Tilley Swamp sub-catchment is set aside for conservation purposes. The agricultural land surrounding the wetlands and floodplains is predominantly used as grazing land for sheep and cattle. Tilley Swamp is the former terminus of the Reedy Creek watercourse, and the sub-catchment supports many wetland habitats dominated by Salt Paperback shrublands and low forests, as well as areas of Gahnia tussock sedgeland (de Jong 2005).

One drain passes through Tilley Swamp (the Tilley Swamp drain) which is directly connected to both the Henry Swamp drain and the Taratap drain (both downstream), and is connected to the Kercoonda and Bald Hill drain by the S-bend connector (refer to Figure 12). At the Northern end of the drain it connects with the Northern Outlet drain and then feeds into Morella Basin, the terminus of the system. The main purpose of the Tilley Swamp drain is to be the waterway for all drain water generated in the northern and central catchments (de Jong 2005).

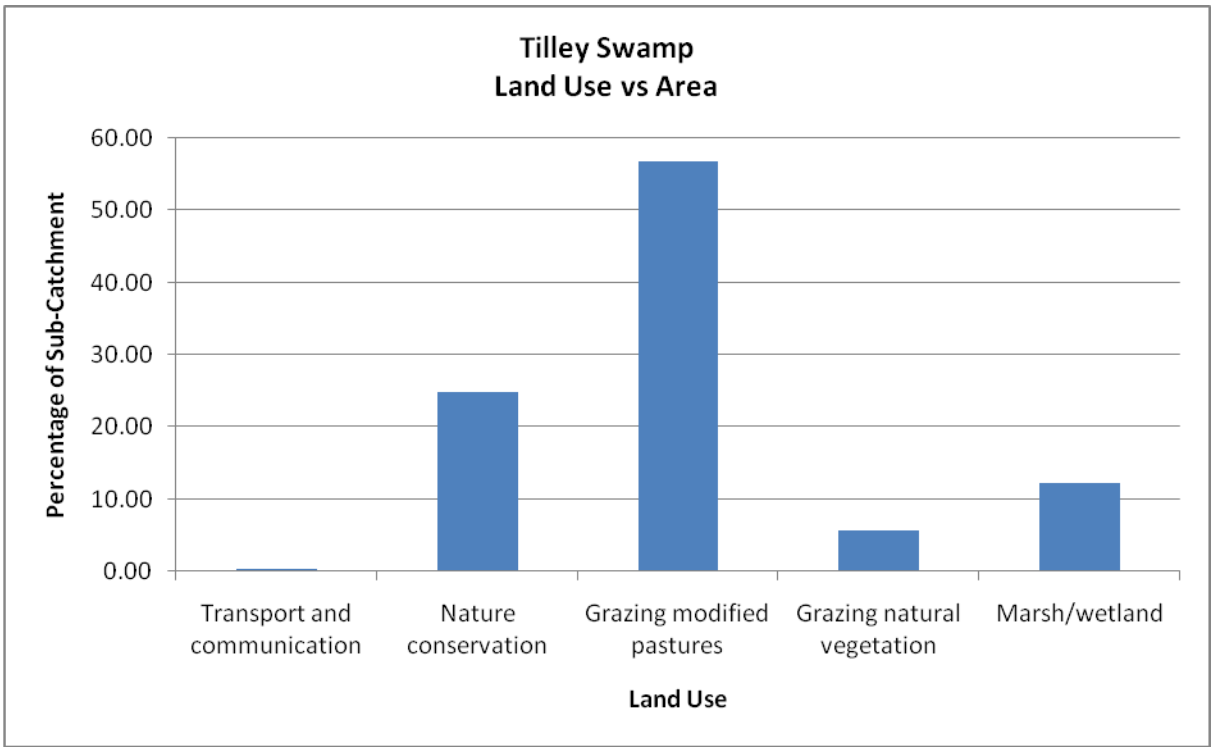


Figure 11. Land uses versus area in Tilley Swamp sub-catchment

3.3.2 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Tilley Swamp sub-catchment are to:

- Preserve and enhance seasonal wetlands
- Protect and enhance submerged aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macroinvertebrate populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.3.3 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Tilley Swamp sub-catchment was based on data collected via the Water Quality Monitoring Program and some local consultation.

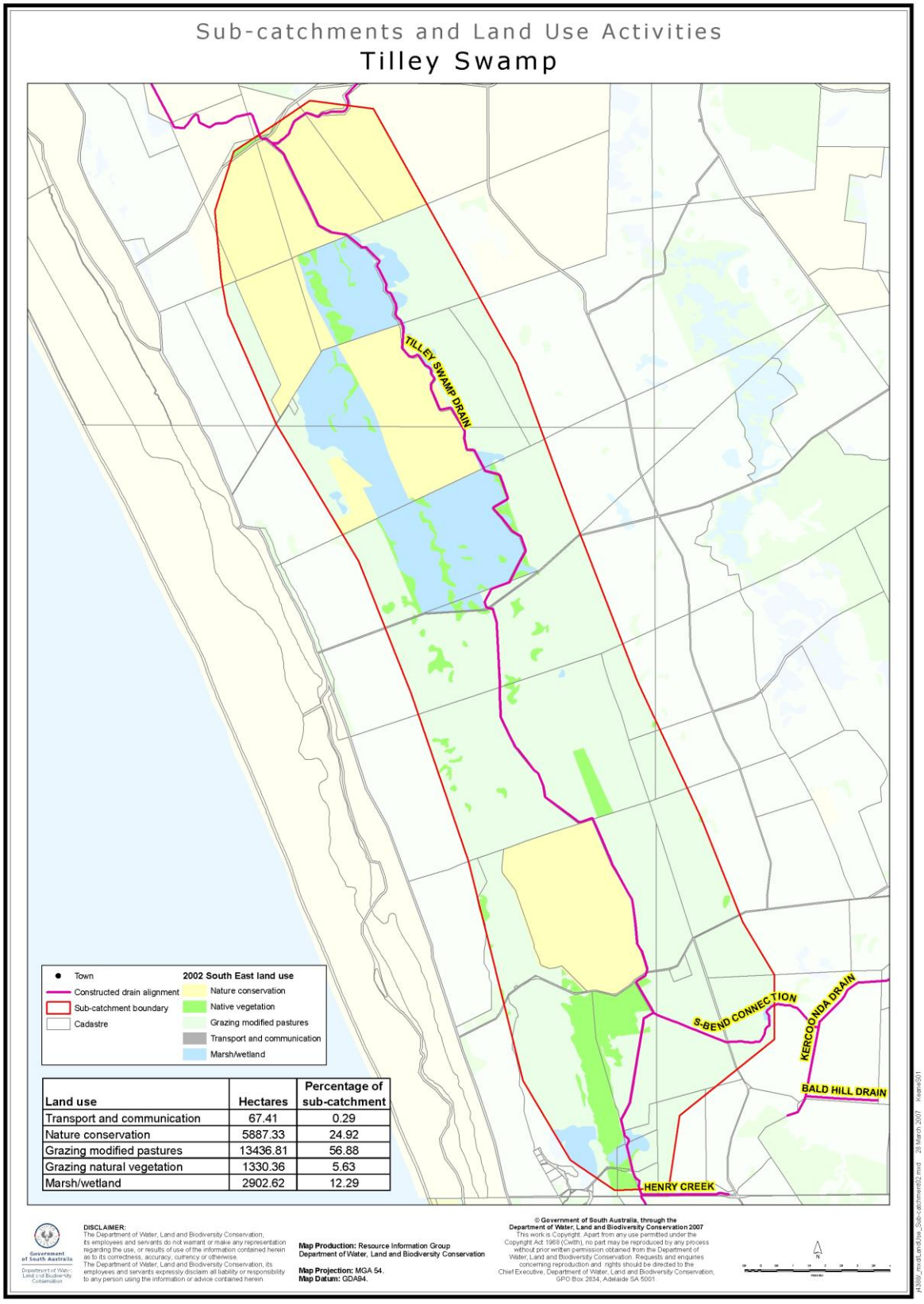


Figure 12. Map of Tilley Swamp sub-catchment

3.3.4 RISKS TO WATER QUALITY

3.3.4.1 SALINITY

Several specific salinity risks were identified in the Tilley Swamp sub-catchment, one 'high', two 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM Program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Tilley Swamp sub-catchment (shown in Table 10) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 10. Frequency of identified risk to water quality in Tilley Swamp sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

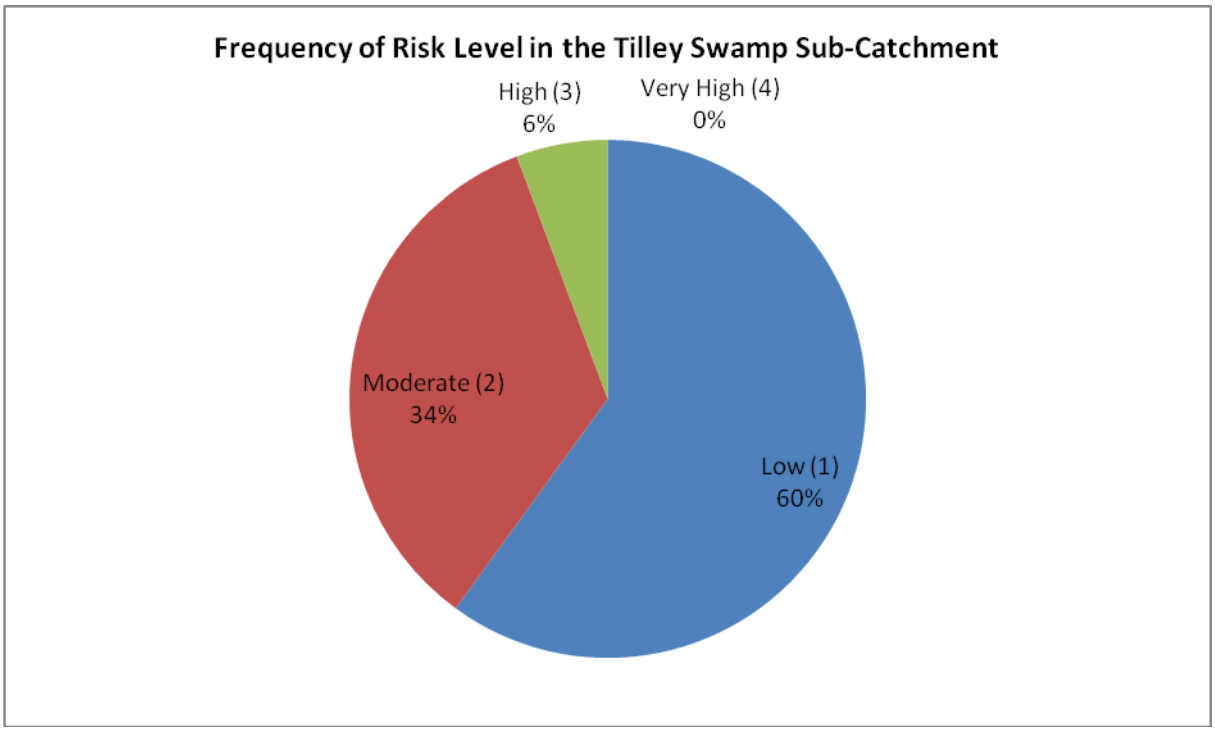


Figure 13. Frequency of risk levels identified in the Tilley Swamp sub-catchment

3.3.5 DATA RESULTS

The Risk Assessment was based on 35 samples, collected between May 2000 and December 2006.

There are two water quality monitoring sites In the Tilley Swamp sub-catchment. At site one samples were collected between 2000 and 2005 and analysed once a year; a sample was collected in January 2006; and then monthly from May to December 2006. At site two samples were collected between 2003 and 2004 and analysed once a year; twice in 2005; a sample was collected in January 2006; and then monthly from May to December 2006.

Table 11 below shows the parameters were found to exceed ANZECC guidelines (refer to Appendix 4).

Table 11. Parameters exceeding Water Quality Guidelines in Tilley Swamp sub-catchment

METALS
Aluminium (total)
Arsenic (inorganic)
Cadmium (total)
Chromium (total)
Copper (total)
Iron (total)
Nickel (total)
Selenium
Silver (total)
Zinc (total and soluble)

Quantitative and qualitative information was used in the assessment of Tilley Swamp sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using available water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Tilley Swamp are displayed in Table 12. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 12. Parameters screened from the Risk Assessment of Tilley Swamp sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No guideline, limited data
Pesticide	AMPA	No guideline, limited data
Metal	Antimony (sol)	No guideline, no data

Metal	Antimony (total)	Limited data
Pesticide	Atrazine	Limited data
Metal	Arsenic (sol)	No guideline, no data
Anions	Bicarbonate	No guideline
Metal	Cadmium (sol)	No guideline, no data
Cation	Calcium	No exceedences
Derived Data	Hardness	No exceedences
Derived Data	Carbonate Hardness	No exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No data
Metal	Copper (sol)	No data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit

		of Reporting
Pesticide	Endrin	No exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No data
Pesticide	Lindane	No exceedences
Cation	Magnesium	No guideline
Derived Data	Magnesium hardness	No guideline
Pesticide	Malthion	No exceedences
Metal	Mercury (sol)	No data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No exceedences
Nutrients	Phosphorus Total	No exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting

Nutrients	Silica Reactive	No guideline
Metal	Silver (sol)	No data
Pesticide	Simazine	No exceedences
Cation	Sodium	No guideline
Derived Data	Sodium Adsorption Ration	No guideline
Derived Data	Sodium /Total Cations Ratio	No guideline
Anion	Sulphate	No guideline
Physical	Suspended Solids	No guideline
Physical	Temperature	No guideline
Nutrient	TKN	No guideline
Derived Data	Total Chlorides as NaCl	No guideline
Physical	TDS by EC	No guideline
Physical	TDS by Evaporation	No guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No exceedences
Pesticide	Trifluran	No exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.3.6 DISCUSSION

Many metals found in Tilley swamp sub-catchment exceeded ANZECC guidelines, and these metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences and/or values which were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, hence this is also an issue for further investigation.

In the Tilley Swamp sub-catchment (as in all sub-catchments with the exception of Morella Basin) organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation. 'Stock grazing near watercourses' is also a nutrient risk.

3.3.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE TILLEY SWAMP SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Tilley Swamp sub-catchment and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Tilley Swamp sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

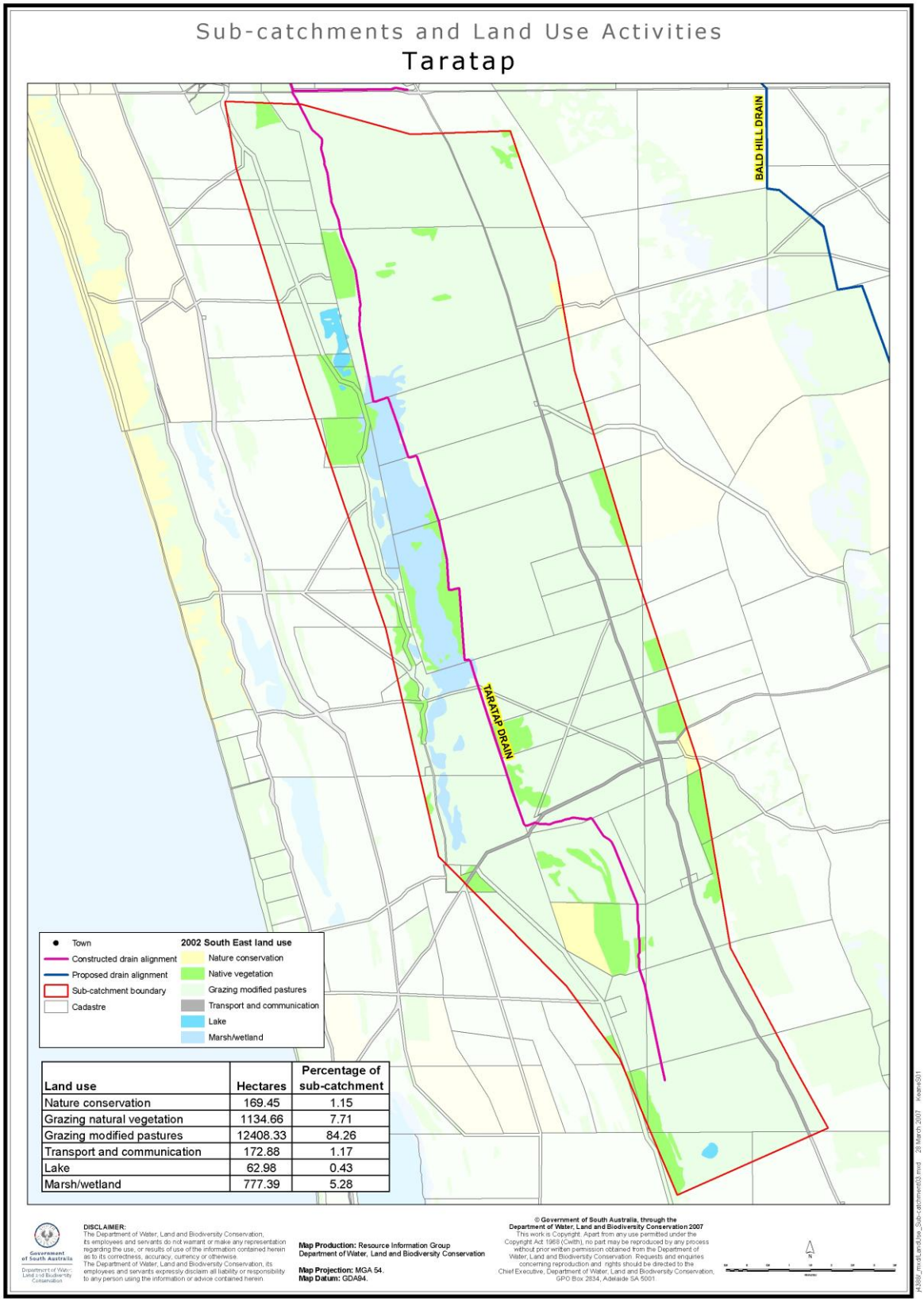
It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable (such as the above recommendations for a metals analysis).

3.4 TARATAP SUB-CATCHMENT 3

3.4.1 DESCRIPTION OF THE AREA

The dominant land uses in the Taratap sub-catchment are the 'grazing of modified pasture', some 'grazing of natural vegetation' and 'marsh/wetlands'. A string of wetlands exist at the eastern foot of the Taratap range and follow the former path of the Tilley Swamp Wetlands (de Jong 2005).

One drain runs through Taratap (the Taratap drain) that intercepts with the Henry Creek drain in the north and flows into the Tilley Swamp drain. The main purpose of this drain is to collect surface water flow from the Taratap Flat and channel it to wetlands via diversion structures (de Jong 2005).



Land use	Hectares	Percentage of sub-catchment
Nature conservation	169.45	1.15
Grazing natural vegetation	1134.66	7.71
Grazing modified pastures	12408.33	84.26
Transport and communication	172.88	1.17
Lake	62.98	0.43
Marsh/wetland	777.39	5.28

Figure 14. Map of Taratap sub-catchment

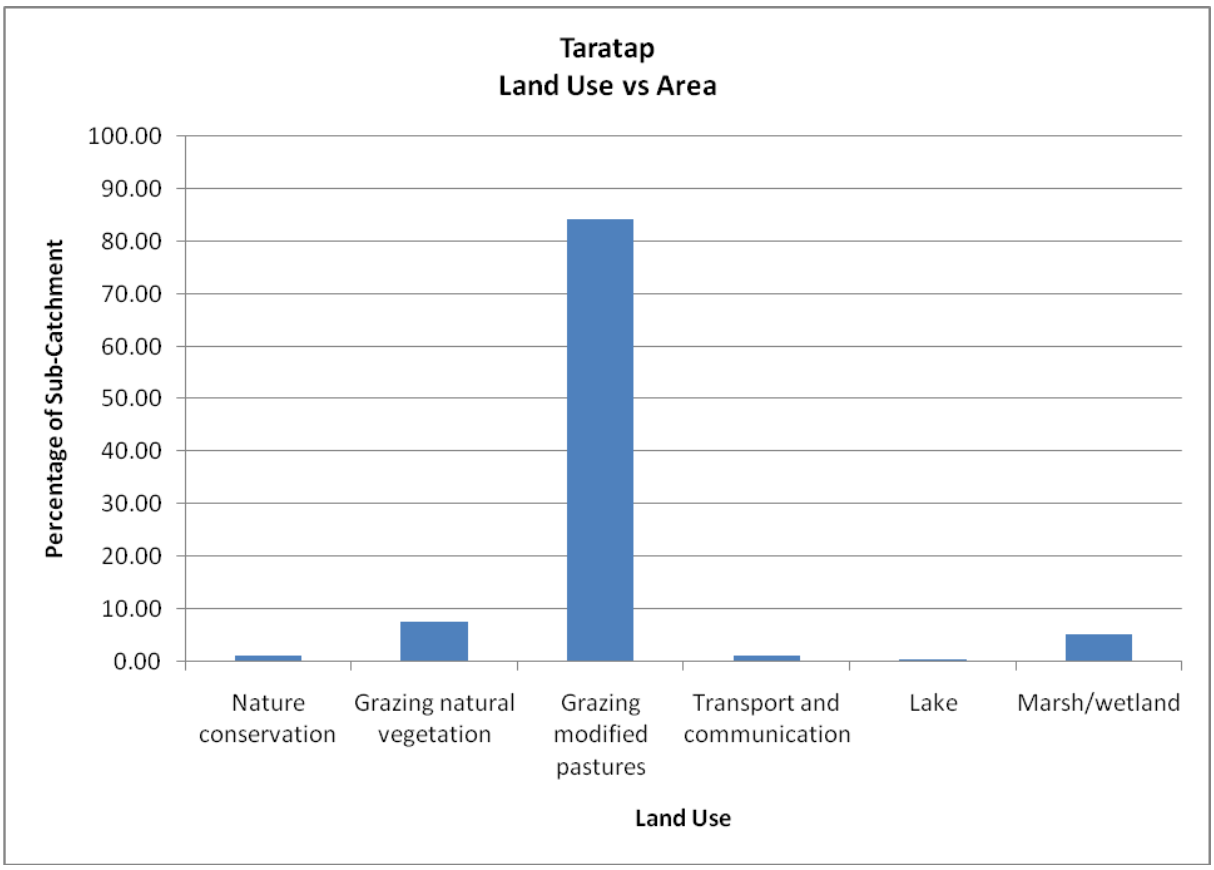


Figure 15. Land use versus area in Taratap sub-catchment

3.4.2 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Taratap sub-catchment are to:

- Preserve and enhance seasonal wetlands
- Protect and enhance submerged aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macroinvertebrate populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.4.3 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Taratap sub-catchment was based on data collected through landholder consultation

3.4.4 RISKS TO WATER QUALITY

3.4.4.1 SALINITY

Several specific salinity risks were identified in the Taratap sub-catchment, one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.4.4.2 PESTICIDE APPLICATION

One significant ('high') pesticide risk was identified in the Taratap sub-catchment. This was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. Although a relatively low portion of the Taratap sub-catchment is used for cropping, the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks identified in the Taratap sub-catchment (shown in Table 13) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 13. Frequency of identified risk to water quality in Taratap sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	2	4	3	0	0	7	0	1	**17**	**45**
Moderate (2)	5	3	1	0	0	7	0	2	**18**	**47**
High (3)	0	0	0	1	0	1	0	1	**3**	**8**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**7**	**7**	**4**	**1**	**0**	**15**	**0**	**4**	38	
Percentage	**18**	**18**	**11**	**3**	**0**	**39**	**0**	**11**	**100**	

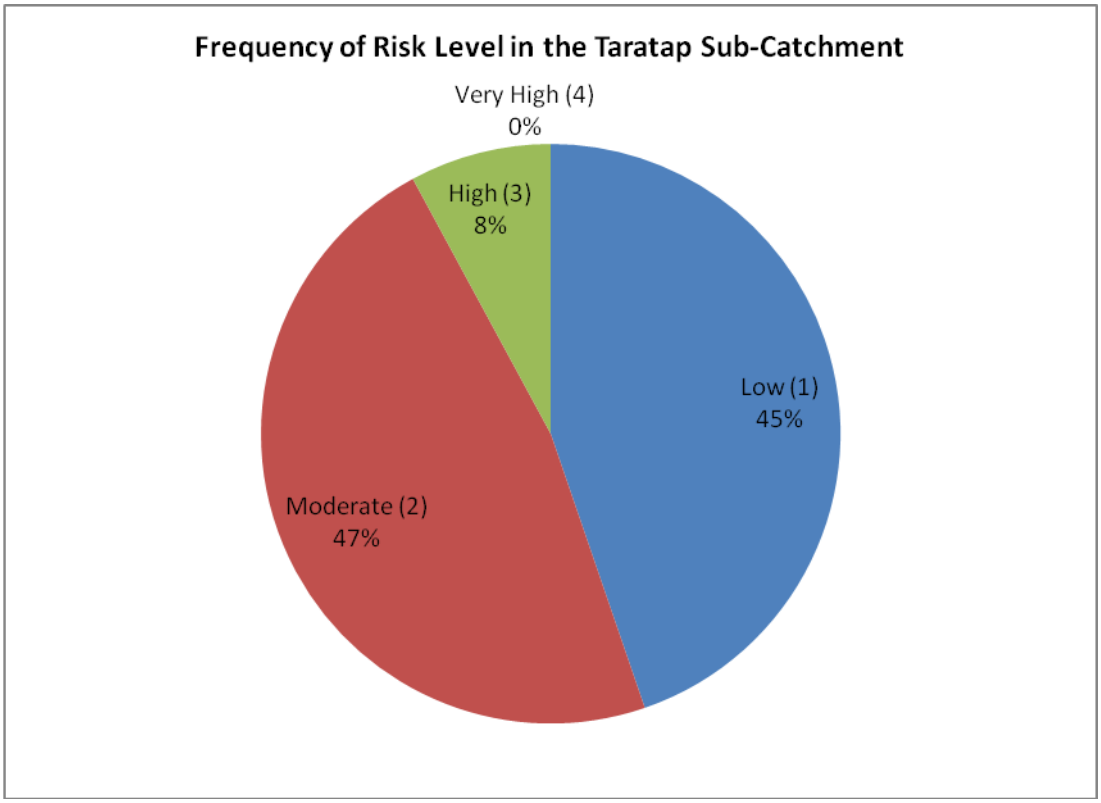


Figure 16. Frequency of risk levels identified in Taratap sub-catchment

3.4.5 DATA RESULTS

The Risk Assessment process in the Taratap sub-catchment was based on landholder consultation and GIS data interpretation. This included using aerial photographs and interviewing landholders in the sub-catchment to identify what land uses are in the sub-catchment and also the percentages of each land use (i.e. 56% grazing modified pastures). The process also identified land use practices such as land 'renovation' and frequency, duration and timing of pesticides, fertilisers etc, as well as any other hazards perceived by the landholders.

Only qualitative information was used in the assessment of Taratap sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards for which water quality data was available.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a ‘certainty level’ matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.4.6 DISCUSSION

No water quality data was available in the Taratap sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as ’moderate’ and ’high’ risks.

As in all sub-catchments, with the exception of Morella Basin, OM presented as a ’high’ risk. This was attributed to ‘stock grazing near watercourses’ and is an issue for investigation.

‘Stock grazing near watercourses’ is also classed as a nutrient risk, as was the use of fertilisers. This is an issue for investigation.

3.4.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE TARATAP SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the Taratap sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. This investigation could be conducted in the Taratap sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of ‘stock grazing near watercourses’ (including contribution to nutrient loads) be conducted in either the Taratap sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the contribution of fertiliser to nutrient exceedences be conducted. This could involve sampling before fertiliser application, after fertiliser application, and at a time when runoff is initially occurring. This could be conducted in the Taratap sub-catchment or at a location that is representative of the USE Catchment.

3.5 WATERVALLEY WETLANDS SUB-CATCHMENT 4

3.5.1 DESCRIPTION OF THE AREA

The Watervalley Wetlands sub-catchment is dominated by three land uses – 'grazing modified pastures', 'grazing native vegetation' and 'nature conservation'. Three drains pass through the sub-catchment – the Kercoonda drain in the south, and the northern outlet and deepwater drain in the north. The Kercoonda drain contains brackish groundwater and has the capacity to act as a waterway for fresh surface water. It is an extension of the Watervalley drain and intercepts with the Bald Hill drain before connecting with Tilley Swamp drain via the S-bend connector (de Jong 2005).

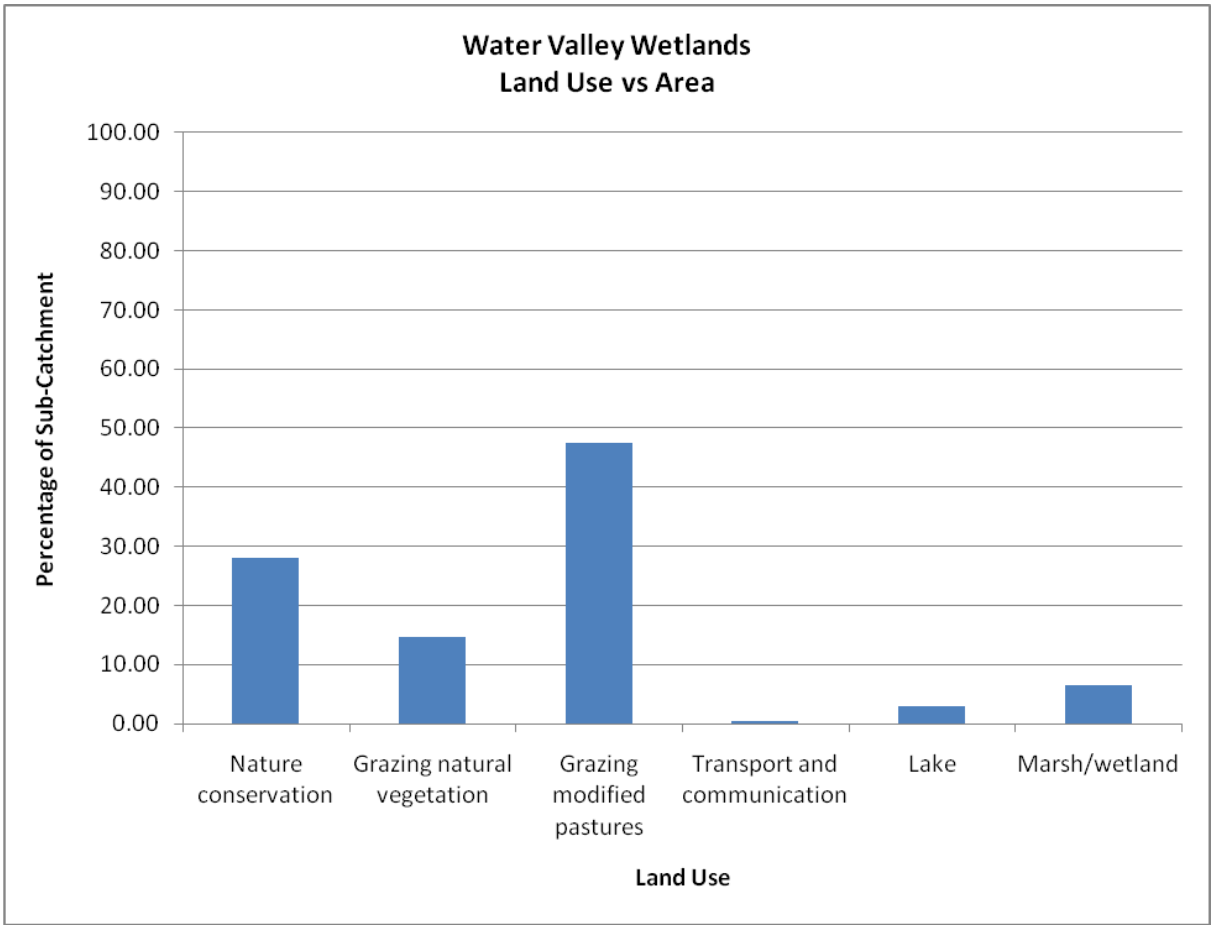


Figure 17. Land use versus area in the Watervalley Wetlands sub-catchment

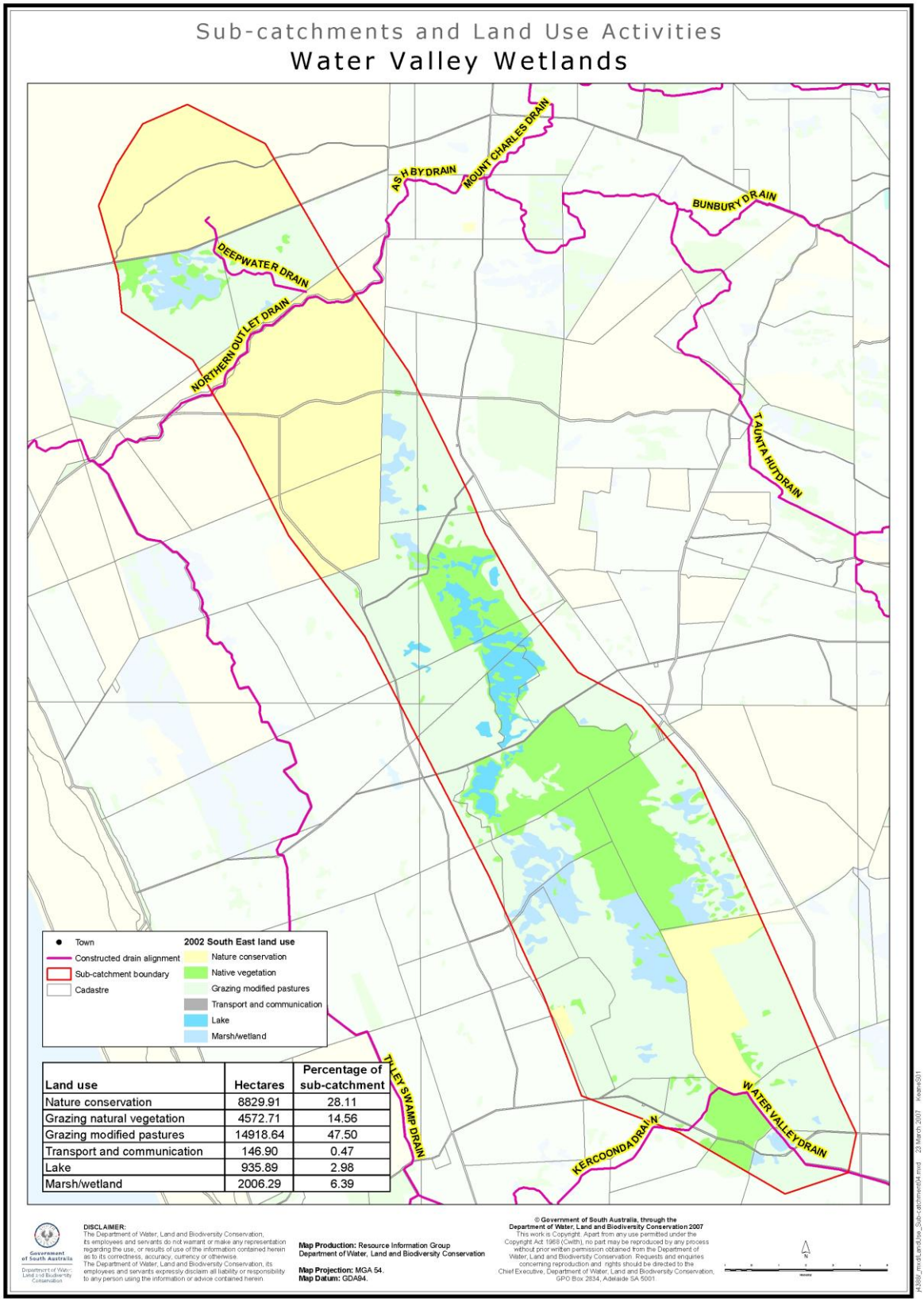


Figure 18. Map of Watervalley Wetlands sub-catchment

3.5.2 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Watervalley Wetlands sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macroinvertebrate populations
- Preserve habitat for waterbird refuge
- Preserve habitat for colonial nesting waterbirds.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.5.3 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Watervalley Wetlands sub-catchment was based on data collected in the Water Quality Monitoring Program and some local consultation (see section 2.2).

3.5.4 RISKS TO WATER QUALITY

3.5.4.1 SALINITY

The ‘high’ risk was attributed to ‘discharge’ where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a ‘high’ risk as it is a naturally occurring, likely event with significant consequences.

The ‘moderate’ risks were attributed to the hazard ‘management/infrastructure failure’. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a ‘moderate’ risk as if this was to happen, there would be significant consequences.

The ‘low’ risk is also attributed to ‘management/infrastructure failure’ and the hazard event ‘event discharge (during rainfall events)’. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows

through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Watervalley Wetlands sub-catchment (shown in Table 14) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 14. Frequency of identified risk to water quality in Watervalley Wetlands sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

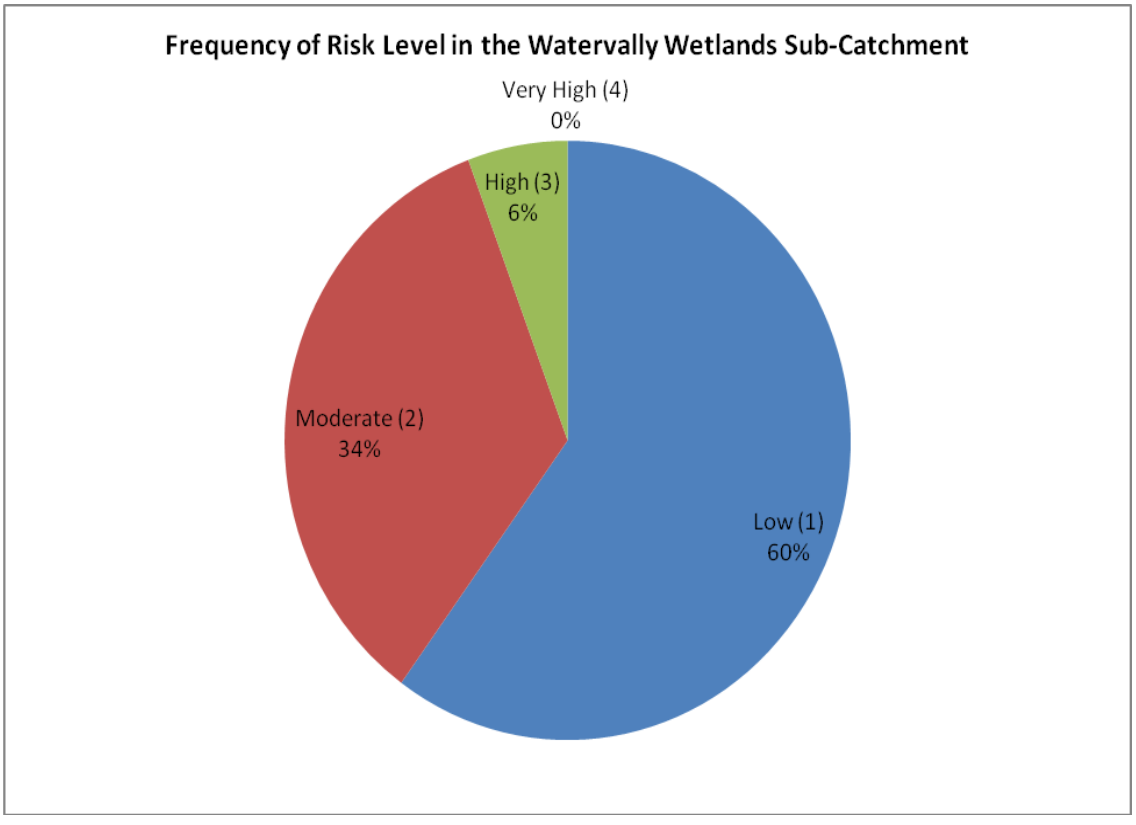


Figure 19. Frequency of identified risk to water quality in Watervalley Wetlands sub-catchment

3.5.5 DATA RESULTS

Limited water quality data has been collected in Watervalley Wetlands since May 2001. Between 2001 and 2004 samples were collected and analysed once a year. The Risk Assessment was based on 4 samples, collected between May 2001and May 2004.

The following parameters were found to exceed the ANZECC guidelines (refer Appendix 4).

Table 15. Parameters exceeding Water Quality Guidelines in Watervalley Wetlands sub-catchment

METALS
Aluminium (total)
Zinc (total and soluble)

Both quantitative and qualitative information was used in the assessment of Watervalley Wetlands. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using available water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Watervalley Wetlands sub-catchment are displayed in Table 16. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 16. Parameters screened from the Risk Assessment for Watervalley Wetlands sub-catchment

Parameter Type	**Parameter**	**Reason for Screen**
Pesticide	Aldrin	No Guideline, Limited Data
Metal	Aluminium (sol)	No Data
Nutrients	Ammonia (NH_3 as N)	No Data
Nutrients	Ammonium (NH_4 as N)	No Data

Pesticide	AMPA	No Guideline, Limited Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (total and sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit

		of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences

Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.5.6 DISCUSSION

Very limited water quality data was available in the Watervalley Wetlands sub-catchment, however of the data that was available, total aluminium and total and soluble zinc were seen to exceed ANZECC guidelines. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Also based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.5.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE WATERVALLEY WETLANDS SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in the Watervalley Wetlands sub-catchment and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Watervalley Wetlands sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Watervalley Wetlands sub-catchment or at a location that is representative of the USE Catchment.

3.6 WEST AVENUE SUB-CATCHMENT 5

3.6.1 DESCRIPTION OF THE AREA

The West Avenue sub-catchment is dominated by 'grazing of modified pastures' and 'grazing of native vegetation'. Bald Hill drain is the only drain located in this sub-catchment. This drain runs from the south, near the Fairview drain, to north where it is connected to the Kercoonda drain.

3.6.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the West Avenue sub-catchment was based on data collected through landholder consultation (see section 2.2).

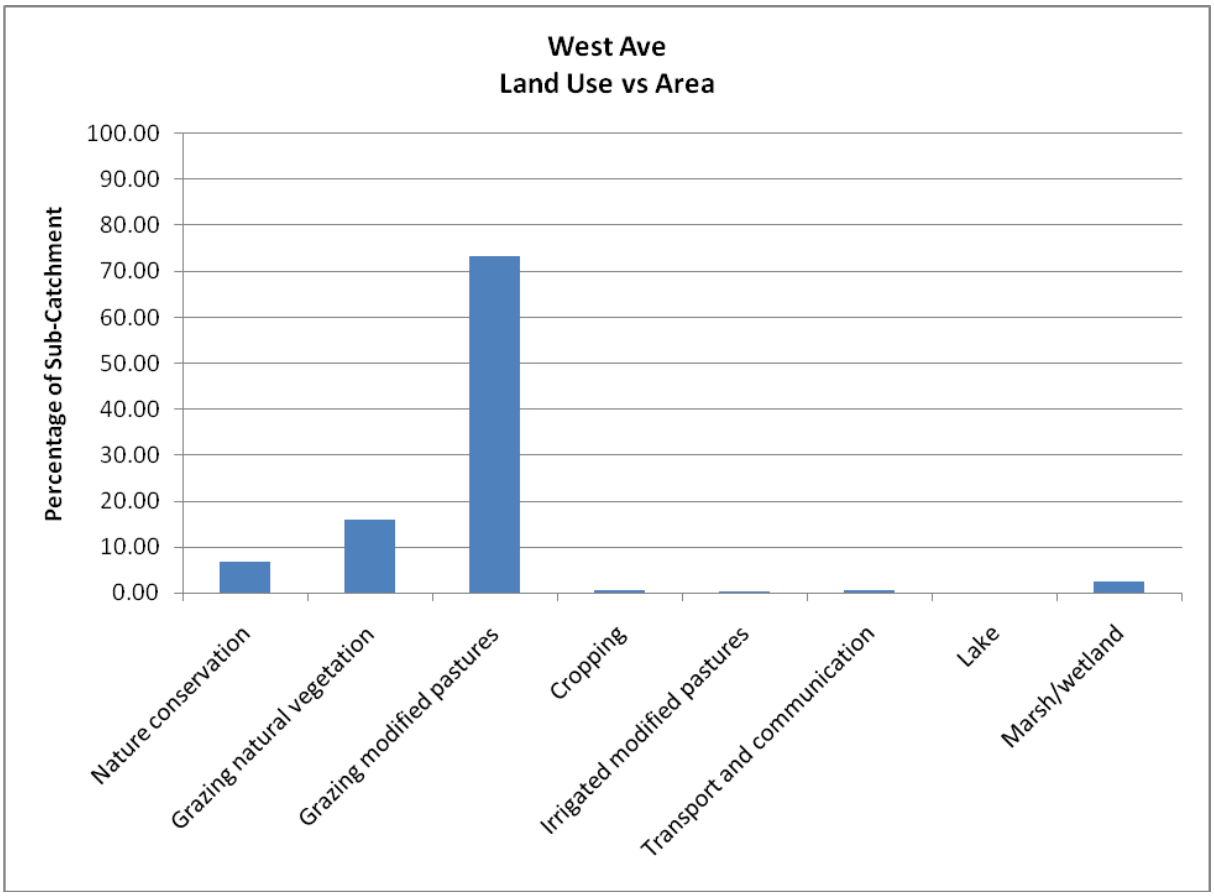


Figure 20. Land use versus area in West Avenue sub-catchment

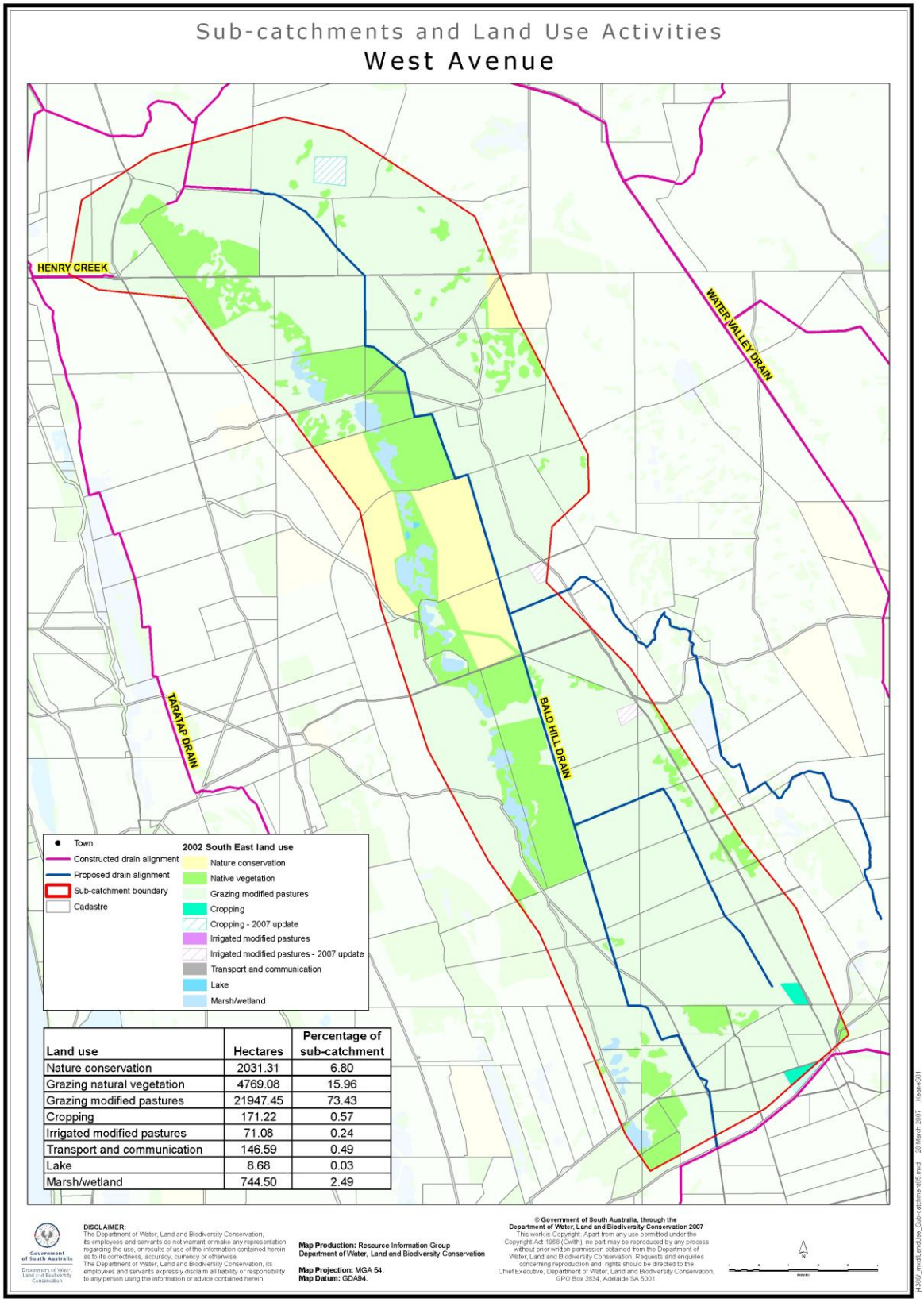
3.6.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the West Avenue sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance the Yarra Pygmy Perch population
- Protect and enhance the Southern Bell Frog population
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.



Land use	Hectares	Percentage of sub-catchment
Nature conservation	2031.31	6.80
Grazing natural vegetation	4769.08	15.96
Grazing modified pastures	21947.45	73.43
Cropping	171.22	0.57
Irrigated modified pastures	71.08	0.24
Transport and communication	146.59	0.49
Lake	8.68	0.03
Marsh/wetland	744.50	2.49

Figure 21. Map of West Avenue sub-catchment

3.6.4 RISKS TO WATER QUALITY

3.6.4.1 SALINITY

Several specific salinity risks were identified in the West Avenue sub-catchment – one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the West Avenue sub-catchment (shown in Table 17) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 17. Frequency of identified risk to water quality in West Avenue sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	4	6	4	0	0	7	0	1	**22**	**45**
Moderate (2)	8	6	1	0	0	7	0	2	**24**	**49**
High (3)	0	0	0	1	0	1	0	1	**3**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**12**	**12**	**5**	**1**	**0**	**15**	**0**	**4**	49	
Percentage	**24**	**24**	**10**	**2**	**0**	**31**	**0**	**8**	**100**	

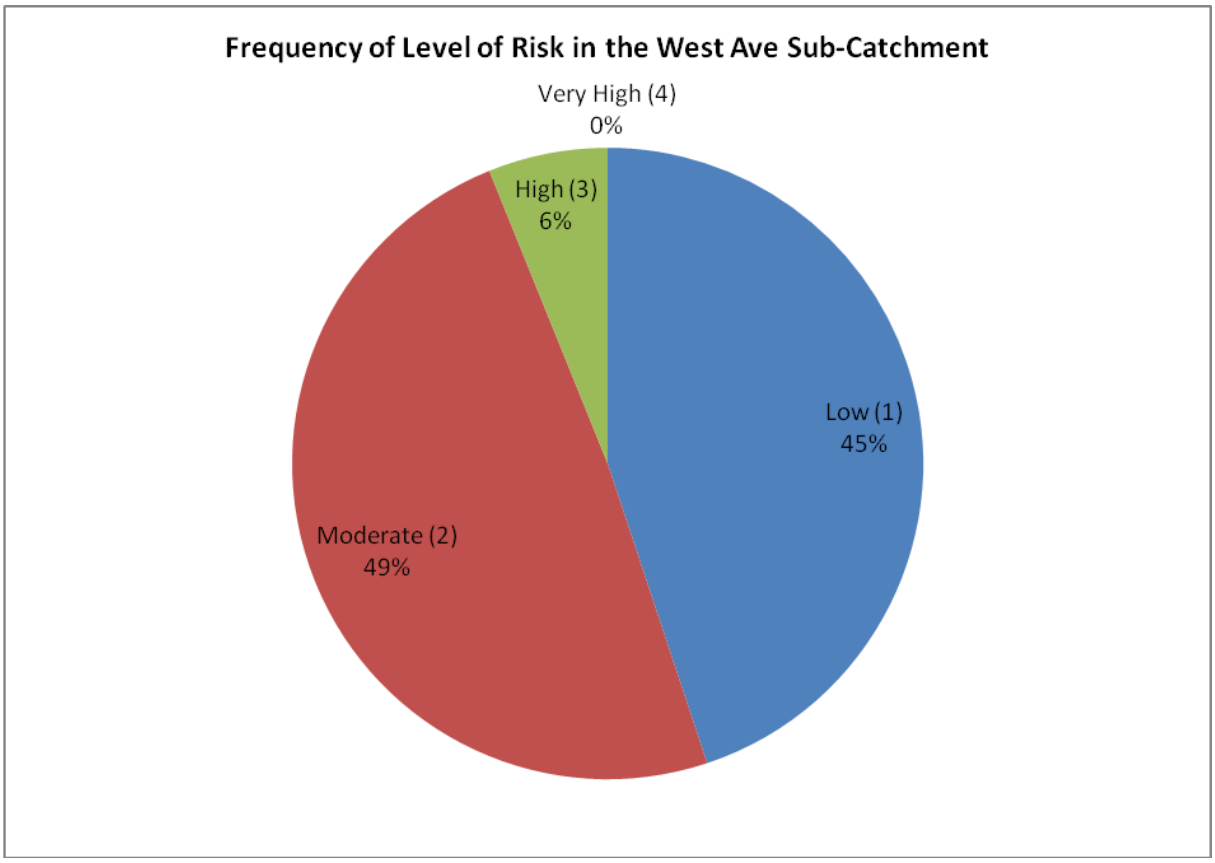


Figure 22. Frequency of risk levels identified in West Avenue sub-catchment

3.6.4.2 PESTICIDES

One significant ('high') pesticide risk was identified in the West Avenue sub-catchment. This was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. West Avenue has a slightly higher percentage of area used for cropping then the Taratap sub-catchment, and the reasons for a 'high' Risk Assessment are also similar – i.e. the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

3.6.5 DATA RESULTS

The Risk Assessment process in the West Avenue sub-catchment was based on landholder consultation and GIS data interpretation. This included using aerial photographs and interviewing landholders in the sub-catchment to identify what land uses are in the sub-catchment, and also the percentages of each land use (i.e. 56% 'grazing modified pastures'). The process also identified land use practices such as 'land renovation' and frequency, duration and timing of pesticides, fertilisers etc, as well as any other hazards perceived by the landholders.

Only qualitative information was used in the assessment of West Avenue sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards which had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4)

3.6.6 DISCUSSION

No water quality data was available in the West Avenue sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.6.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE WEST AVENUE SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the West Avenue sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the West Avenue sub-catchment or at a location that is representative of the USE Catchment.

3.7 WINPINMERIT SUB-CATCHMENT 6

3.7.1 DESCRIPTION OF THE AREA

The Winpinmerit sub-catchment is dominated by 'grazing modified pastures' and 'grazing native vegetation'. It is mainly grazed by sheep and cattle in large open paddocks with some areas supporting melaleuca/gahnia shrubland and sedgelands. A few wetlands remain along the Winpinmerit watercourse.

The Winpinmerit drain is the only drain in the sub-catchment, and its main purpose is to provide drainage for agricultural land and to enable delivery of water into wetlands (de Jong 2005).

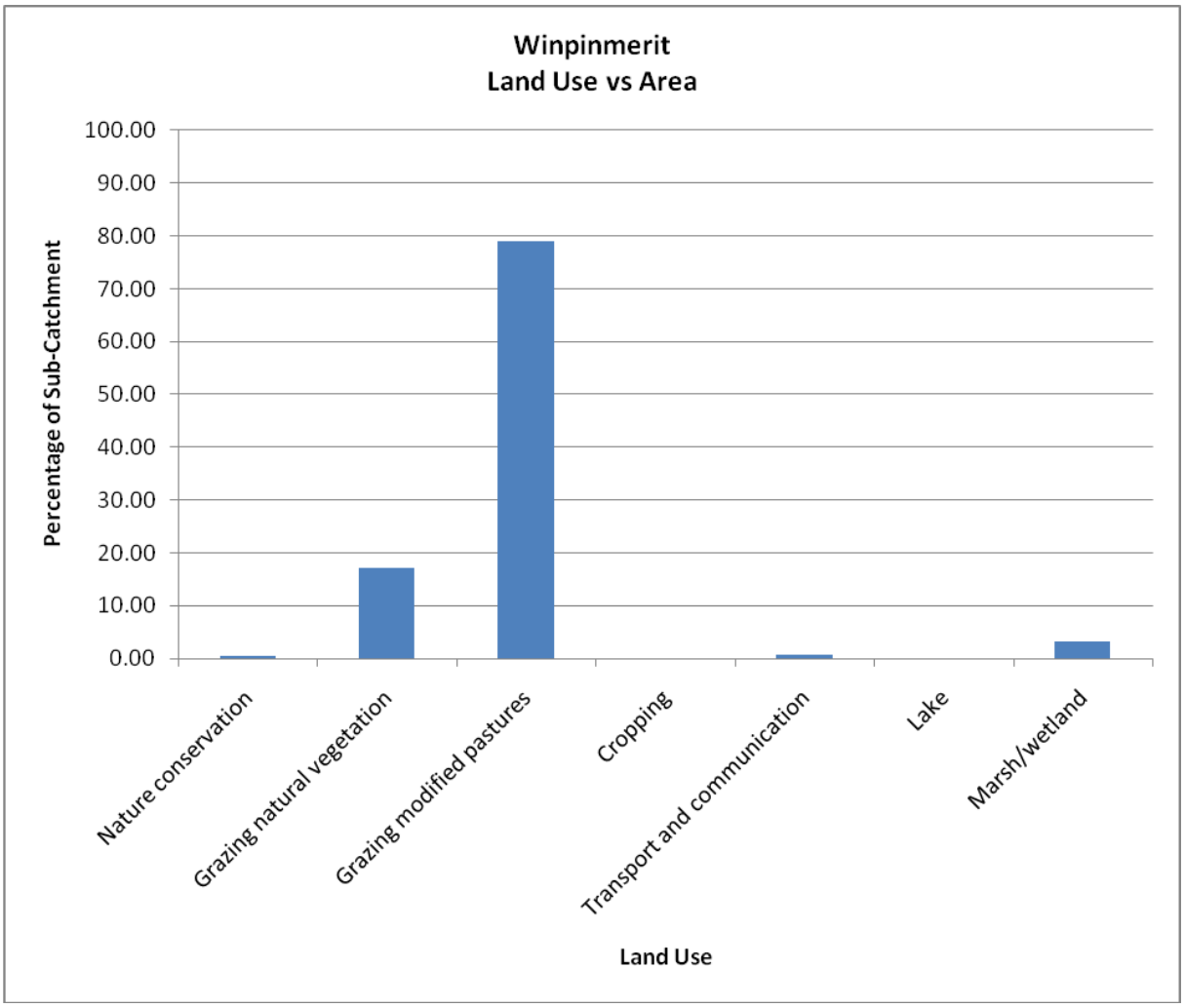
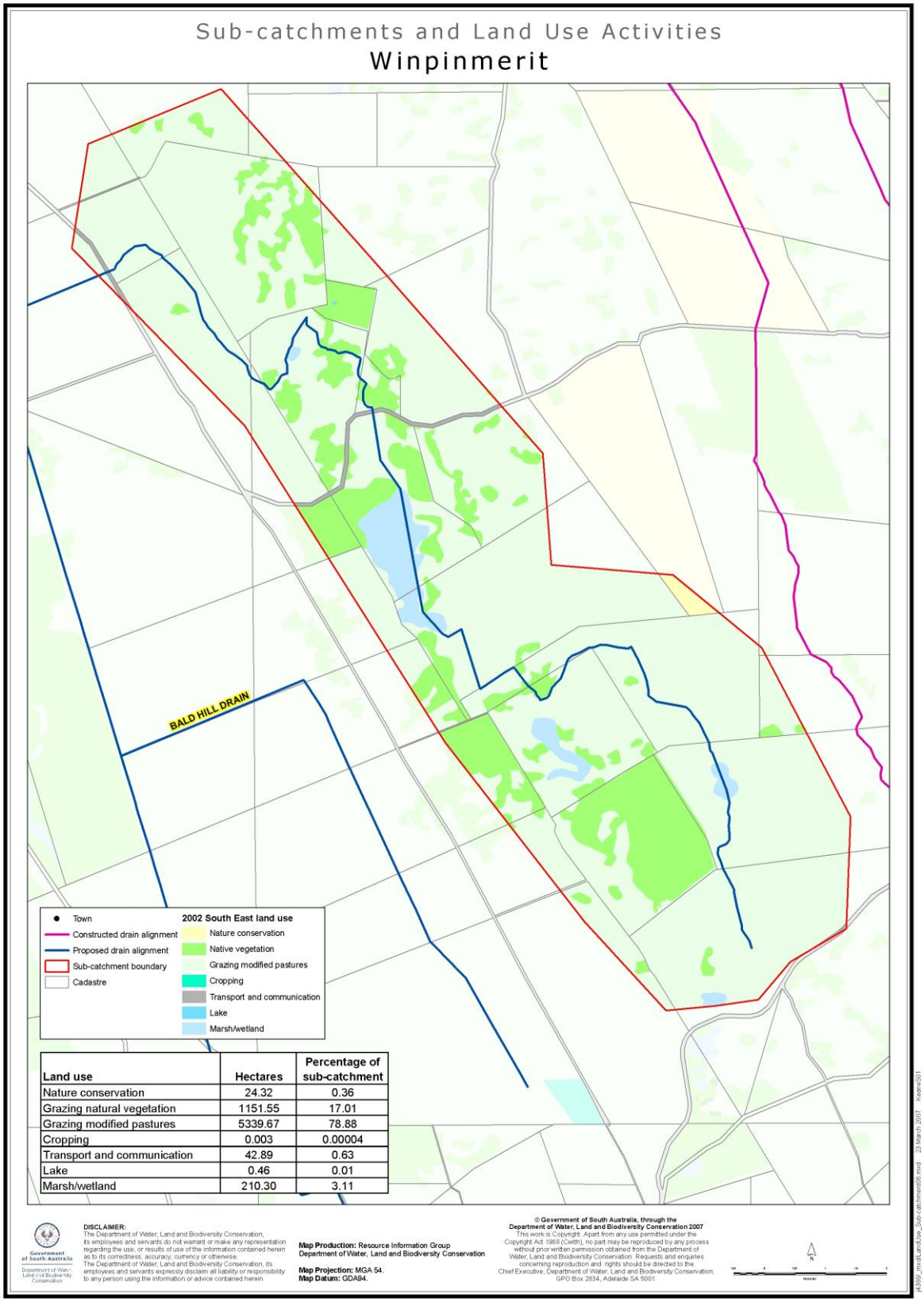


Figure 23. Land use versus area in Winpinmerit sub-catchment



Land use	Hectares	Percentage of sub-catchment
Nature conservation	24.32	0.36
Grazing natural vegetation	1151.55	17.01
Grazing modified pastures	5339.67	78.88
Cropping	0.003	0.00004
Transport and communication	42.89	0.63
Lake	0.46	0.01
Marsh/wetland	210.30	3.11

Figure 24. Map of Winpinmerit sub-catchment

3.7.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Winpinmerit sub-catchment was based on data collected from limited local consultation (see section 2.2).

3.7.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the WQ objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments grouped into like catchments (in terms of wetland character and WQ management goals).

The management goals for the Winpinmerit sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macroinvertebrate populations
- Preserve waterbird populations

Each management goal has a list of associated pressures and indicators, which can be found in Appendix 2.

3.7.4 RISKS TO WATER QUALITY

3.7.4.1 SALINITY

Several specific salinity risks were identified in the Winpinmerit sub-catchment – one 'high', one 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows

through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Winpinmerit sub-catchment (shown in Table 18) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 18. Frequency of identified risk to water quality in Winpinmerit sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	7	0	1	**18**	**58**
Moderate (2)	3	2	1	0	0	4	0	1	**11**	**35**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**11**	**0**	**3**	31	
Percentage	**19**	**19**	**13**	**3**	**0**	**35**	**0**	**10**	**100**	

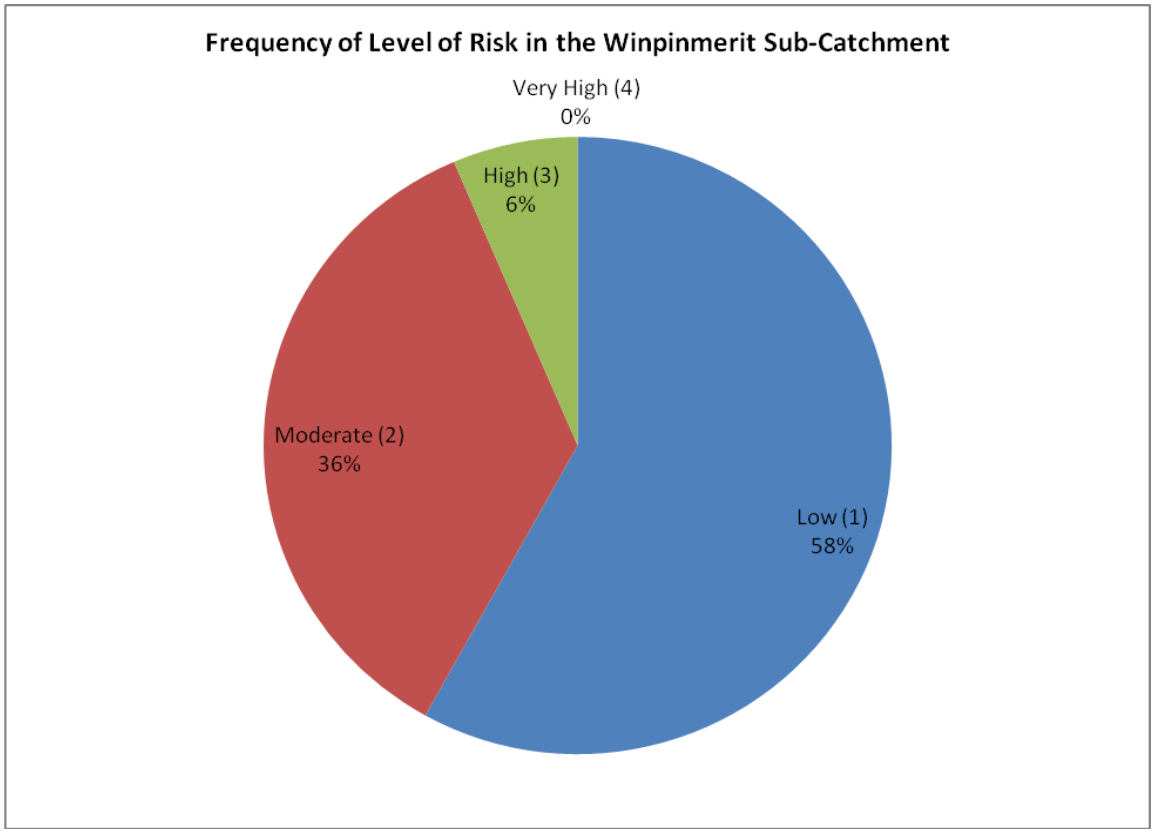


Figure 25. Frequency of risk levels identified in Winpinmerit sub-catchment

3.7.5 DATA RESULTS

The Risk Assessment process in the Winpinmerit sub-catchment was based on some local consultation and GIS data interpretation. This included using aerial photographs to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% grazing modified pastures).

Only qualitative information was used in the assessment of Winpinmerit sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.7.6 DISCUSSION

No water quality data and very limited consultation results was available in the Winpinmerit sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.7.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE WINPINMERIT SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Winpinmerit sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser

application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Winpinmerit sub-catchment or at a location that is representative of the USE Catchment.

3.8 KEILIRA SUB-CATCHMENT 7

3.8.1 DESCRIPTION OF THE AREA

The Keilira sub-catchment is a relatively small sub-catchment that is dominated by 'sheep and cattle grazing of modified pastures', which are surrounded by patches of scattered remnant native vegetation (de Jong 2005).

The Fairview drain is the only drain located in the Keilira sub-catchment, and it runs from east to west.

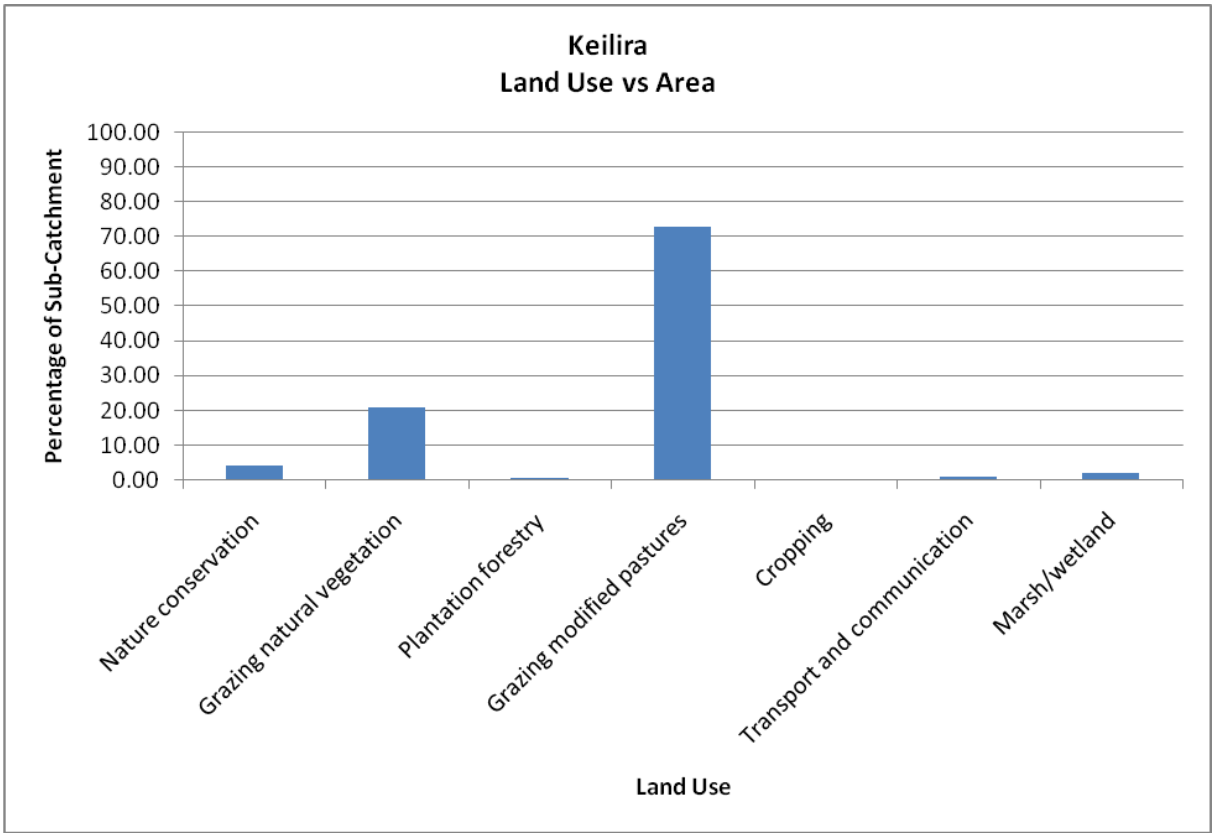
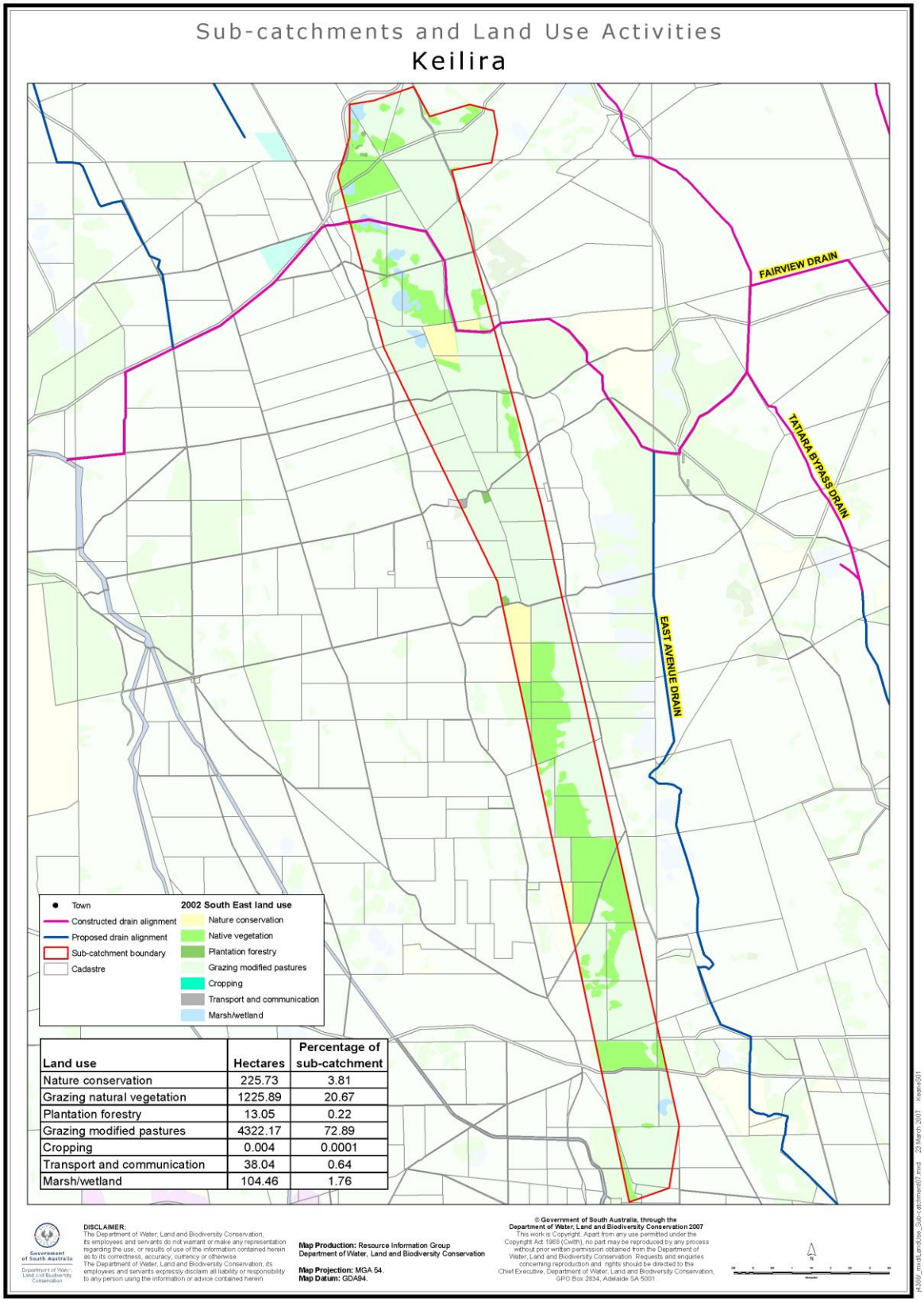


Figure 26. Land use versus area in Keilira sub-catchment



Land use	Hectares	Percentage of sub-catchment
Nature conservation	225.73	3.81
Grazing natural vegetation	1225.89	20.67
Plantation forestry	13.05	0.22
Grazing modified pastures	4322.17	72.89
Cropping	0.004	0.0001
Transport and communication	38.04	0.64
Marsh/wetland	104.46	1.76

Figure 27. Map of Keilira sub-catchment

3.8.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Keilira sub-catchment was based on data collected from limited local consultation (2.2).

3.8.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Keilira sub-catchment are to:

- Preserve and enhance seasonal wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macroinvertebrate populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.8.4 RISKS TO WATER QUALITY

3.8.4.1 SALINITY

Several specific salinity risks were identified in the Keilira sub-catchment – one 'high', two 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full

enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Keilira sub-catchment (shown in Table 19) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 19. Frequency of identified risk to water quality in Keilira sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

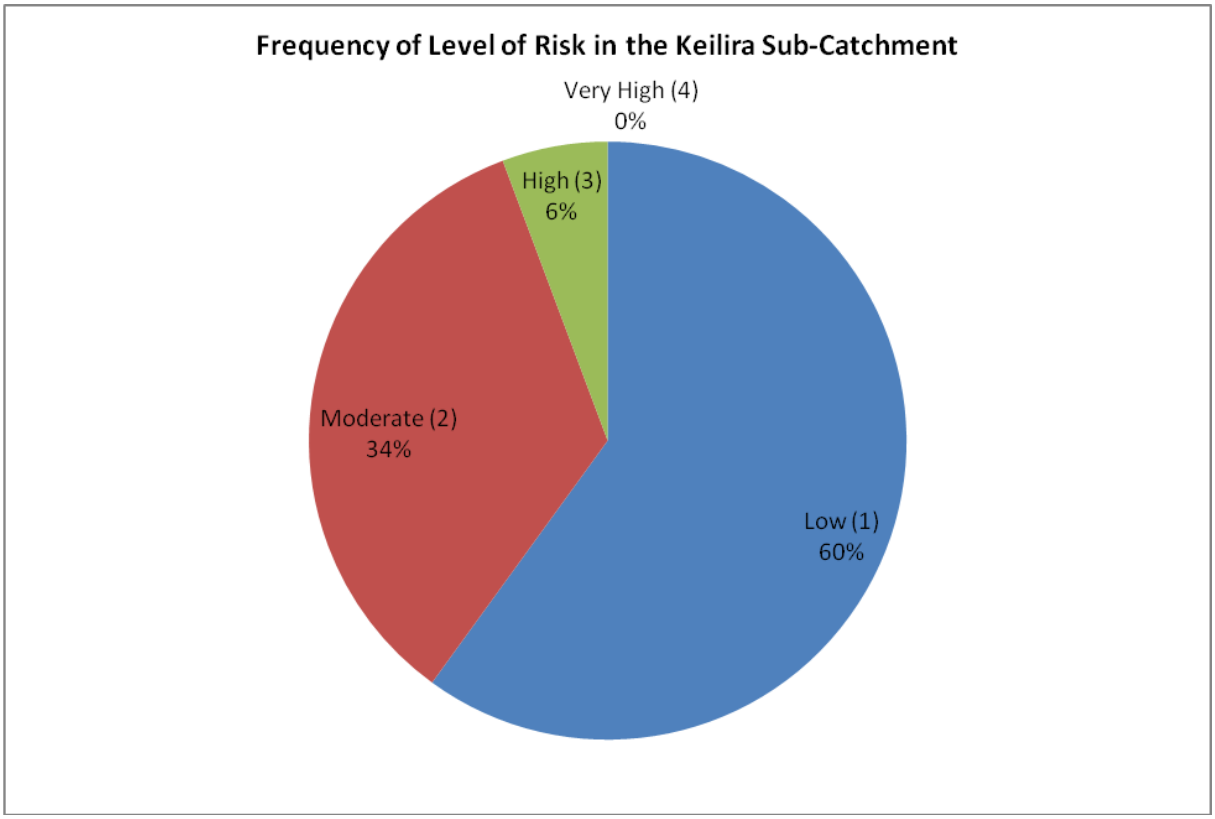


Figure 28. Frequency of risk levels identified in Keilira sub-catchment

3.8.5 DATA RESULTS

The Risk Assessment process in the Keilira sub-catchment was based on some local consultation and GIS data interpretation. This included using aerial photographs to identify

what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% 'grazing modified pastures').

Only qualitative information was used in the assessment of Keilira sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards which had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.8.6 DISCUSSION

No water quality data and very limited consultation results were available in the Keilira sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to the land use 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' was also classed as a nutrient risk, as was the use of fertilisers. This is an issue for investigation.

3.8.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE KEILIRA SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Keilira sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Keilira sub-catchment or at a location that is representative of the USE Catchment.

3.9 EAST AVENUE SUB-CATCHMENT 8

3.9.1 DESCRIPTION OF THE AREA

The East Avenue sub-catchment is dominated by the land use 'sheep and cattle grazing on modified pastures'. Within the sub-catchment are the East Avenue Swamps, which are a linear complex of wetlands that extend for ten kilometres. The drainage area for these swamps has been progressively intercepted by drains and consequently the wetlands rely mostly on water from the local catchment (de Jong 2005).

One drain is located within the East Avenue sub-catchment which is the East Avenue drain that runs from the south to the north where it connects to the Fairview drain.

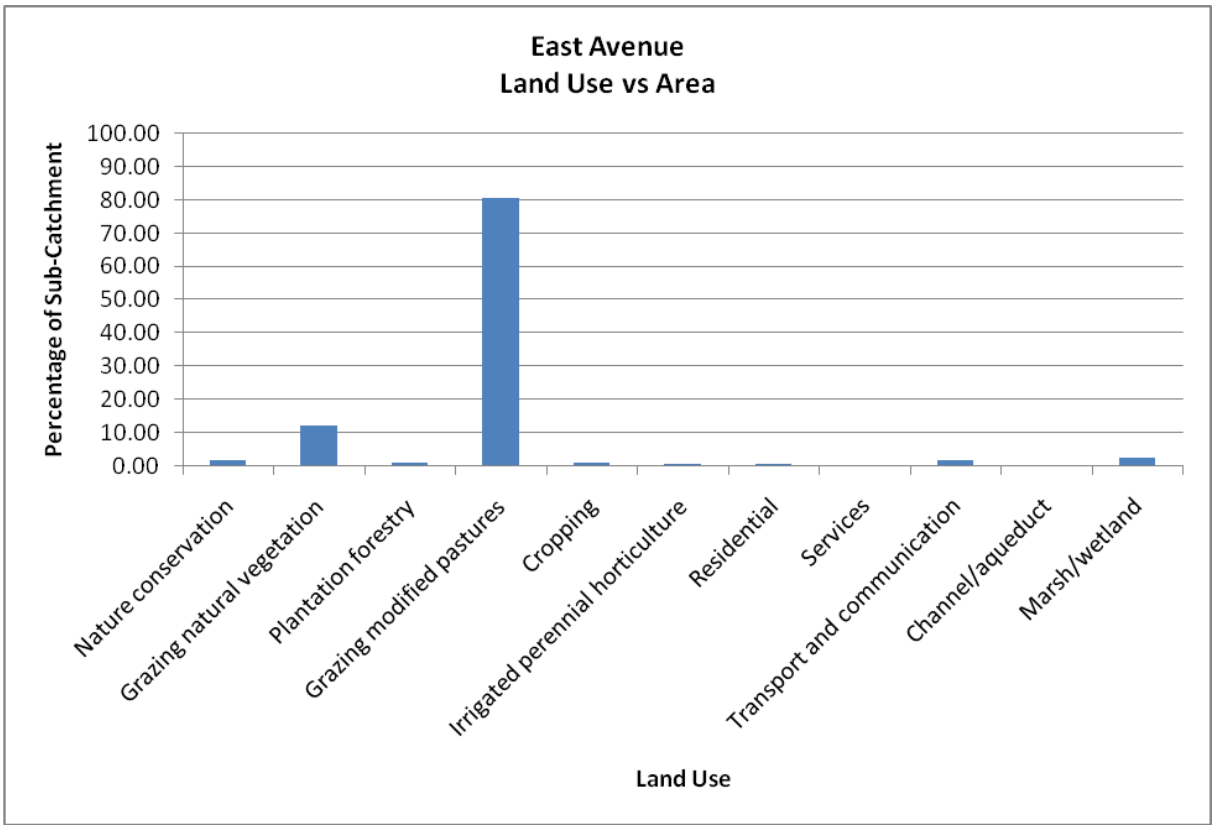
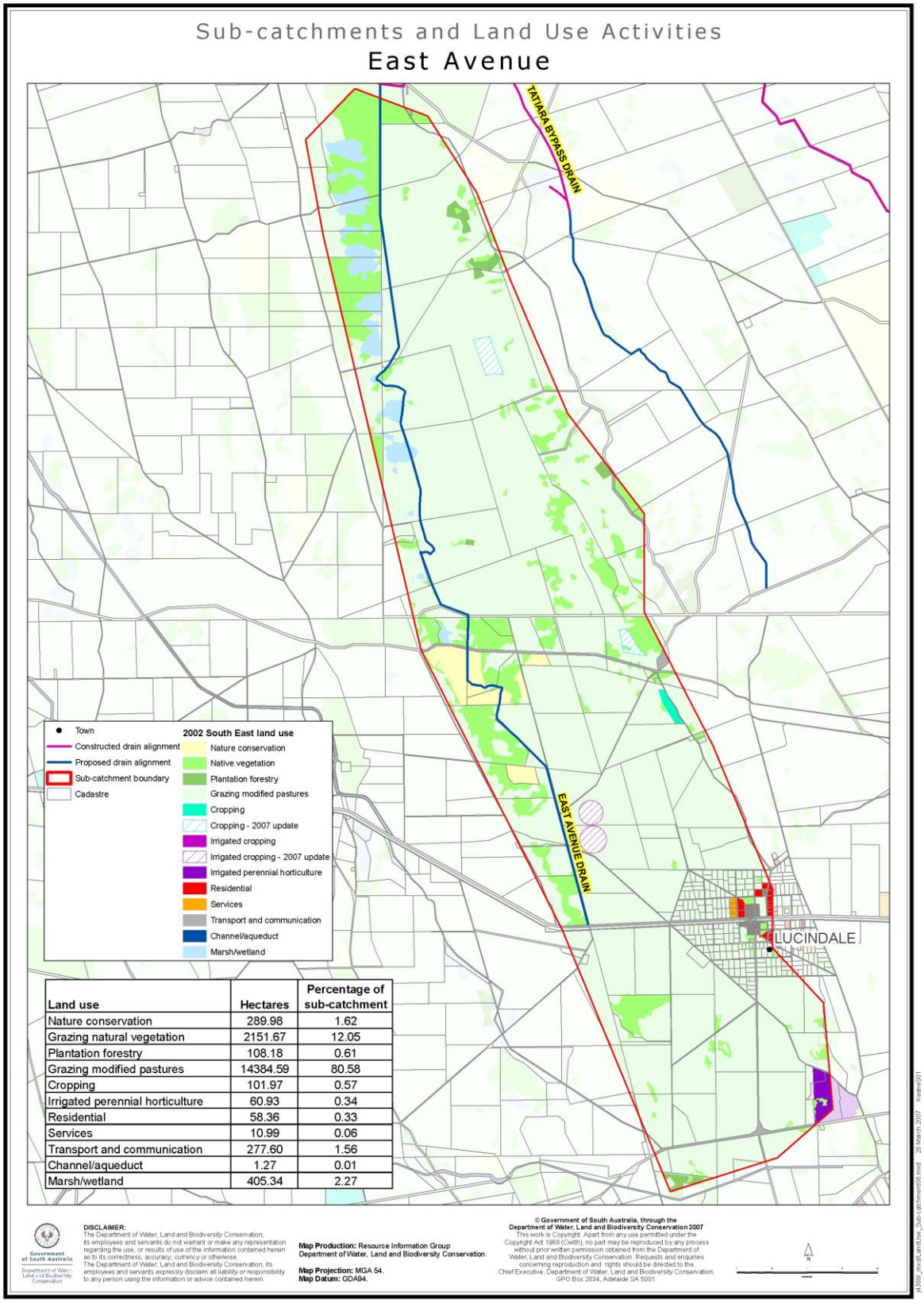


Figure 29. Land uses versus area in East Avenue sub-catchment

3.9.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the East Avenue sub-catchment was based on data collected through landholder consultation (see 2.2).



Land use	Hectares	Percentage of sub-catchment
Nature conservation	289.98	1.62
Grazing natural vegetation	2151.67	12.05
Plantation forestry	108.18	0.61
Grazing modified pastures	14384.59	80.58
Cropping	101.97	0.57
Irrigated perennial horticulture	60.93	0.34
Residential	58.36	0.33
Services	10.99	0.06
Transport and communication	277.60	1.56
Channel/aqueduct	1.27	0.01
Marsh/wetland	405.34	2.27

Figure 30. Map of East Avenue sub-catchment

3.9.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the East Avenue sub-catchment are to:

- Restore and enhance seasonal wetlands
- Restore submerged aquatic vegetation
- Restore emergent aquatic vegetation
- Restore environmental flow requirements
- Restore breeding habitat for waterbirds
- Restore macro-invertebrate population.

Each management goal has a list of associated pressures and indicators which these can be found in Appendix 2.

3.9.4 RISKS TO WATER QUALITY

3.9.4.1 SALINITY

Several specific salinity risks were identified in the East Avenue sub-catchment – one 'high', two 'moderate, and two 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

The other 'low' risk is attributed to 'deep ripping'. 'Deep ripping' is the process of churning the soil, bringing lower soil profiles to the surface. This may cause salts to come to the surface if the lower soil profiles are saline; these salts may then runoff into drains and watercourses during rainfall events and eventually find their way to aquatic ecosystems.

3.9.4.2 NUTRIENTS

Fertiliser application in the land use 'irrigated cropping' was identified as a 'high' risk in the East Avenue sub-catchment. Although 'irrigated cropping' does not make up a large area of the East Avenue sub-catchment, it has been identified as a 'high' risk as one of the fertilisers used (Potash) is applied in the wet months of the year (July/August/September) as it requires rain to 'wash it in', otherwise it simply sits on the surface. This increases the likelihood of the fertiliser transporting into the watertable, and eventually making its way to the wetlands and floodways which could cause eutrophication and subsequent algal blooms.

3.9.4.3 PESTICIDES

'Cropping' and 'irrigated cropping' both present a 'high' pesticide risk in the East Avenue sub-catchment, both associated with 'event drift' in the application of pesticides. Although these land uses combined do not offer a high percentage of the total sub-catchment area (<3%) the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks identified in the East Avenue sub-catchment (shown in Table 20) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 20. Frequency of identified risk to water quality in East Ave sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	**Total**	**Percentage**
Low (1)	7	9	3	0	0	10	0	2	**31**	**53**
Moderate (2)	5	4	1	0	0	10	0	2	**22**	**38**
High (3)	1	0	0	1	0	2	0	1	**5**	**9**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**13**	**13**	**4**	**1**	**0**	**22**	**0**	**5**	58	
Percentage	**22**	**22**	**7**	**2**	**0**	**38**	**0**	**9**		

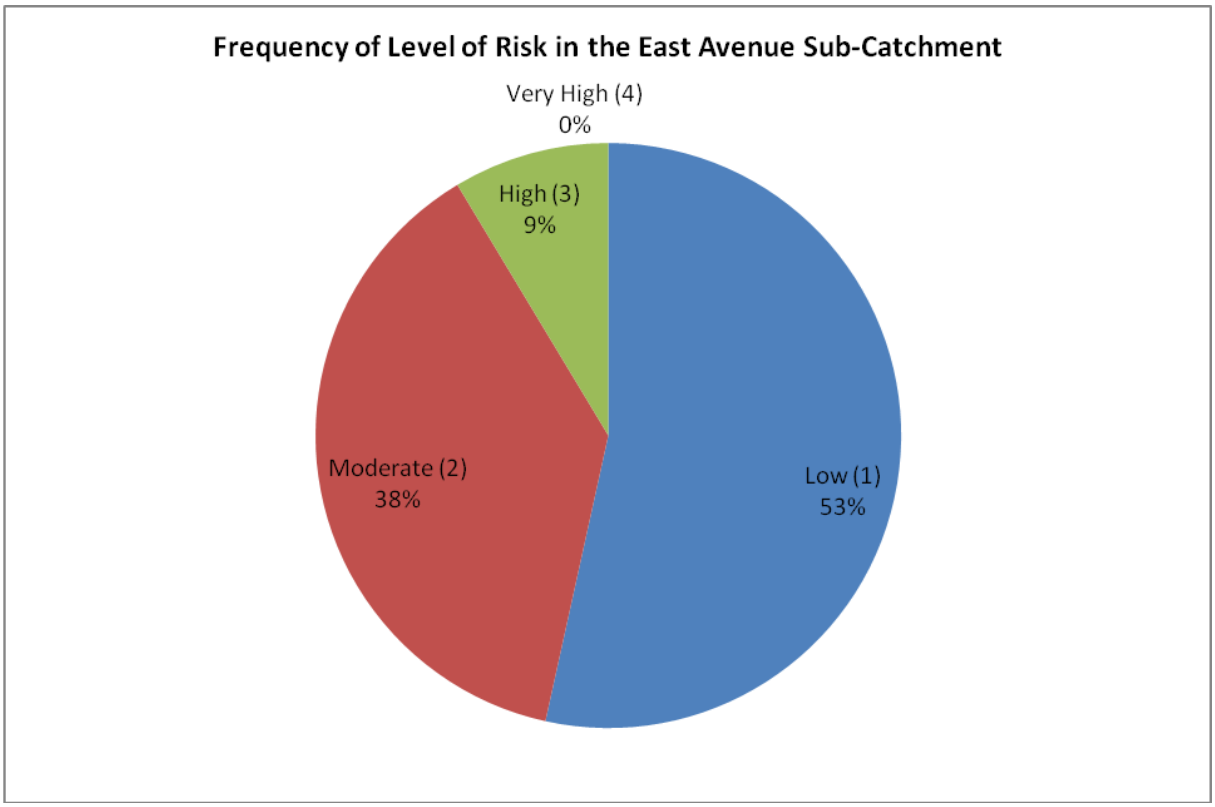


Figure 31. Frequency of risk levels identified in East Ave sub-catchment

3.9.5 DATA RESULTS

The Risk Assessment process in the East Ave sub-catchment was based on landholder consultation and GIS data interpretation. This included using aerial photographs and interviewing landholder/s in the sub-catchment to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% 'grazing modified pastures'). The process also identified land use practices such as land 'renovation' and frequency, duration and timing of the use of pesticides, fertilisers etc, as well as any other hazards perceived by the landholder/s.

Only qualitative information was used in the assessment of East Ave sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.9.6 DISCUSSION

No water quality data was available in the East Avenue sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.9.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE EAST AVENUE SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the East Avenue sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the East Avenue sub-catchment or at a location that is representative of the USE Catchment.

3.10 BAKERS RANGE SUB-CATCHMENT 9

3.10.1 DESCRIPTION OF THE AREA

The Bakers Range sub-catchment is the southernmost sub-catchment in the Upper South East project area. The dominant land uses in the area are 'grazing modified pastures' and 'plantation forestry'. At the eastern end of the sub-catchments exist the Southern Bakers Range Swamps, which comprise of open water habitats surrounded by woodland and shrubland vegetation (de Jong 2005).

The Bakers Range drain and the Lower South East Connector–Bakers Range (southern end) run from the south to the north end of the sub-catchment, where they connect with the Fairview drain and Bakers Range Watercourse and continue onto the Watervalley drain.

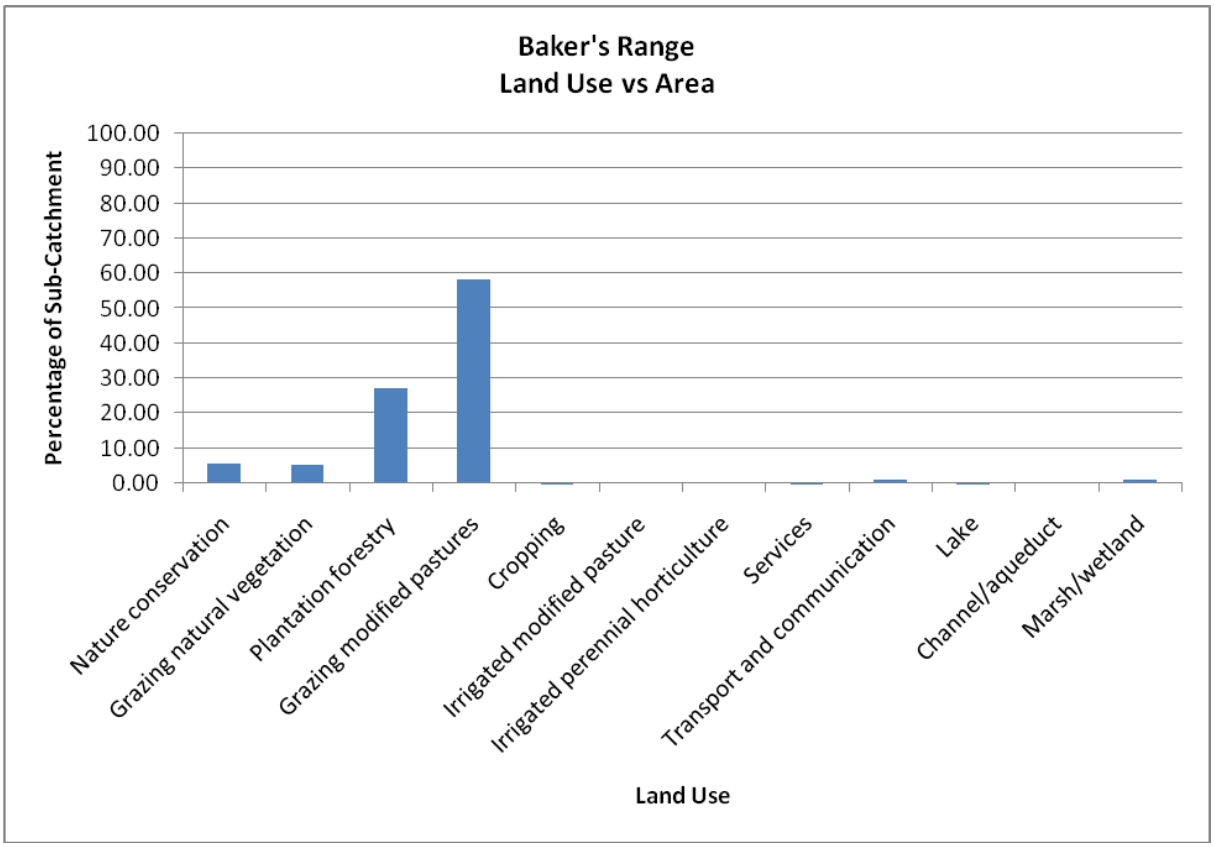


Figure 32. Land use versus area in Bakers Range sub-catchment

3.10.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Bakers Range sub-catchment was based on data collected through landholder consultation (see section 2.2).

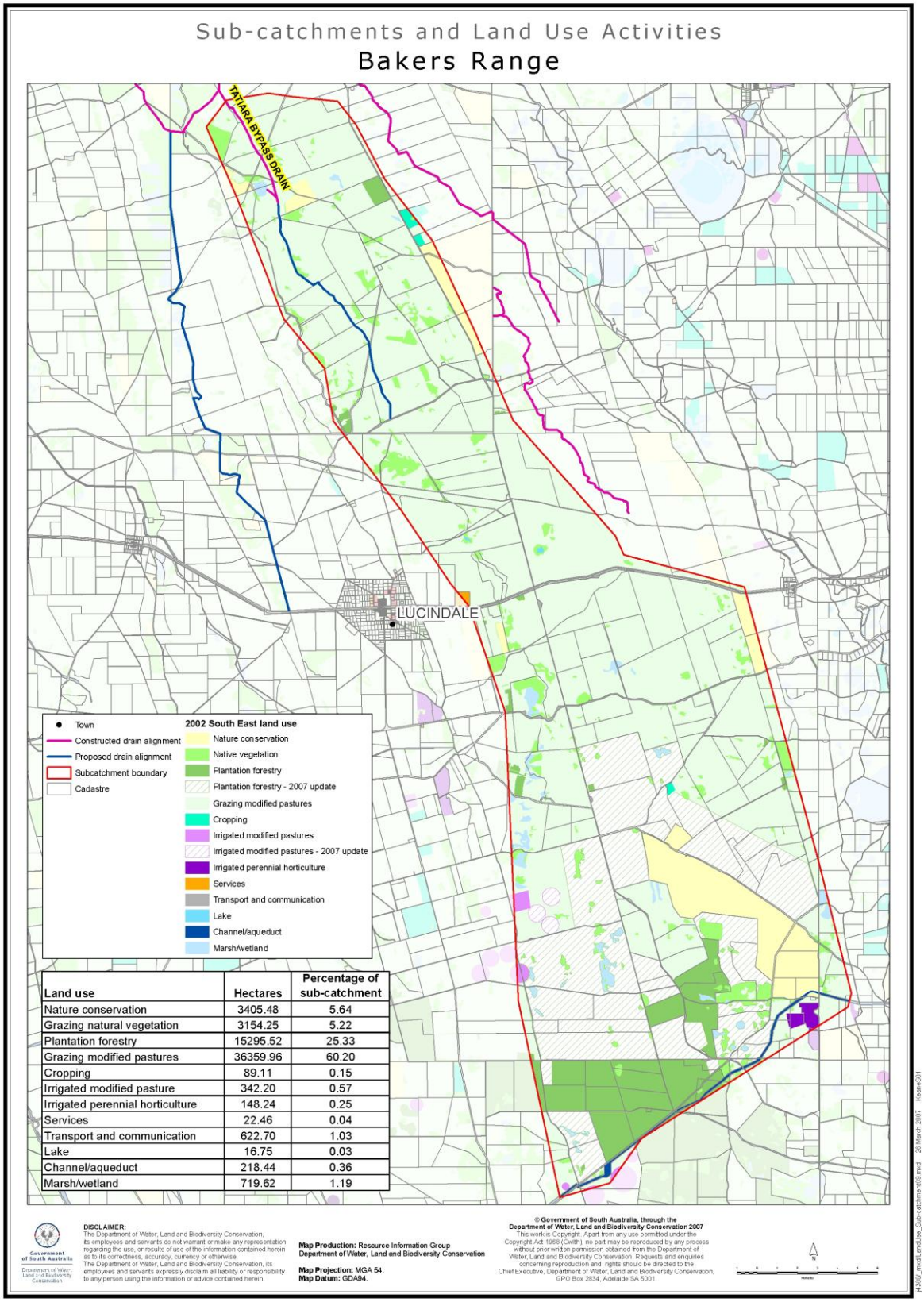
3.10.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Bakers Range sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.



Land use	Hectares	Percentage of sub-catchment
Nature conservation	3405.48	5.64
Grazing natural vegetation	3154.25	5.22
Plantation forestry	15295.52	25.33
Grazing modified pastures	36359.96	60.20
Cropping	89.11	0.15
Irrigated modified pasture	342.20	0.57
Irrigated perennial horticulture	148.24	0.25
Services	22.46	0.04
Transport and communication	622.70	1.03
Lake	16.75	0.03
Channel/aqueduct	218.44	0.36
Marsh/wetland	719.62	1.19

Figure 33. Map of Bakers Range sub-catchment

3.10.4 RISKS TO WATER QUALITY

3.10.4.1 NUTRIENTS

Fertiliser application in the land use 'irrigated cropping' was identified as a 'high' risk in the Bakers Range sub-catchment. As in the East Avenue sub-catchment, 'irrigated cropping' does not account for a large area of the sub-catchment, however it has been identified as a 'high' risk as many of the fertilisers used are applied in the wet months of the year (July/August/September). This increases the likelihood of the fertiliser transporting into the watertable, and eventually making its way to the wetlands and floodways, which could cause eutrophication and subsequent algal blooms.

3.10.4.2 SALINITY

Several specific salinity risks were identified in the Bakers Range sub-catchment – one 'high', five 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

'Leakage (subsurface into watertable or aquatic environment)' is attributed to irrigation. This is due to excess water (via irrigation) being drawn into the watertable, which, over time, could cause the watertable to rise, bringing salts to the surface and causing the groundwater to become increasingly saline.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.10.4.3 PESTICIDES

As in the East Avenue sub-catchment, 'cropping' and 'irrigated cropping' both presented a 'high' pesticide risk in the Bakers Range sub-catchment, both associated with 'event drift' in the application of pesticides. Although these land uses combined do not offer a high

percentage of the total sub-catchment area, the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks in the Baker's Range sub-catchment were common to the USE Catchment, refer section 3.2.

Table 20. Frequency of identified risk to water quality in Baker's Range sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	12	15	3	0	0	17	0	1	**48**	**53**
Moderate (2)	9	7	1	0	0	15	0	5	**37**	**41**
High (3)	1	0	0	1	0	2	0	1	**5**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**22**	**22**	**4**	**1**	**0**	**34**	**0**	**7**	90	
Percentage	**24**	**24**	**4**	**1**	**0**	**38**	**0**	**8**	**100**	

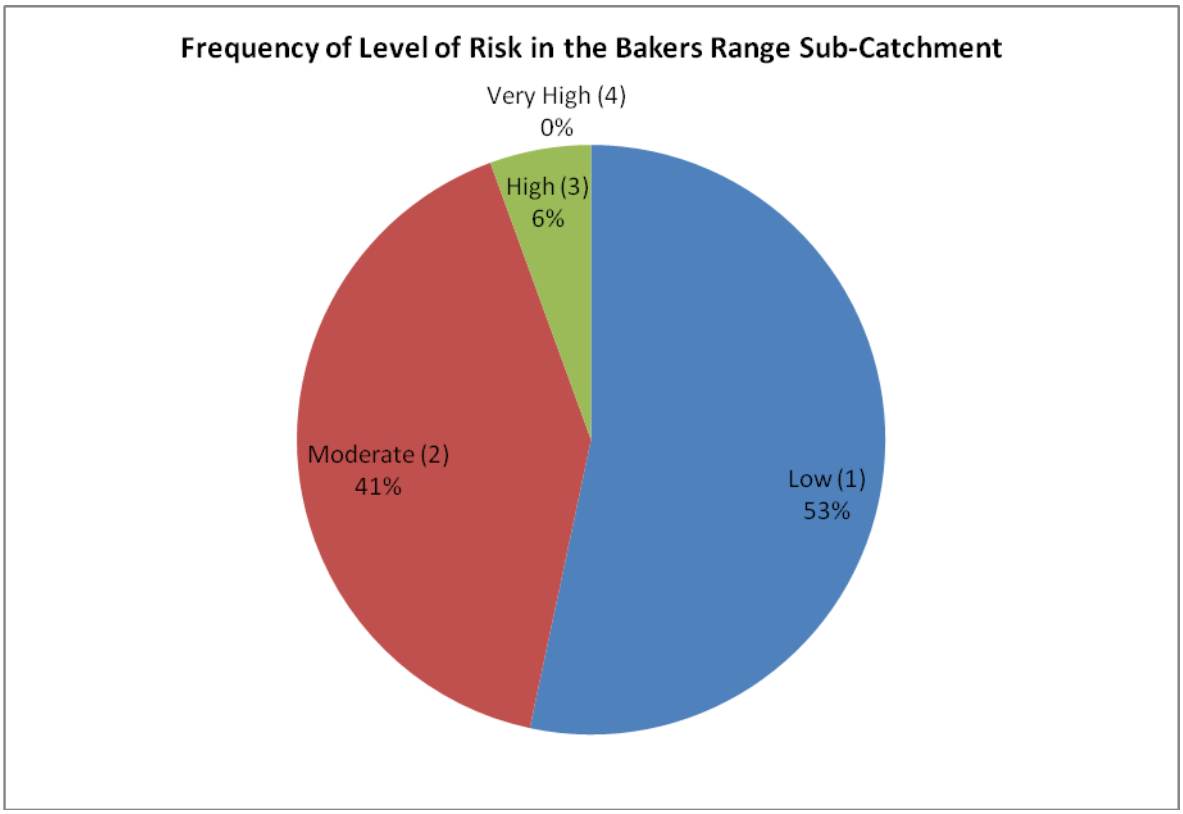


Figure 34. Frequency of risk levels identified in Baker's Range sub-catchment

3.10.5 DATA RESULTS

The Risk Assessment process in the Bakers Range sub-catchment was based on landholder consultation and GIS data interpretation. This included using aerial photographs and interviewing landholder/s in the sub-catchment to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% 'grazing modified pastures'). The process also identified land use practices such as land 'renovation' and frequency,

duration and timing of the use of pesticides, fertilisers etc, as well as any other hazards perceived by the landholder/s.

Only qualitative information was used in the assessment of Bakers Range sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.10.6 DISCUSSION

No water quality data was available in the Bakers Range sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

Bakers Range sub-catchment is also an area of irrigation, and as a consequence salinity is a risk to water quality. Constant irrigation may cause excess water to be drawn into the watertable, causing it to rise, bringing salts to the surface.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.10.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE BAKERS RANGE SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Bakers Range sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be

conducted in the Bakers Range sub-catchment or at a location that is representative of the USE Catchment.

3.11 FAIRVIEW SUB-CATCHMENT 10

3.11.1 DESCRIPTION OF THE AREA

The Fairview sub-catchment sits between the Bakers Range sub-catchment and the Marcollat sub-catchment and is dominated by the land use 'sheep and cattle grazing of modified pastures'.

Two drains are located in the Fairview sub-catchment – the Fairview drain, which runs south-east to west, and the Tresant drain, which is located slightly south of Fairview drain.

The Tresant drain acts as a waterway for surface water and a weir exists on the drain to divert water into Bloomfield Swamp South. It also acts to alleviate flooding on a local landholder's property and to provide a potential source of freshwater for the Fairview drain (de Jong 2005).

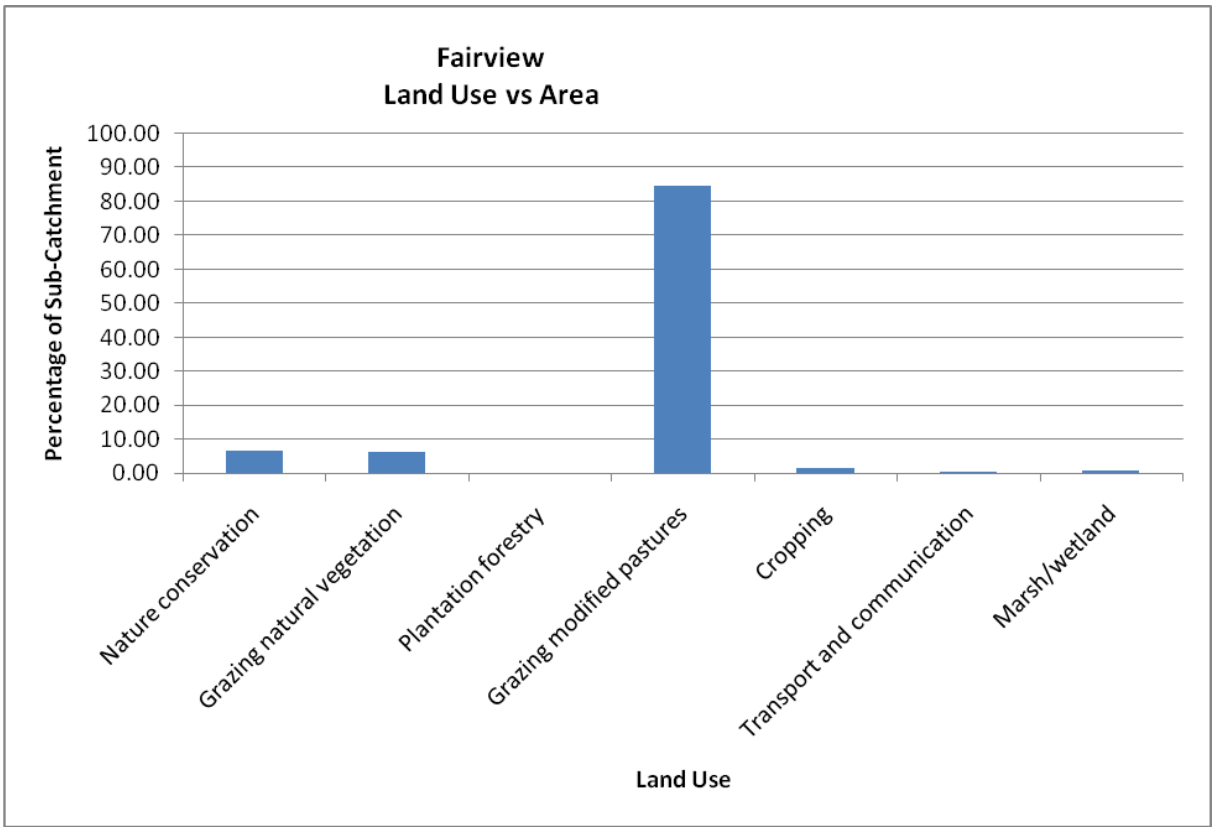
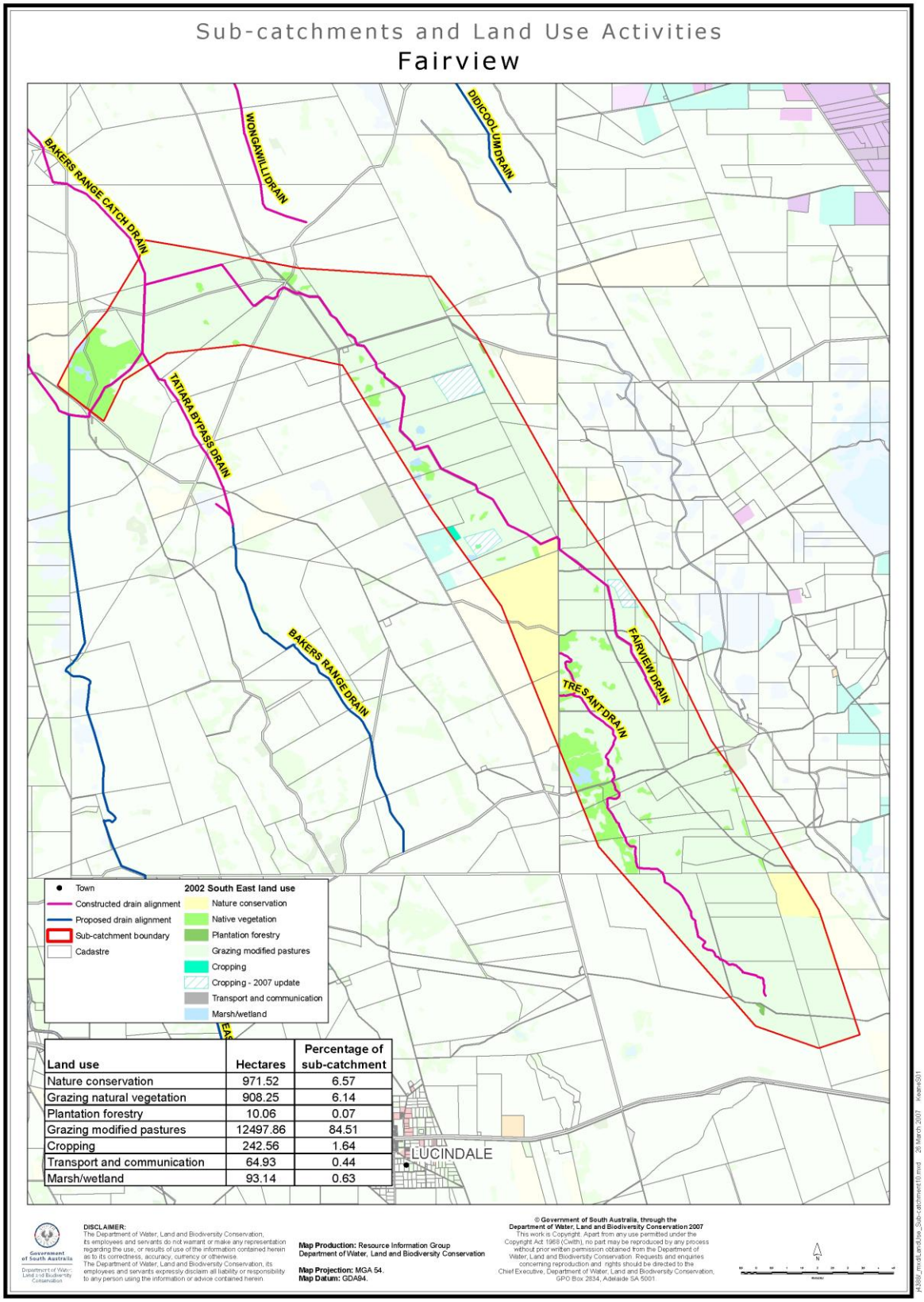


Figure 35. Land use versus area in Fairview sub-catchment



Land use	Hectares	Percentage of sub-catchment
Nature conservation	971.52	6.57
Grazing natural vegetation	908.25	6.14
Plantation forestry	10.06	0.07
Grazing modified pastures	12497.86	84.51
Cropping	242.56	1.64
Transport and communication	64.93	0.44
Marsh/wetland	93.14	0.63

Figure 36. Map of Fairview sub-catchment

3.11.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Fairview sub-catchment was based on data collected through landholder consultation (see section 2.2).

3.11.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Fairview sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.11.4 RISKS TO WATER QUALITY

3.11.4.1 SALINITY

Several specific salinity risks were identified in the Fairview sub-catchment – one 'high', two 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows

through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.11.4.2 PESTICIDES

One significant ('high') pesticide risk was identified in the Fairview sub-catchment—this was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. Although a relatively low portion of the Fairview sub-catchment is used for cropping, the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks identified in the Fairview sub-catchment (shown in Table 21) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 21. Frequency of identified risk to water quality in Fairview sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	5	3	0	0	10	0	1	**22**	**51**
Moderate (2)	5	3	1	0	0	7	0	2	**18**	**42**
High (3)	0	0	0	1	0	1	0	1	**3**	**7**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**8**	**8**	**4**	**1**	**0**	**18**	**0**	**4**	43	
Percentage	**19**	**19**	**9**	**2**	**0**	**42**	**0**	**9**	**100**	

3.11.5 DATA RESULTS

The Risk Assessment process in the Fairview sub-catchment was based on landholder consultation and GIS data interpretation. This included using aerial photographs and interviewing landholder/s in the sub-catchment to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% 'grazing modified pastures'). The process also identified land use practices such as land 'renovation' and frequency, duration and timing of pesticides, fertilisers etc, as well as any other hazards perceived by the landholder/s.

Only qualitative information was used in the assessment of Fairview sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

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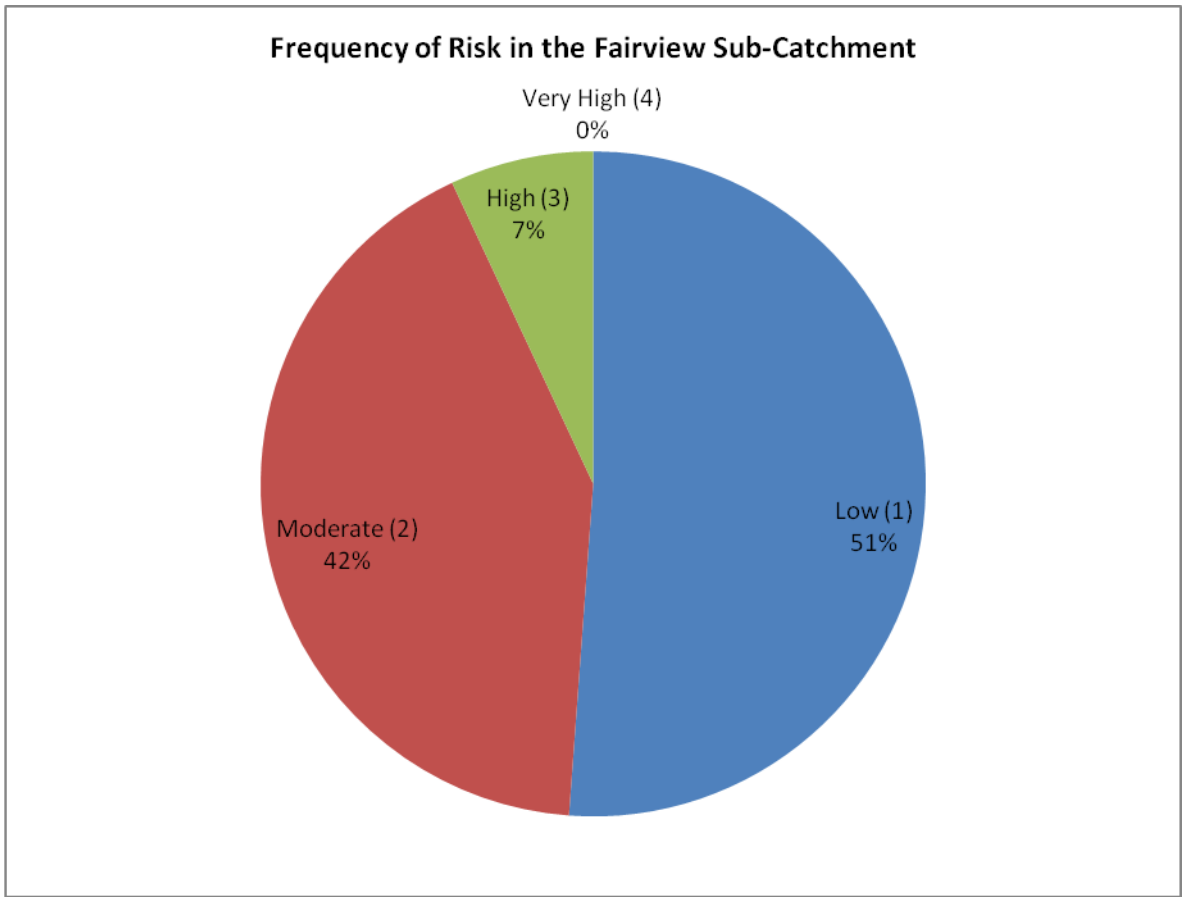


Figure 37. Frequency of risk levels identified in Fairview sub-catchment

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.11.6 DISCUSSION

No water quality data was available in the Fairview sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

3.11.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE FAIRVIEW SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Fairview sub-catchment or at a location that is representative of the USE Catchment.

3.12 MARCOLLAT SUB-CATCHMENT 11

3.12.1 DESCRIPTION OF THE AREA

The Marcollat sub-catchment is one of the biggest sub-catchments in the Upper South East Program study area. It is an important sub-catchment as it acts as a conduit for water from Victoria and contains several important waterways such as Naracoorte Creek and Mosquito Creek. The Marcollat sub-catchment also contains two townships, Naracoorte and Padthaway, and is dominated by the grazing of modified pastures.

The Diddicoolum drain is located at the northern end of the sub-catchment—it runs from south to north where it intercepts the Rosemary Downs drain and then runs to north-west connecting to the Watervalley drain.

3.12.2 HAZARD IDENITIFICATION PROCESS

The hazard identification process for the Marcollat sub-catchment was based on data collected through extensive Landholder and local government consultation (see section 2.2).

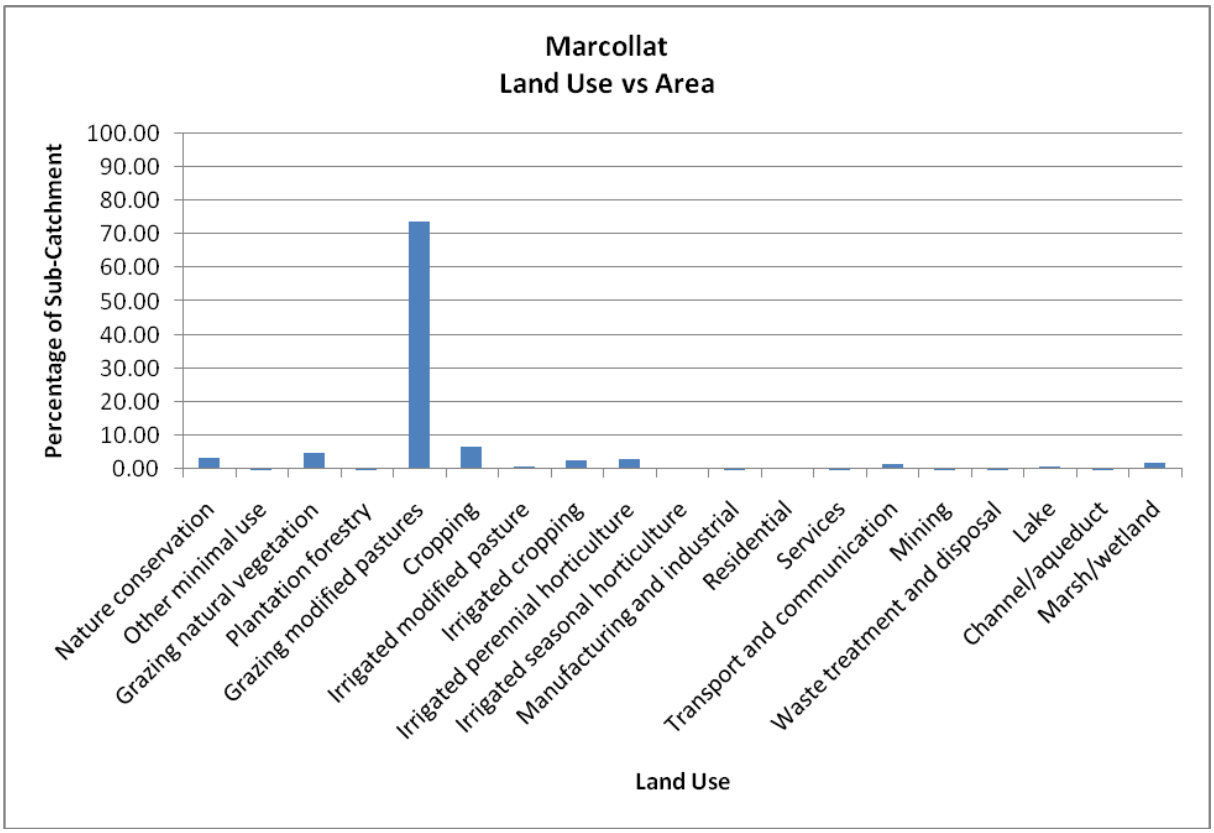


Figure 38. Land use versus area in Marcollat sub-catchment

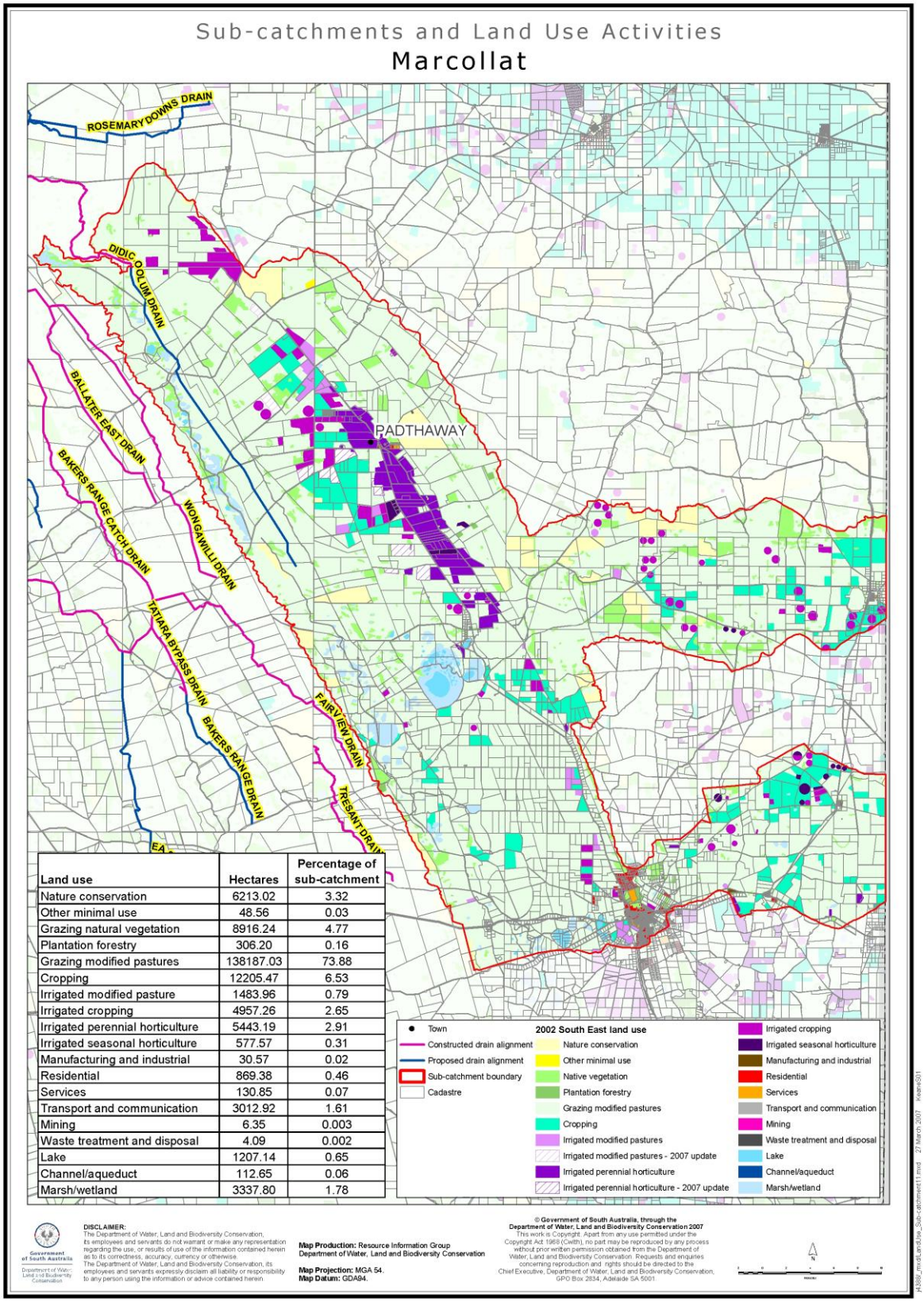
3.12.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Marcollat sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations

Each management goal has a list of associated pressures and indicators, which can be found in Appendix 2.



Land use	Hectares	Percentage of sub-catchment
Nature conservation	6213.02	3.32
Other minimal use	48.56	0.03
Grazing natural vegetation	8916.24	4.77
Plantation forestry	306.20	0.16
Grazing modified pastures	138187.03	73.88
Cropping	12205.47	6.53
Irrigated modified pasture	1483.96	0.79
Irrigated cropping	4957.26	2.65
Irrigated perennial horticulture	5443.19	2.91
Irrigated seasonal horticulture	577.57	0.31
Manufacturing and industrial	30.57	0.02
Residential	869.38	0.46
Services	130.85	0.07
Transport and communication	3012.92	1.61
Mining	6.35	0.003
Waste treatment and disposal	4.09	0.002
Lake	1207.14	0.65
Channel/aqueduct	112.65	0.06
Marsh/wetland	3337.80	1.78

Figure 39. Map of Marcollat sub-catchment

3.12.4 RISKS TO WATER QUALITY

3.12.4.1 NUTRIENTS

'Irrigated cropping' and 'waste treatment and disposal' were both identified as 'high' nutrient risk land uses.

'Irrigated cropping' is the fifth highest land use in the Marcollat sub-catchment. Fertiliser (the hazard responsible for the 'high' risk) is applied twice a year and is often applied via the flood irrigation system. Fertiliser application has been classed as a 'high' risk as the nature and frequency of fertiliser application increases the likelihood of the fertiliser transporting into the watertable, and eventually making its way to the wetlands and floodways, which could cause eutrophication and subsequent algal blooms. Urea and Super Phosphate are some of the more commonly used fertilisers.

The townships of Naracoorte and Padthaway are located within the Marcollat sub-catchment. This presents a new sweep of hazards not seen in the farming areas of the USE Catchment. One such hazard is septic tank overflow, and even though 'waste treatment and disposal' accounts for a very small amount of area in the Marcollat sub-catchment, the consequence of septic tanks and the associated management and infrastructure failing would be high. The likelihood of such failure is also high, as many of the septic tanks in the area are not properly sealed and are located close to the Naracoorte creek.

3.12.4.2 ORGANIC MATTER

Marcollat sub-catchment has a significant number of organic matter risks (refer Table 22), however the majority of this risk is in the 'low' category, with only one 'high' risk (described in section 3.1.4.2) and few 'moderate' risks. The reason that there are many organic matter risks could be due to Marcollat being one of the largest sub-catchments in the USE Catchment (along with Mount Charles), with many different land uses. As Marcollat contains two townships and at least one dairy, there are many different types of effluent ponds located within the sub-catchment: abattoir, dairy, feedlot, industrial, sewage and stockyard. The effluent ponds may leak, overflow or fail, which could cause large amounts of organic matter to enter the watertable or aquatic environment. They have been classed as 'low' and 'moderate' as the likelihood of such events occurring is low because of the stringent operating and construction procedures in place.

There are also several organic matter risks associated with sewage tanks in the townships; these are for the same reasons as described in section 3.12.4.1 above.

3.12.4.3 SALINITY

Several specific salinity risks were identified in the Marcollat sub-catchment – one 'high', five 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The ‘moderate’ risks were attributed to the hazard ‘management/infrastructure failure’. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a ‘moderate’ risk as if this was to happen, there would be significant consequences.

The ‘low’ risk is also attributed to ‘management/infrastructure failure’ and the hazard event ‘event discharge (during rainfall events)’. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.12.4.4 HEAVY METALS

Only two sub-catchments in the USE Catchment were identified to contain heavy metal risks—Marcollat and Mount Charles—this may be due to these being the only sub-catchments to contain townships. All heavy metal risk in the Marcollat sub-catchment was classed in the ‘low’ and ‘moderate’ risk categories.

Historical contaminated sites—i.e. sites that are known to be contaminated and have been remediated and monitored—are classed as ‘low’ risk. There is some chance that these sites may cause leakage of heavy metals into the watertable, however the likelihood is greatly reduced due to the mitigation procedures currently in place such as the construction of a physical buffer between the contaminated soil and the watertable.

Landfills were seen to be more of a threat and were placed in the ‘moderate’ risk category. Currently, township landfill is stored on a rubble pad in Frances before it is relocated to the Naracoorte landfill, which is almost full (consideration is being made whether to cart all waste away from the region). Landfills have the potential to become a ‘high’ risk, however due to the mitigation procedures in place, such as the waste being contained in clay lined cells, it has been downgraded to ‘moderate’.

3.12.4.5 HYDROCARBONS

As with heavy metals, only two sub-catchments in the USE Catchment were identified to contain hydrocarbon risk—Marcollat and Mount Charles—this may be due to these being the only sub-catchments to contain townships. All hydrocarbon risk in the Marcollat sub-catchment was classed in the ‘low’ and ‘moderate’ risk categories.

Historical contaminated sites (for the reasons mentioned above in section 3.12.4.4), fuel storage, and transport routes were classed as ‘low’ risk hazards. It is possible but unlikely that hazardous events such as leakage from fuel storage containers or fuel transport containers/vehicles would occur. ‘Stormwater infrastructure’ failing was seen as a larger threat and was classed as a ‘moderate’ risk. Runoff from highways, local sealed and unsealed roads and the local aerodrome could contain hydrocarbons, which flow into watercourses and drains with no mitigation.

3.12.4.6 PESTICIDES

'Cropping' and 'irrigated cropping' both presented a 'high' pesticide risk in the Marcollat sub-catchment, both associated with 'event drift' in the application of pesticides. These land uses combined make up a significant percentage of the total sub-catchment area—about 10%—hence the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

In the Marcollat sub-catchment a 'low' pesticide risk was associated with an uncommon hazard – 'stormwater infrastructure'. This hazard presented only in the Marcollat sub-catchment because in the town of Naracoorte, stormwater is allowed to flow straight into Naracoorte Creek with no treatment, and therefore there is a possibility that pesticides used by local council (for roadside weed control, on the local golf course, etc.) could run off into the creek. However, this is classed as a 'low' risk as the concentration and amount of pesticide used and the likelihood of the pesticide reaching the environmental values is low.

Table 22. Frequency of identified risk to water quality in Marcollat sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	**Total**	**Percentage**
Low (1)	29	14	8	19	1	21	5	1	**98**	**62**
Moderate (2)	14	11	3	4	3	12	1	5	**53**	**34**
High (3)	2	1	0	1	0	2	0	1	**7**	**4**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**45**	**26**	**11**	**24**	**4**	**35**	**6**	**7**	158	
Percentage	**28**	**16**	**7**	**15**	**3**	**22**	**4**	**4**	**100**	

3.12.5 DATA RESLUTS

The Risk Assessment process in the Marcollat sub-catchment was based on extensive landholder and local government consultation, and GIS data interpretation. This included using aerial photographs and interviewing landholder/s in the sub-catchment to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% 'grazing modified pastures'). The process also identified land use practices such as land 'renovation' and frequency, duration and timing of pesticides, fertilisers etc, as well as any other hazards perceived by the landholder/s.

Only qualitative information was used in the assessment of Marcollat sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

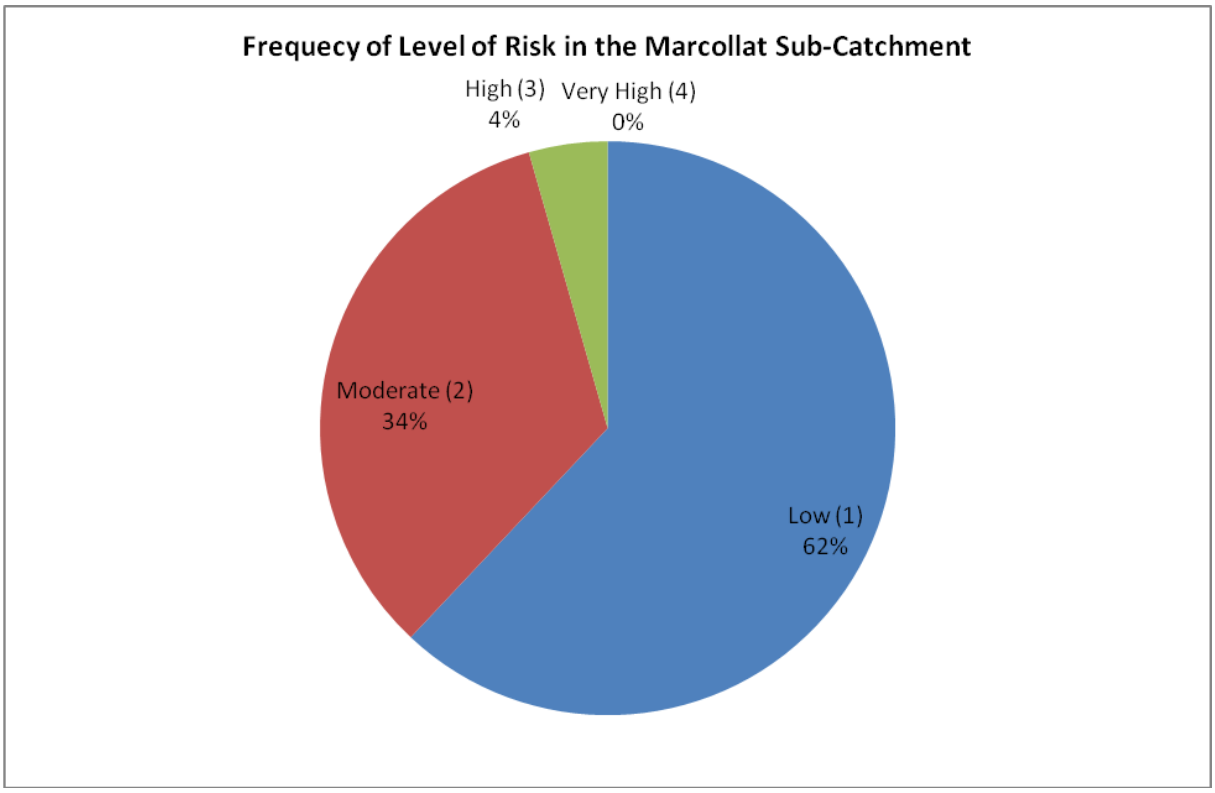


Figure 40. Frequency of risk levels identified in Marcollat sub-catchment

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.12.6 DISCUSSION

There is no available water quality data in the Marcollat sub-catchment, however extensive consultation was carried out in this sub-catchment.

The Marcollat sub-catchment contains within its boundaries the two townships of Naracoorte and Padthaway, and at least one dairy and abattoir. Risks to water quality such as heavy metals and hydrocarbons are observed in this sub-catchment, and such risks as nutrient and organic matter are exacerbated due to the presence of the dairy. However, some of the risk caused by dairies and abattoirs is mitigated through stringent operating procedures and EPA licensing.

It was also deduced that many septic tanks in the area of Naracoorte were unsealed or have not been maintained. This is a nutrient and organic matter risk as sewage could be leaking into the groundwater and eventually moving into Naracoorte Creek.

Heavy Metals and hydrocarbons were risks to water quality not observed in other sub-catchments (other than Mount Charles) as part of this Risk Assessment. This is due to the

townships presenting many unique hazards and hazardous events such as fuel storage areas and landfills. Within the town of Naracoorte there is also at least one historical contaminated site. This has been classed as a 'low' risk as the site was sealed under EPA supervision.

It was also discovered that there is no regular monitoring program in Naracoorte Creek to determine whether these risks are just perceived or real. This is an issue for investigation.

Marcollat sub-catchment is also an area of irrigation, and as a consequence salinity is a risk to water quality. Constant irrigation may cause excess water to be drawn into the watertable, causing it rise, bringing salts to the surface.

Pesticides also presented as 'low', 'moderate' and high' risks. The 'moderate' and 'high' risks were due to similar reasons to other sub-catchments such as 'pesticide spraying', however Marcollat presented a unique pesticide hazard associated with 'stormwater infrastructure'. Small amounts of pesticides are used around the township and on golf courses for general weed control. These pesticides may run off into the stormwater infrastructure and eventually into Naracoorte Creek.

3.12.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE MARCOLLAT SUB-CATCHMENT

It is recommended that a regular monitoring program for Naracoorte Creek be instigated, which should include nutrient and heavy metal sampling.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Marcollat sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Marcollat sub-catchment or at a location that is representative of the USE Catchment.

3.13 WONGAWILLI SUB-CATCHMENT 12

3.13.1 DESCRIPTION OF THE AREA

The Wongawilli sub-catchment is dominated by the land use 'grazing of modified pastures', which covers up to 95% of the area. Two drains are located within the sub-catchment – the Ballater East drain and the Wongawilli drain. These drains connect at the northern end of the sub-catchment and continue north to the Watervalley drain.

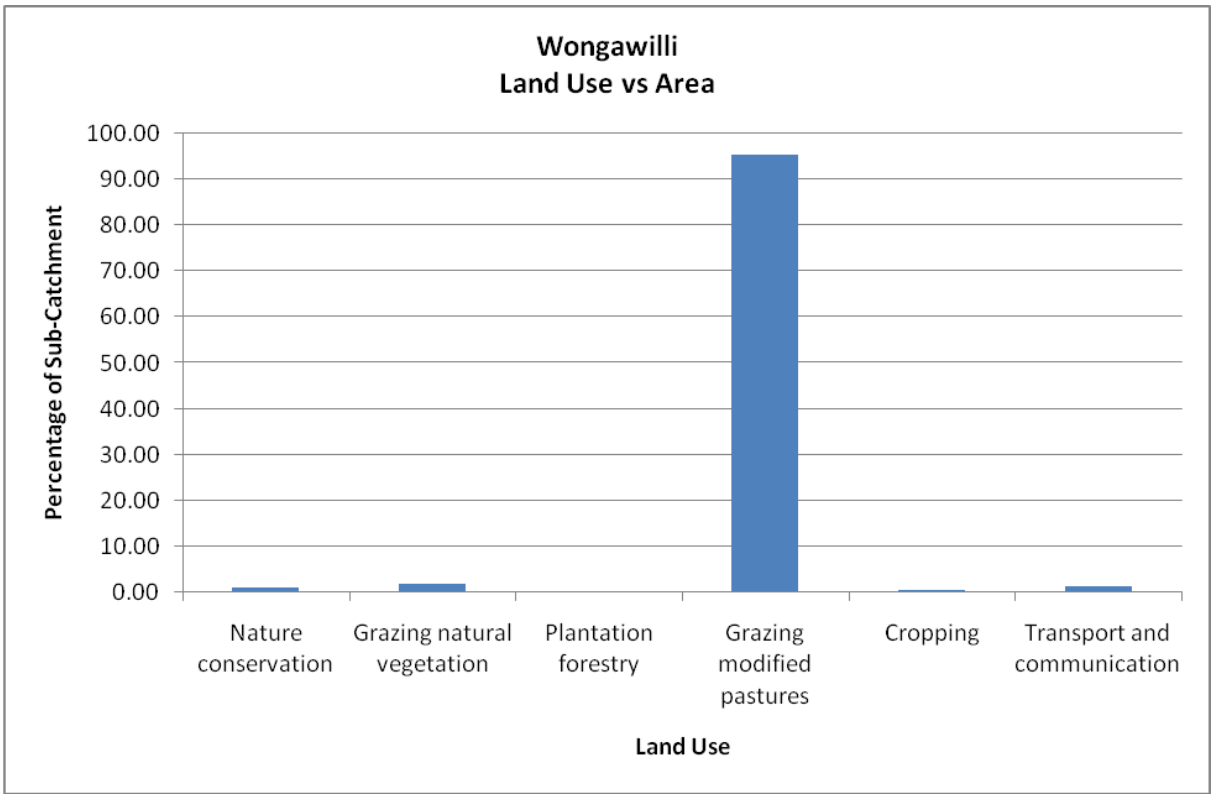


Figure 41. Land use versus area in Wongawilli sub-catchment

3.13.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Wongawilli sub-catchment was based on data collected through the Water Quality Monitoring Program and landholder consultation (see section 2.2)

3.13.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals. It should be noted that there are no wetlands in this sub-catchment.

The management goal for the Wongawilli sub-catchment is to:

- Supply Watervalley sub-catchment 18 with water no greater than 6000EC.

This management goal has a list of associated pressures and indicators which can be found in Appendix 2.

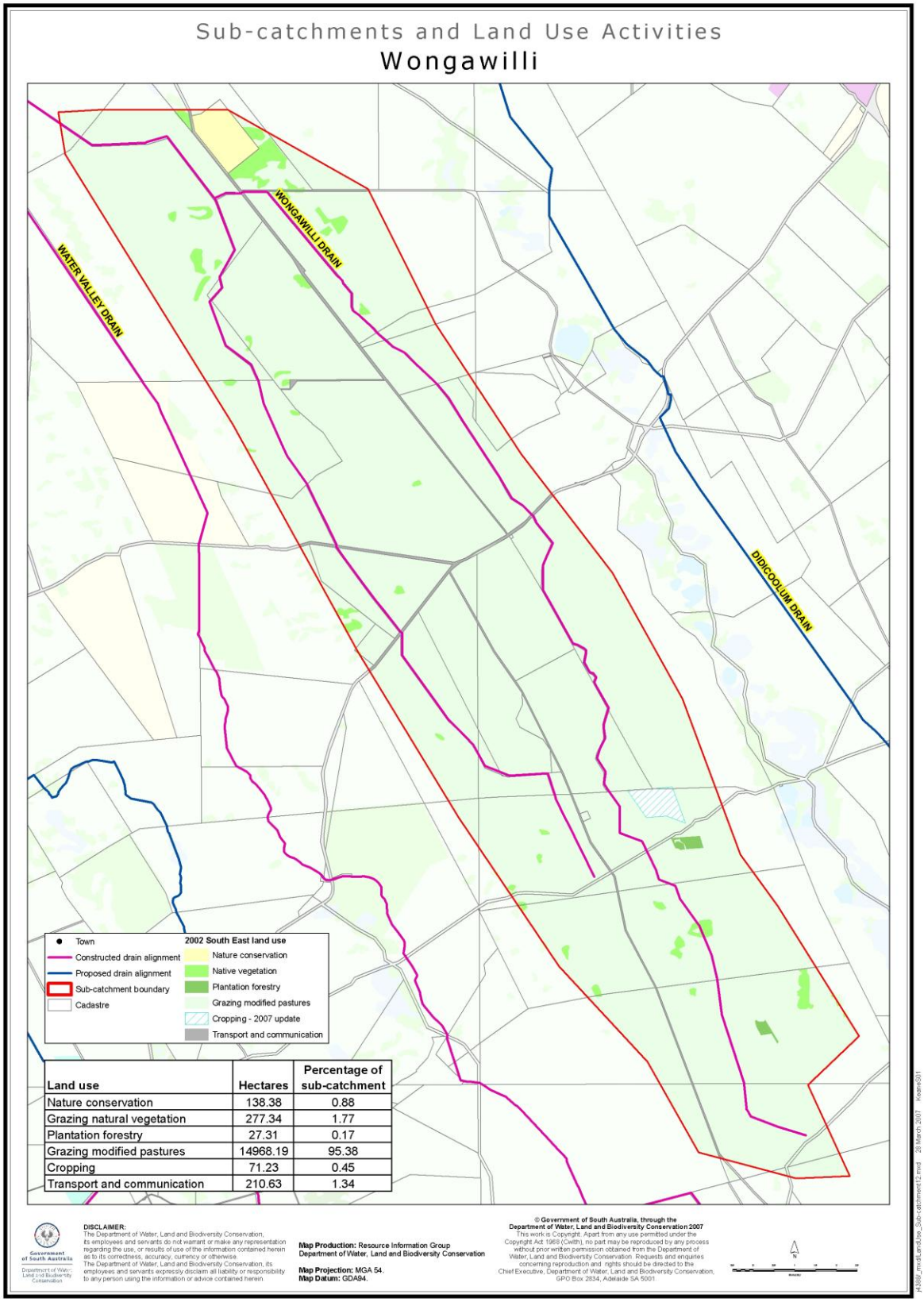


Figure 42. Map of Wongawilli sub-catchment

3.13.4 RISKS TO WATER QUALITY

3.13.4.1 SALINITY

Several specific salinity risks were identified in the Wongawilli sub-catchment – one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.13.4.2 PESTICIDES

One significant ('high') pesticide risk was identified in the Wongawilli sub-catchment. This was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. Although a relatively low portion of the Wongawilli sub-catchment is used for cropping (<0.5%), the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks identified in the Wongawilli sub-catchment (shown in Table 23) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

3.13.5 DATA RESULTS

In the Wongawilli sub-catchment there are two Water Quality Monitoring sites. At both sites, data has been collected from 2000 to 2005. Samples were collected and analysed twice in 2000 and between 2001 and 2005 samples were collected and analysed once a year.

The Risk Assessment was based on 14 samples collected between May 2000 and September 2005.

Table 23. Frequency of identified risk to water quality in Wongawilli sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	5	3	0	0	7	0	1	**19**	**48**
Moderate (2)	5	3	1	0	0	7	0	2	**18**	**45**
High (3)	0	0	0	1	0	1	0	1	**3**	**8**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**8**	**8**	**4**	**1**	**0**	**15**	**0**	**4**	40	
Percentage	**20**	**20**	**10**	**3**	**0**	**38**	**0**	**10**		

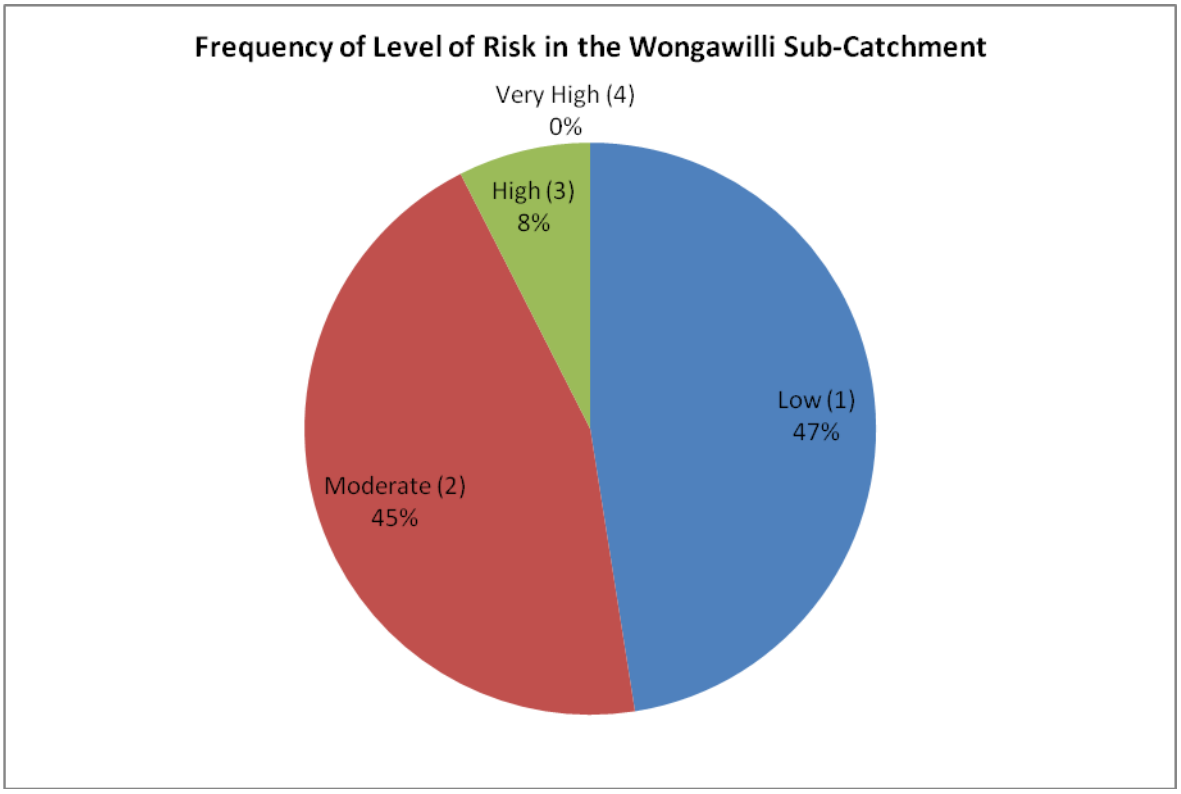


Figure 43. Frequency of risk levels identified in Wongawilli sub-catchment

The following parameters were found to exceed the ANZECC guidelines (refer Appendix 4).

Table 24. Parameters exceeding Water Quality Guidelines in Wongawilli sub-catchment

METALS	NUTRIENTS
Aluminium (total)	Nitrate as N
Cadmium (total)	
Chromium (total)	
Iron (total)	
Silver (total)	

Zinc (total)

Quantitative and qualitative information was used in the assessment of Wongawilli sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using WQ data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Wongawilli sub-catchment are displayed in Table 25. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 25. Parameters screened from the Risk Assessment of Wongawilli sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No Guideline, Limited Data
Nutrients	Ammonia (NH_3 as N)	No Data
Nutrients	Ammonium (NH_4 as N)	No Data
Pesticide	AMPA	No Guideline, Limited Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting

Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (sol)	No Data
Metal	Copper (total)	Limited Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit

		of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline

Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.13.6 DISCUSSION

Several metals and one nutrient parameter exceeded ANZECC guidelines in the Wongawilli sub-catchment. These metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences, and/or values were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, and this is an issue for investigation.

In the Wongawilli sub-catchment (as in all sub-catchments with the exception of Morella Basin) organic matter presented as a 'high' risk. This was attributed to the land use 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' is also classed as nutrient risk, as was fertiliser application.

Pesticide application also presented as a 'high' risk in the Wongawilli sub-catchment, due to the nature of the application (spraying). This is an issue for investigation.

3.13.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE WONGAWILLI SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Wonagwilli sub-catchment and the USE. This should include a determination of

actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Wongawilli sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Wongawilli sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable (such as the above recommendation for a metals analysis).

3.14 GUM LAGOON SUB-CATCHMENT 13

3.14.1 DESCRIPTION OF THE AREA

The Gum Lagoon sub-catchment is located between the Rosemary Downs sub-catchment and the Watervalley Wetlands sub-catchment. It is dominated by the land uses 'grazing modified pastures' and 'nature conservation'. One drain runs through Gum Lagoon sub-catchment at the southern end from east to west before connecting to the Watervalley drain.

3.14.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Gum Lagoon sub-catchment was based on data collected through the Water Quality Monitoring Program and some local consultation (see section 2.2).

3.14.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

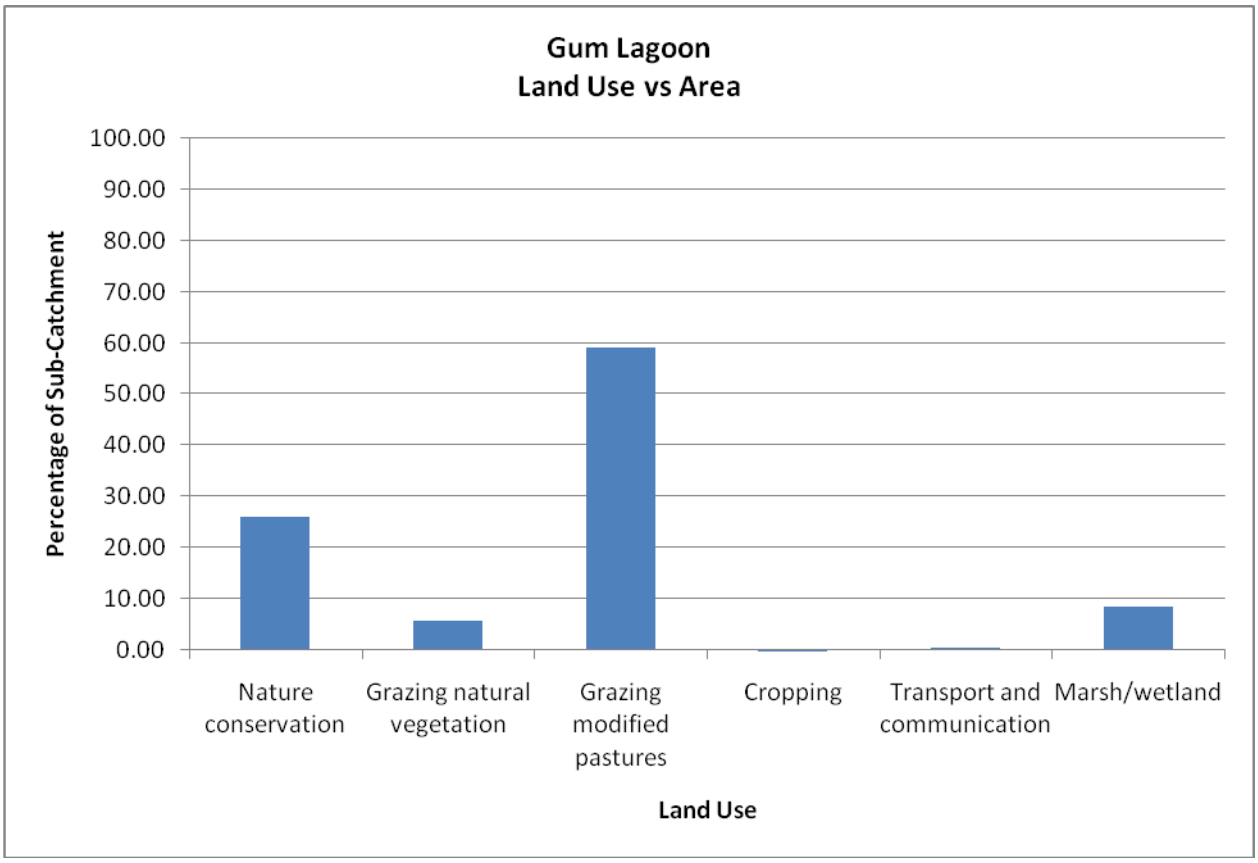


Figure 44. Land use versus area in Gum Lagoon sub-catchment

The management goals for the Gum Lagoon sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators that can be found in Appendix 2.

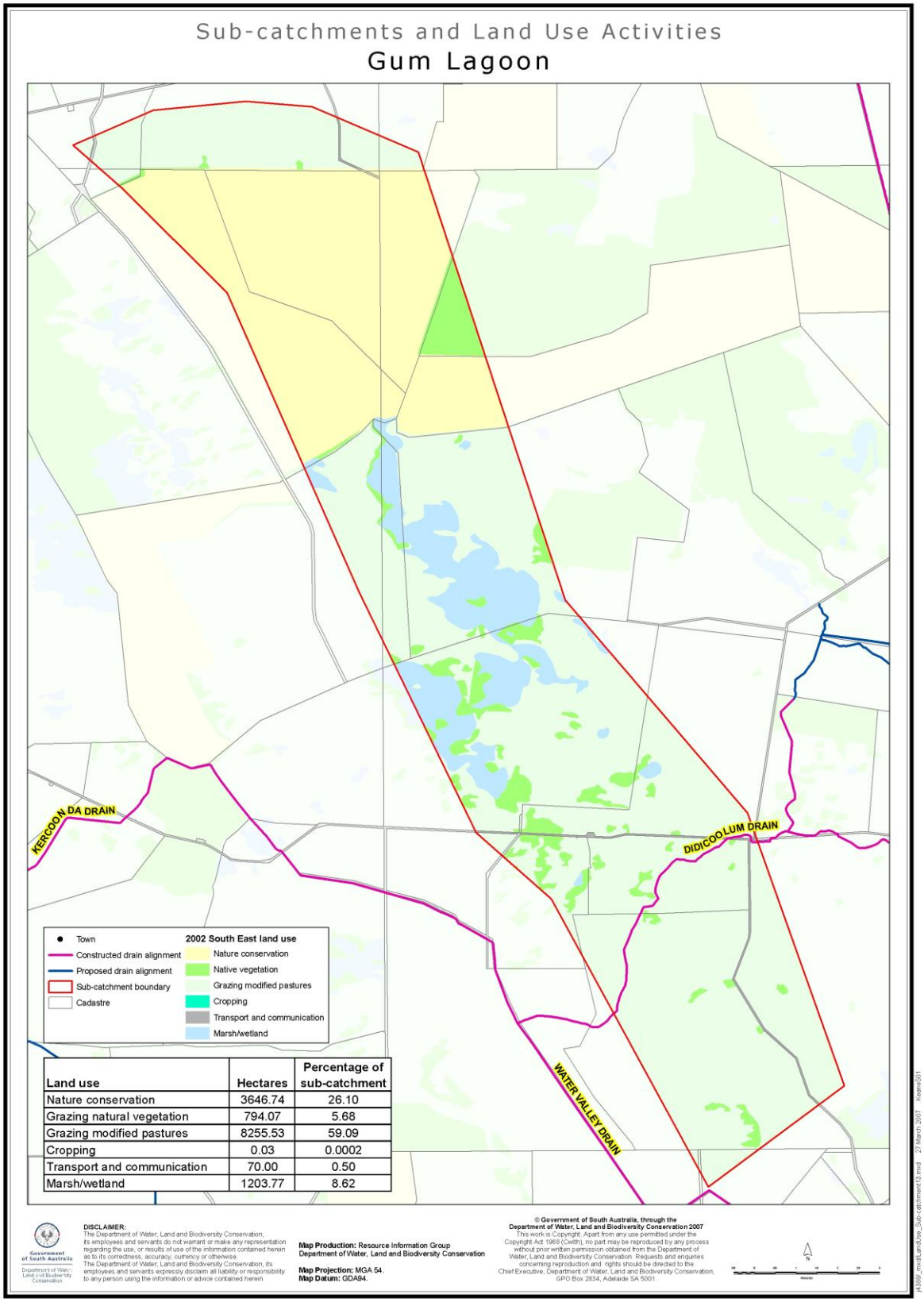


Figure 45. Map of Gum Lagoon sub-catchment

3.14.4 RISKS TO WATER QUALITY

3.14.4.1 SALINITY

Several specific salinity risks were identified in the Gum Lagoon sub-catchment – one 'high', two 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Gum Lagoon sub-catchment (shown in Table 26) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 26. Frequency of identified risk to water quality in Gum Lagoon sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

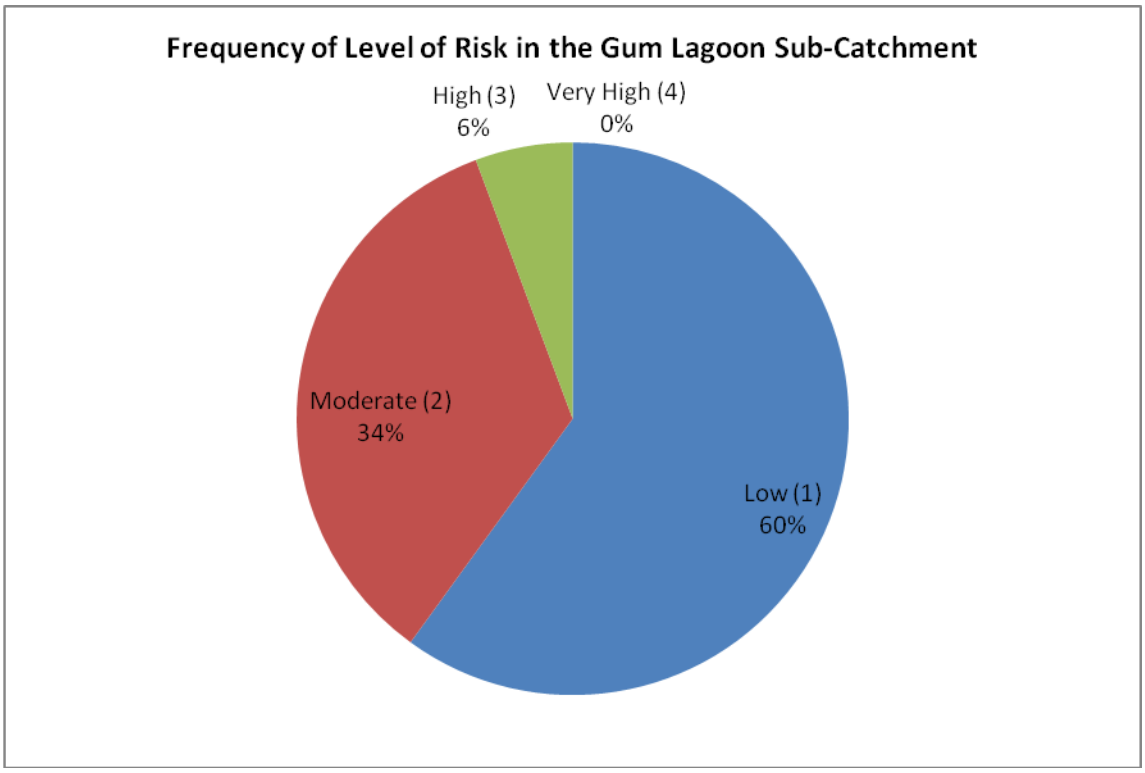


Figure 46. Frequency of risk levels identified in Gum Lagoon sub-catchment

3.14.5 DATA RESULTS

In Gum Lagoon sub-catchment there are two Water Quality Sites. At site one data has been collected since early 2000, between 2000 and 2005 samples were collected and analysed once or twice a year, and In 2006 a sample was collected in January, and then every month from May to December 2006.

At site two data has been collected since May 2000, twice in 2000, and once a year between 2001 and 2005.

The Risk Assessment was based on 22 samples, collected between May 2000 and December 2006.

Quantitative and qualitative information was used in the assessment of Gum Lagoon sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be

some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

Table 27. Parameters exceeding Water Quality Guidelines in Gum Lagoon sub-catchment

METALS	NUTRIENTS
Aluminium (total)	Ammonia (N as NH_3)
Cadmium (total)	Nitrate as N
Chromium (total)	
Copper (total)	
Iron (total)	
Selenium (total)	
Silver (total)	
Zinc (total)	

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Gum Lagoon sub-catchment are displayed in Table 28. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 28. Parameters screened from the Risk Assessment of Gum Lagoon sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No Guideline, Limited Data
Nutrient	Ammonia (NH_3 as N)	No Data
Nutrient	Ammonium (N as NH_4)	No Data
Pesticide	AMPA	No Guideline, Limited Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting

Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting.

		Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline

Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.14.6 DISCUSSION

Many metals exceeded ANZECC guidelines in the Gum Lagoon sub-catchment, these metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Ammonia as both N and NH_3 exhibited exceedences in Gum Lagoon. These exceedences may be explained by the high pH of the system, generally caused by a high salinity level. The Ammonia as NH_3 value is derived using the pH value, and the measure of pH will vary depending on the ionic solution with which the pH sensor is calibrated, and the salinity of the water being measured. Therefore, if the pH level has been artificially forced up (due to calibration of the pH sensor in fresh water rather than saline water) then this will in turn cause an inflated level of Ammonia as NH_3 (Everingham 2007).

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences and/or values which were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, hence this is also an issue for further investigation.

Pesticide application also presented as a ‘high’ risk in the Gum Lagoon sub-catchment, due to the nature of the application (spraying). This is an issue for investigation.

3.14.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE GUM LAGOON SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Gum Lagoon and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended that an investigation be conducted into the correct analysis of pH and consequent analysis of Ammonia as NH_3. This could include investigation of a method of accurately measuring pH in highly saline conditions.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Gum Lagoon sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable (such as the above recommendations for a metals analysis and pH/ammonia relationship).

3.15 ROSEMARY DOWNS SUB-CATCHMENT 14

3.15.1 DESCRIPTION OF THE AREA

The Rosemary Downs sub-catchment is nestled between the Bunbury, Marcollat, Mount Charles and Gum Lagoon sub-catchments, and is dominated by the land use 'grazing modified pastures'. One drain, the Rosemary Downs drain, is located within the sub-catchment and runs from east to west before connecting with the Diddicoolum drain.

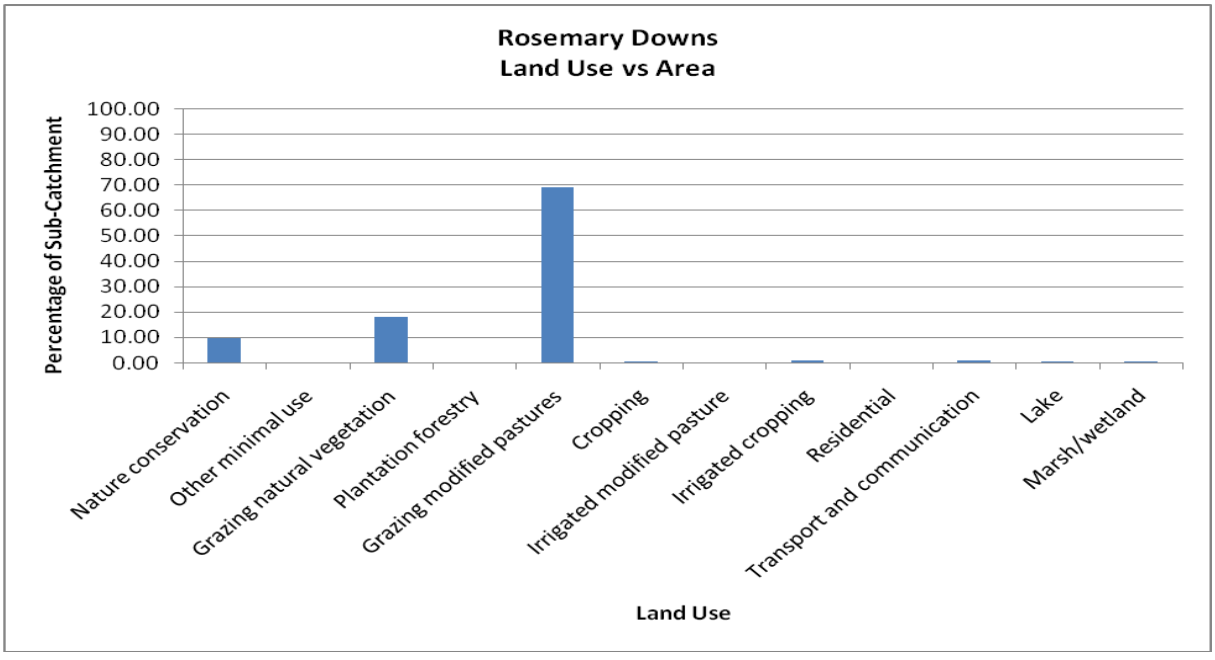
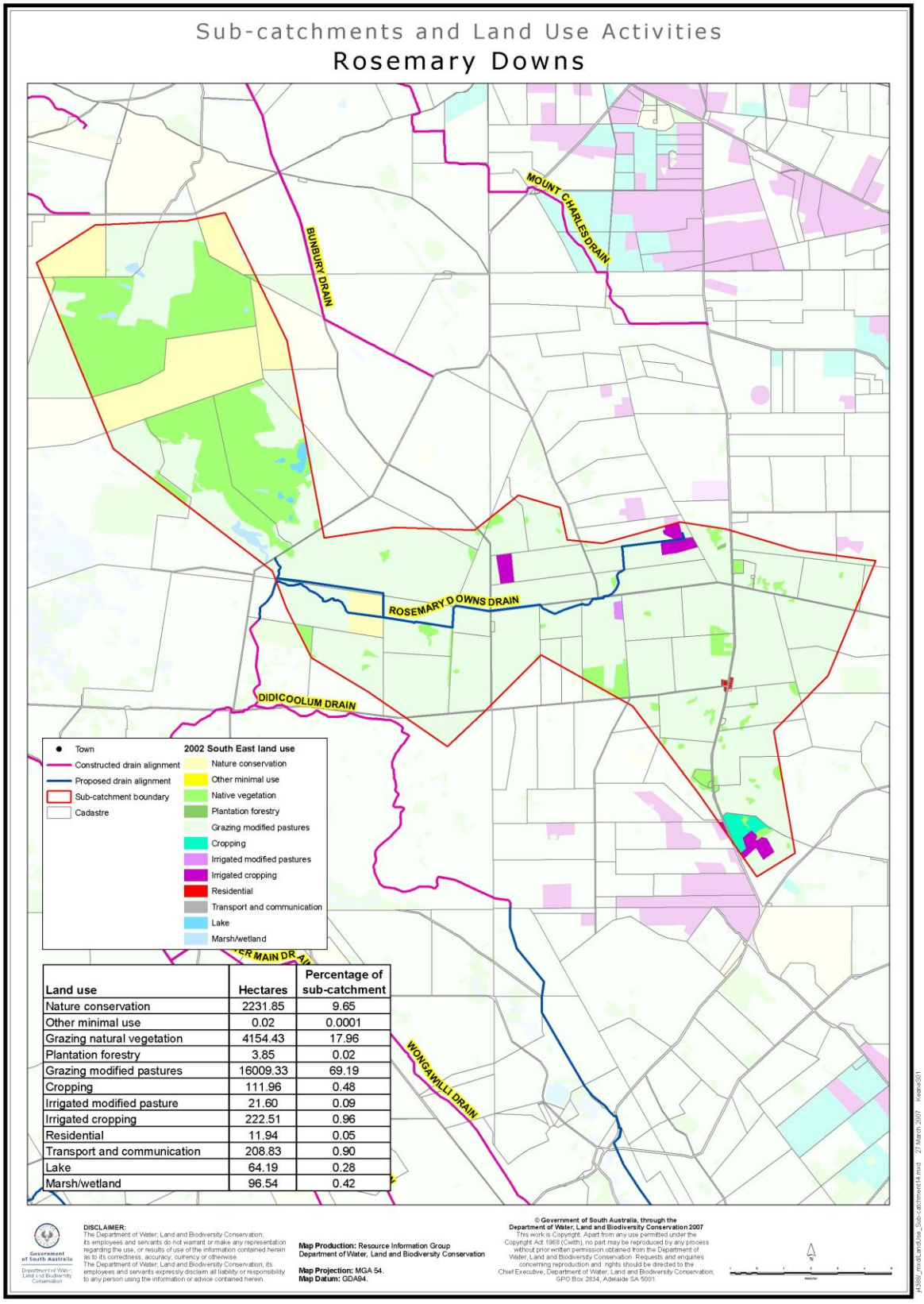


Figure 47. Land use versus area in Rosemary Downs sub-catchment



Land use	Hectares	Percentage of sub-catchment
Nature conservation	2231.85	9.65
Other minimal use	0.02	0.0001
Grazing natural vegetation	4154.43	17.96
Plantation forestry	3.85	0.02
Grazing modified pastures	16009.33	69.19
Cropping	111.96	0.48
Irrigated modified pasture	21.60	0.09
Irrigated cropping	222.51	0.96
Residential	11.94	0.05
Transport and communication	208.83	0.90
Lake	64.19	0.28
Marsh/wetland	96.54	0.42

Figure 48. Map of Rosemary Downs sub-catchment

3.15.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Rosemary Downs sub-catchment was based on data collected from limited local consultation (see section 2.2).

3.15.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Rosemary Downs sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators that can be found in Appendix 2.

3.15.4 RISKS TO WATER QUALITY

3.15.4.1 SALINITY

Several specific salinity risks were identified in the Rosemary Downs sub-catchment – one 'high', one 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows

through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

Table 29. Frequency of identified risk to water quality in Rosemary Downs sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	4	6	3	0	0	10	0	1	**24**	**55**
Moderate (2)	6	4	1	0	0	5	0	1	**17**	**39**
High (3)	0	0	0	1	0	1	0	1	**3**	**7**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**10**	**10**	**4**	**1**	**0**	**16**	**0**	**3**	44	
Percentage	**23**	**23**	**9**	**2**	**0**	**36**	**0**	**7**	**100**	

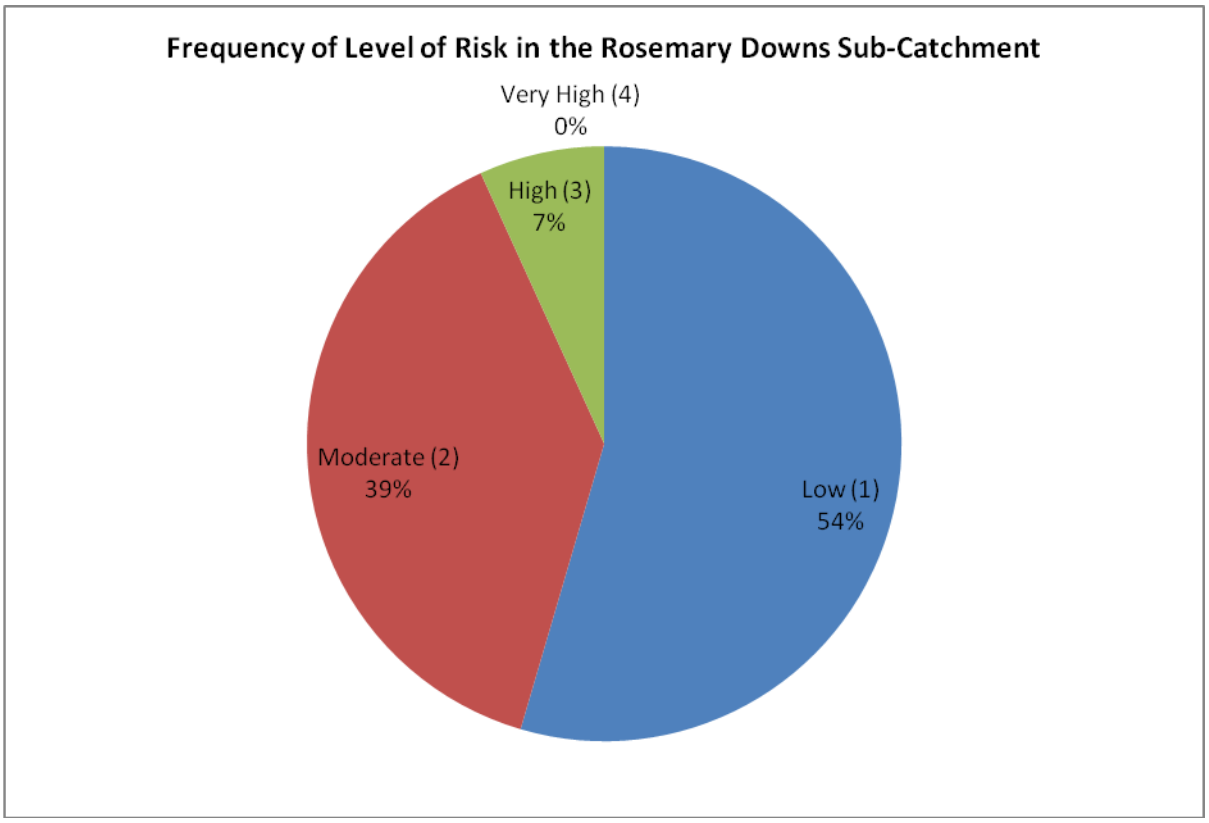


Figure 49. Frequency of risk levels identified in Rosemary Downs sub-catchment

3.15.4.2 PESTCIDES

One significant ('high') pesticide risk was identified in the Rosemary Downs sub-catchment – this was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. Although a relatively low portion of the Rosemary Downs sub-catchment is used for cropping

(<0.5%), the pesticide risk has been classed as ‘high’ due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks identified in the Rosemary Downs sub-catchment (shown in Table 29) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

3.15.5 DATA RESULTS

The Risk Assessment process in the Rosemary Downs sub-catchment was based on some local consultation and GIS data consultation. This included using aerial photographs to identify what land uses are in the sub-catchment and also the percentages of each land use (e.g. 56% ‘grazing modified pastures’).

Only qualitative information was used in the assessment of Rosemary Downs sub-catchment, however this information was strengthened by comparing it to a sub-catchment with similar hazards that had available water quality data.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a ‘certainty level’ matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

3.15.6 DISCUSSION

No water quality data was available in the Rosemary Downs sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as ’moderate’ and ’high’ risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a ’high’ risk. This was attributed to ‘stock grazing near watercourses’ and is an issue for investigation.

‘Stock grazing near watercourses’ and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

Pesticide application presented as a ‘high’ risk in the Rosemary Downs sub-catchment, due to the nature of the application (spraying). This is an issue for investigation.

3.15.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE ROSEMARY DOWNS SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in

the Rosemary Downs sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Rosemary Downs sub-catchment or at a location that is representative of the USE Catchment.

3.16 MOUNT CHARLES SUB-CATCHMENT 15

3.16.1 DESCRIPTION OF THE AREA

The Mount Charles sub-catchment is one of the largest sub-catchments in the Upper South East Project area. Historically, the area was the catchment for overflow from the Tatiara and Nalang Creeks, and presently only small swamps remain intact along with few blocks of native vegetation along the alignment of the drain.

The Mount Charles drain is located in the far north of the sub-catchment that connects with the small Ashby drain which flows into the Northern Outlet drain and into Marcollat Watercourse.

The area is dominated by the land use 'grazing modified pastures' and contains two townships within its borders – Keith and Bordertown (de Jong 2005).

3.16.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Mount Charles sub-catchment was based on data collected through the Water Quality Monitoring Program and landholder consultation (see section 2.2).

3.16.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Mount Charles sub-catchment are to:

- Preserve and enhance seasonal and permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements

- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

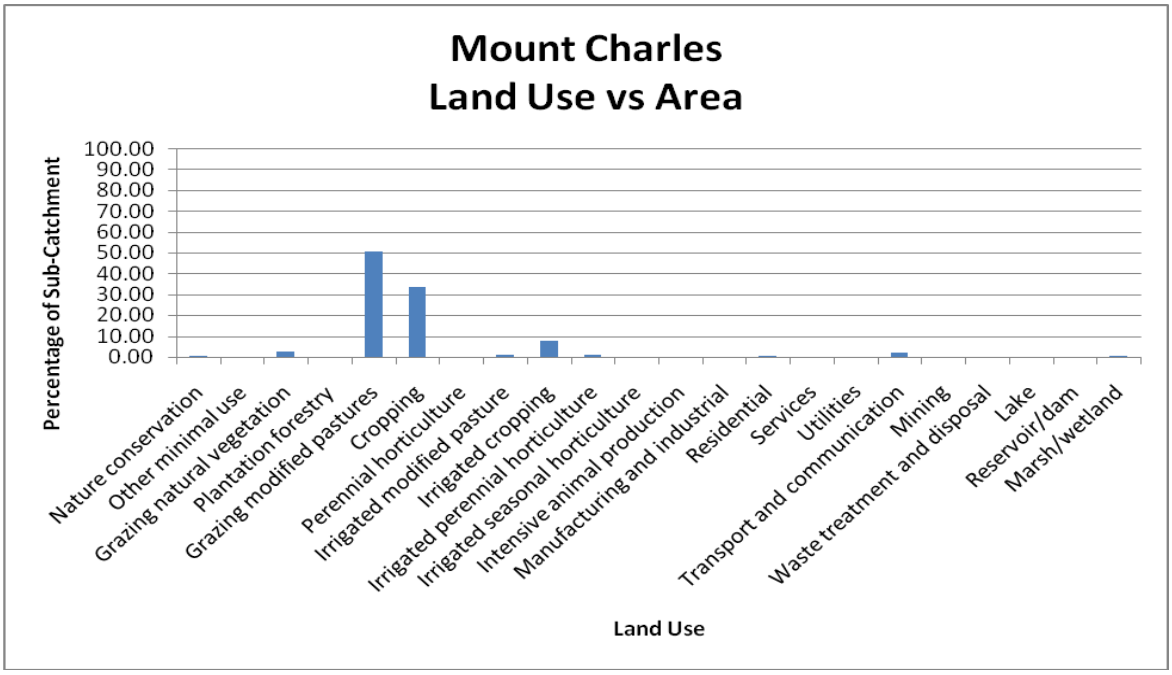


Figure 50. Land use versus area in Mt Charles sub-catchment

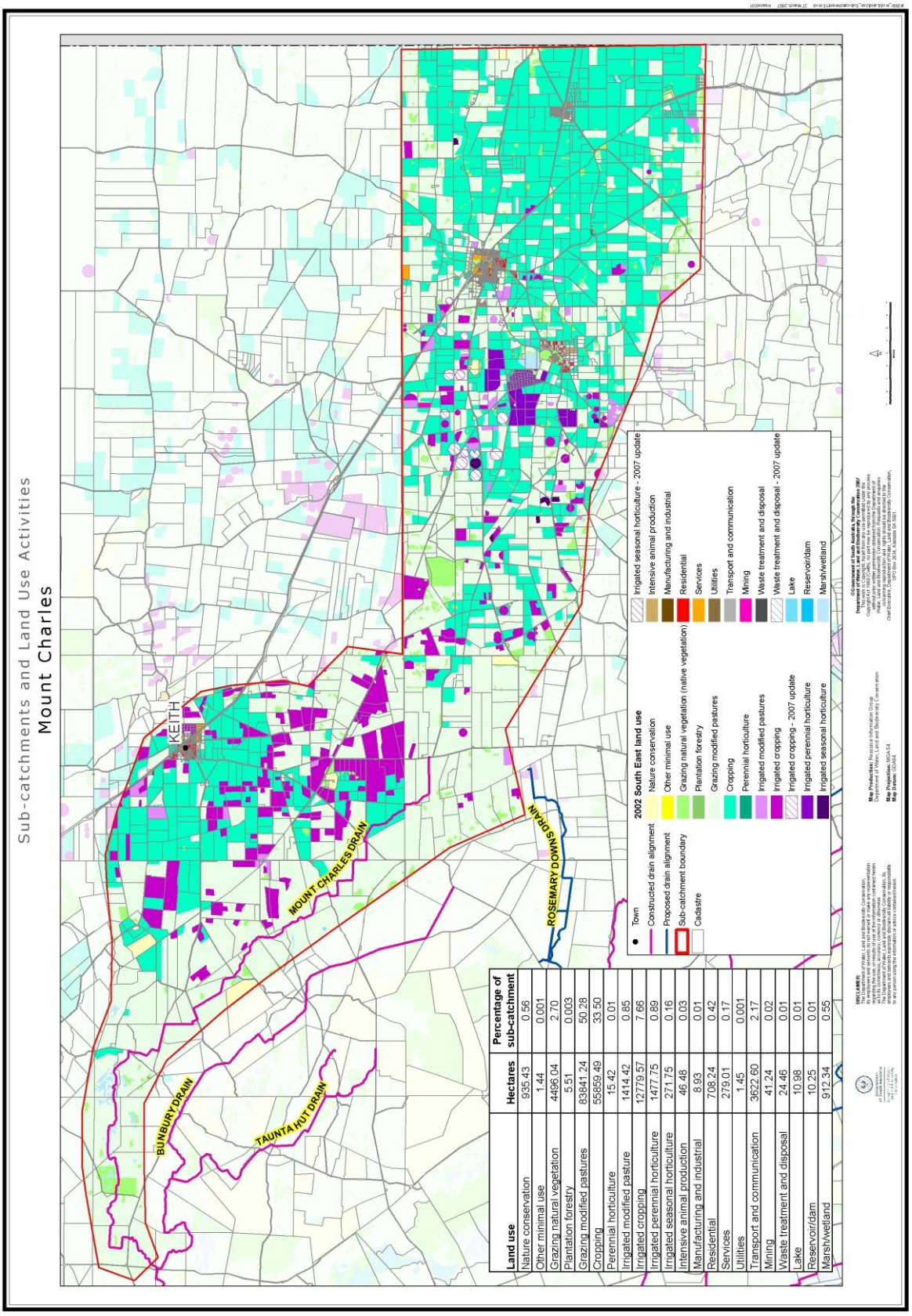
3.16.4 RISKS TO WATER QUALITY

3.16.4.1 NUTRIENTS

'Irrigated cropping' and 'waste treatment and disposal' were both identified as 'high' nutrient risk land uses.

'Irrigated cropping' is the third highest land use in the Mount Charles sub-catchment, and fertiliser (the hazard responsible for the 'high' risk) can be applied up to five times in a year (in regards to copper application). Cadmium, an unwanted by-product of some fertilisers, is indestructible and can leach into sedimentary ponds where it stays. Heavy or cumulative heavy rainfall periods can cause fertiliser runoff into floodways, drains and wetlands which could cause eutrophication and subsequent algal blooms. Urea, cadmium/zinc/copper mix and super phosphate are some of the more commonly used fertilisers.

Two townships—Keith and Bordertown—are located within the Mount Charles sub-catchment. These present a new sweep of hazards not seen in the farming areas of the USE Catchment. One such hazard is 'septic tank overflow', and even though 'waste treatment and disposal' accounts for a very small amount of area in the Mount Charles sub-catchment, the consequence of septic tanks and the associated management and infrastructure failing would be high.



Land use	Hectares	Percentage of sub-catchment
Nature conservation	935.43	0.56
Other minimal use	1.44	0.001
Grazing natural vegetation	4496.04	2.70
Plantation forestry	5.51	0.003
Grazing modified pastures	83841.24	50.28
Cropping	55859.49	33.50
Perennial horticulture	15.42	0.01
Irrigated modified pasture	1414.42	0.85
Irrigated cropping	12779.57	7.66
Irrigated perennial horticulture	1477.75	0.89
Irrigated seasonal horticulture	271.75	0.16
Intensive animal production	46.48	0.03
Manufacturing and industrial	8.93	0.01
Residential	708.24	0.42
Services	279.01	0.17
Utilities	1.45	0.001
Transport and communication	3622.60	2.17
Mining	41.24	0.02
Waste treatment and disposal	24.46	0.01
Lake	10.98	0.01
Reservoir/dam	10.25	0.01
Marsh/wetland	912.34	0.55

Figure 51. Map of Mt Charles sub-catchment

3.16.4.2 ORGANIC MATTER

Mount Charles sub-catchment has a significant number of organic matter risks (refer table 30), however the majority of this risk is in the 'low' category, with only one 'high' risk (described in section 3.1.4.2) and few 'moderate' risks. The reason that there are many organic matter risks could be due to Mount Charles being one of the largest sub-catchments in the USE Catchment (along with Marcollat) with many different land uses.

As Mount Charles contains two townships and at least one piggery, there are many different types of effluent ponds located within the catchment: abattoir, dairy, feedlot, industrial, sewage and stockyard. The effluent ponds may leak, overflow or fail, which could cause large amounts of organic matter to enter the watertable or aquatic environment. They have been classed as 'low' and 'moderate' risks, as the likelihood of such events occurring is low because of the stringent operating and construction procedures in place.

There are also several risks associated with sewage tanks in the township; these are for the same reasons as described above in section 3.16.4.1.

3.16.4.3 SALINITY

Several specific salinity risks were identified in the Mount Charles sub-catchment – one 'high', five 'moderate' and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.16.4.4 HEAVY METALS

Only two sub-catchments in the USE Catchment were identified to contain heavy metal risks—Marcollat and Mount Charles. This may be due to these being the only sub-

catchments to contain townships. All heavy metal risk in the Mount Charles sub-catchment was classed in the 'low' and 'moderate' risk categories.

Historical contaminated sites—i.e. sites that are known to be contaminated and are currently being monitored/mitigated—were classed as 'low' risk. There is some chance that these sites may cause leakage of heavy metals into the watertable, however the likelihood is greatly reduced due to the monitoring procedures currently in place.

Presently contaminated sites, such as the old council depot, were also classed as 'low' risk. The land is currently contaminated, however there are monitoring wells in place to ensure that the groundwater does not also become contaminated.

Landfills were seen to be more of a threat and were placed in the 'moderate' risk category. Currently, industrial and urban waste is stored in a natural clay pit and groundwater is being monitored via a series of wells. Landfills have the potential to become a 'high' risk, however due to the mitigation and monitoring procedures in place, it has been downgraded to 'moderate'.

3.16.4.5 HYDROCARBONS

As with heavy metals, only two sub-catchments in the USE Catchment were identified to contain hydrocarbon risk—Marcollat and Mount Charles. This may be due to these being the only sub-catchments to contain townships. All hydrocarbon risk in the Mount Charles sub-catchment was classed in the 'low' risk category.

Historical and presently contaminated sites (for the reasons mentioned above in section 3.16.4.4), as well as fuel storage and transport routes were identified as hazards. It is possible but unlikely that hazardous events such as 'leakage' from fuel storage containers or fuel transport containers/vehicles would occur. Runoff from highways, local sealed and unsealed roads could also contain hydrocarbons, which flow into watercourses and drains with no mitigation.

3.16.4.6 PESTICIDES

'Cropping' and 'irrigated cropping' both presented a 'high' pesticide risk in the Mount Charles sub-catchment, both associated with 'event drift' in the application of pesticides. These land uses combined make up a significant percentage of the total sub-catchment area (about 41%) and the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

Table 30. Frequency of identified risk to water quality in Mt Charles sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	25	11	7	19	2	19	5	1	**89**	**64**
Moderate (2)	11	8	2	3	2	11	0	5	**42**	**30**
High (3)	2	1	0	1	0	2	0	1	**7**	**5**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**38**	**20**	**9**	**23**	**4**	**32**	**5**	**7**	138	
Percentage	**28**	**14**	**7**	**17**	**3**	**23**	**4**	**5**	**100**	

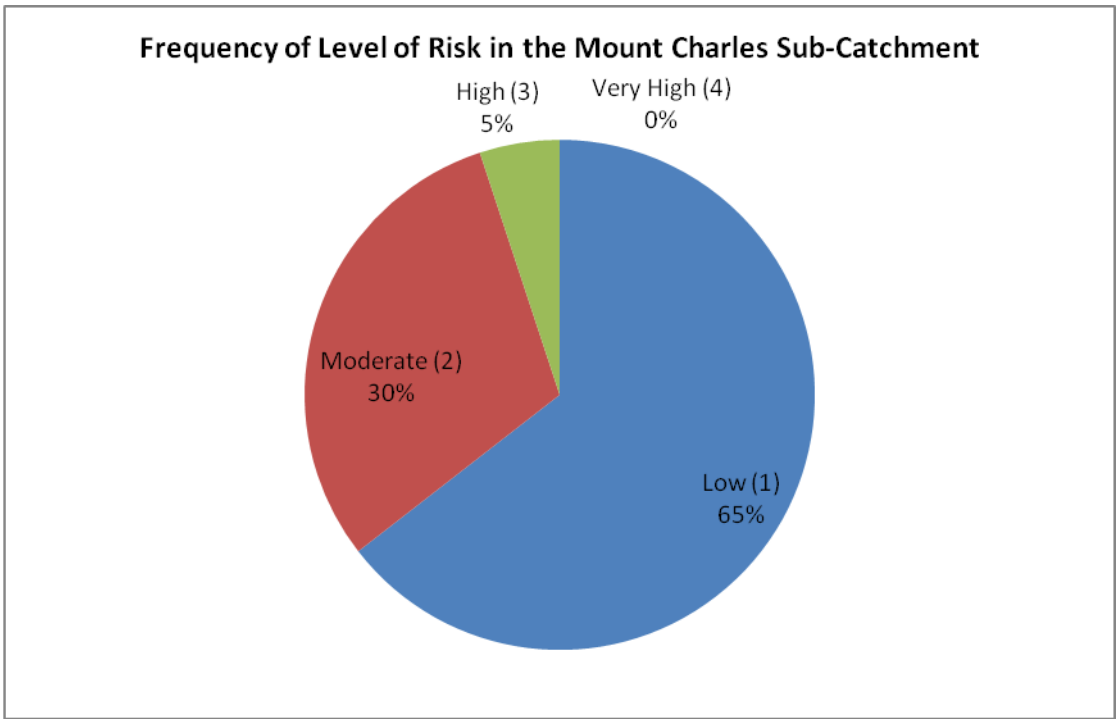


Figure 52. Frequency of risk levels identified in Mt Charles sub-catchment

3.16.5 DATA RESULTS

In the Mount Charles sub-catchment there are two Water Quality Monitoring sites. At site one data has only been collected and analysed once in 2005. At Site two data has been collected and analysed from September 2005 to December 2006. In 2005 data was collected twice in the year and in 2006, once in January and then once a month from May to December.

The Risk Assessment was based on 12 samples, collected between September 2005 and December 2006.

Parameters found to exceed ANZECC Water Quality Guidelines (refer Appendix 4) are shown in Table 31 below.

Quantitative and qualitative information was used in the assessment of Mount Charles sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

Table 31. Parameters exceeding Water Quality Guidelines in Mt Charles sub-catchment

METALS	NUTRIENTS
Aluminium (total)	Ammonia (NH_3 as N)
Arsenic (inorganic)	
Copper (total)	
Iron (total)	
Lead (total)	
Nickel (total)	
Silver (total)	
Zinc (sol and total)	

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Mount Charles sub-catchment are displayed in Table 32. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 32. Parameters screened from the Risk Assessment in Mt Charles sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No Guideline, Limited Data
Nutrient	Ammonia (NH_3 as N)	No Data
Nutrient	Ammonium (NH_4 as N)	No Data
Pesticide	AMPA	No Guideline, Limited Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting

Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit

		of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline

Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.16.6 DISCUSSION

Many metals found in Mount Charles exceeded ANZECC guidelines, and these metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Ammonia as both N and NH_3 exhibited exceedences in Mount Charles. These exceedences may be explained by the high pH of the system, generally caused by a high salinity level. The Ammonia as NH_3 value is derived using the pH value, and the measure of pH will vary depending on the ionic solution with which the pH sensor is calibrated, and the salinity of the water being measured. Therefore, if the pH level has been artificially forced up (due to calibration of the pH sensor in fresh water rather than saline water) then this will in turn cause an inflated level of Ammonia as NH_3 (Everingham 2007).

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences and/or values which were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, hence this is also an issue for further investigation.

The Mount Charles sub-catchment contains within its boundaries the two townships of Keith and Bordertown, and at least one piggery and abattoir. Risks to water quality such as heavy metals and hydrocarbons are observed in this sub-catchment, and such risks as nutrients and organic matter are exacerbated due to the presence of the piggery. However, some of the risk caused by piggeries and abattoirs is mitigated through stringent operating procedures and EPA licensing.

Heavy metals and hydrocarbons were risks to water quality not observed in other sub-catchments (other than Marcollat) as part of this Risk Assessment. This is due to the townships presenting many unique hazards and hazardous events such as fuel storage areas and landfills. Within the town of Keith there are also at least one historical contaminated site and one presently contaminated site (council depot). These have been classed as ‘low’ risks as the sites are currently being monitored.

Mount Charles sub-catchment is also an area of irrigation, and as a consequence salinity is a risk to water quality. Constant irrigation may cause excess water to be drawn into the watertable, causing it rise, bringing salts to the surface.

Pesticides also presented as ‘moderate’ and ‘high’ risks. The ‘moderate’ and ‘high’ risks were due to similar reasons to other sub-catchments such as pesticide spraying.

3.16.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE MOUNT CHARLES SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Mount Charles sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of ‘stock grazing near watercourses’ (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Mount Charles sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Mount Charles and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended that an investigation be conducted into the correct analysis of pH and consequent analysis of Ammonia as NH_3. This could include investigation of a method of accurately measuring pH in highly saline conditions.

It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as ’high’, results exceed guidelines, or when guidelines are unavailable (such as the above recommendations for a metals analysis and pH/ammonia relationship).

3.17 BUNBURY SUB-CATCHMENT 16

3.17.1 DESCRIPTION OF THE AREA

The Bunbury sub-catchment is located between the Mount Charles and Taunta Hut sub-catchments. It is dominated by the land use 'grazing modified pastures' and contains one drain which runs the length of the sub-catchment south to north where it connects with the Taunta Hut drain and flows into the Northern Outlet drain.

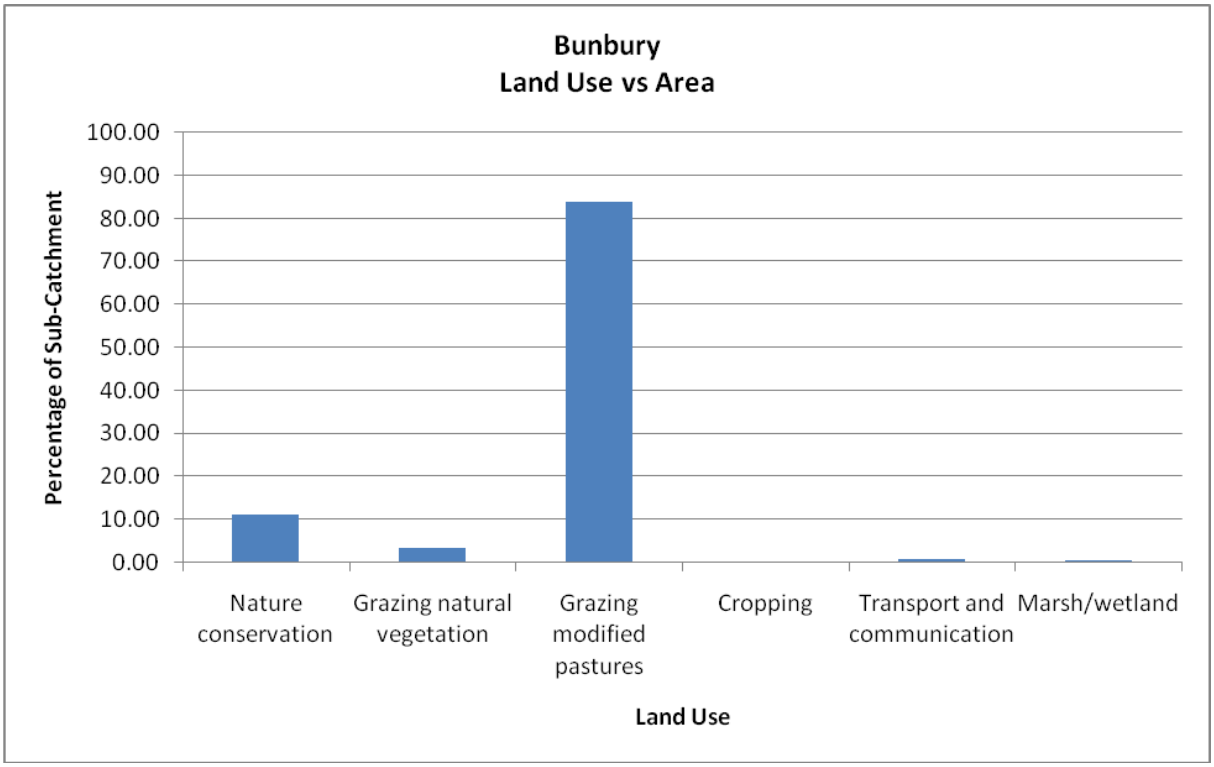
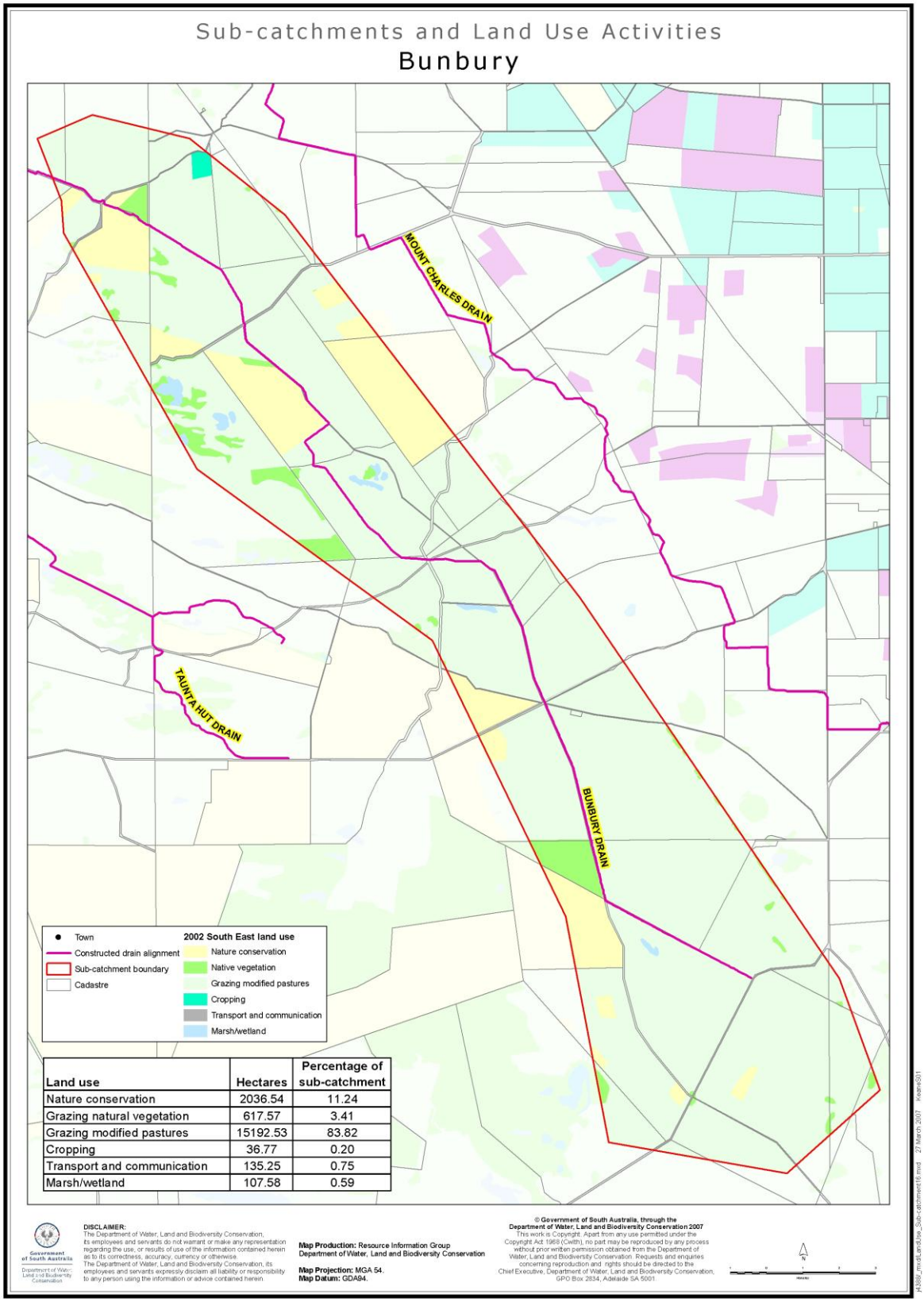


Figure 53. Land use versus area in Bunbury sub-catchment

3.17.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Bunbury sub-catchment was based on limited data collected through the Water Quality Monitoring Program and landholder consultation (see section 2.2).



Land use	Hectares	Percentage of sub-catchment
Nature conservation	2036.54	11.24
Grazing natural vegetation	617.57	3.41
Grazing modified pastures	15192.53	83.82
Cropping	36.77	0.20
Transport and communication	135.25	0.75
Marsh/wetland	107.58	0.59

Figure 54. Map of Bunbury sub-catchment

3.17.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Bunbury sub-catchment are to:

- Preserve and enhance seasonal wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.17.4 RISKS TO WATER QUALITY

3.17.4.1 SALINITY

Several specific salinity risks were identified in the Bunbury sub-catchment – one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

3.17.4.2 PESTICIDES

One significant ('high') pesticide risk was identified in the Bunbury sub-catchment; this was associated with 'event drift' whilst applying pesticides in the land use 'cropping'. Although a relatively low portion of the Bunbury sub-catchment is used for 'cropping' (0.2%), the pesticide risk has been classed as 'high' due to the nature of pesticide application (spraying) and the detrimental consequence it may have on the EV.

All other risks in the Bunbury sub-catchment (presented in Table 33) were common to the USE Catchment, (see section 3.1.4).

Table 33. Frequency of identified risk to water quality in Bunbury sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	4	6	3	0	0	7	0	1	**21**	**50**
Moderate (2)	5	3	1	0	0	7	0	2	**18**	**43**
High (3)	0	0	0	1	0	1	0	1	**3**	**7**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**9**	**9**	**4**	**1**	**0**	**15**	**0**	**4**	42	
Percentage	**21**	**21**	**10**	**2**	**0**	**36**	**0**	**10**	**100**	

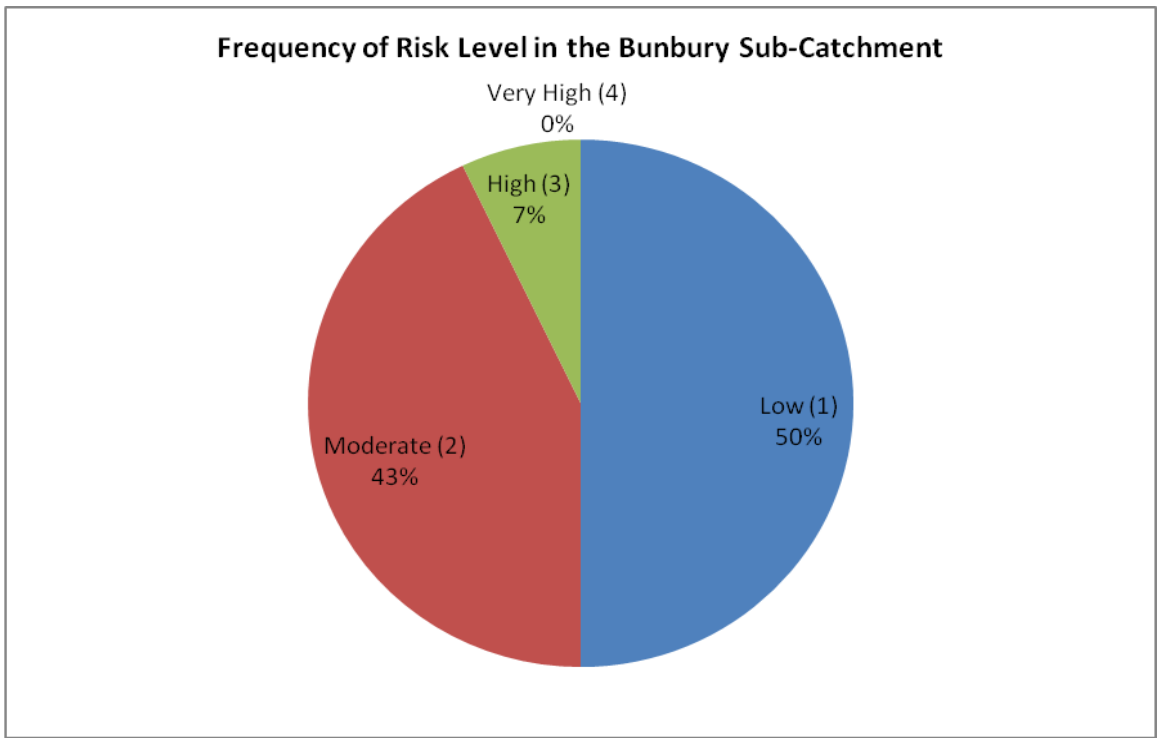


Figure 55. Frequency of risk levels identified in Bunbury sub-catchment

3.17.5 DATA RESULTS

Data has only been collected in the Bunbury sub-catchment once as part of the Water Quality Monitoring Program in 2005. The Risk Assessment was based on that one sample collected in 2005, as well as landholder consultation.

The following parameters were found to exceed the ANZECC guidelines (refer Appendix 4).

Table 34. Parameters exceeding Water Quality Guidelines in Bunbury sub-catchment

METALS
Aluminium (total)
Arsenic (inorganic)
Copper (total)
Iron (total)
Lead (total)

Quantitative and qualitative information was used in the assessment of Bunbury sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Bunbury sub-catchment are displayed in Table 35. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 35. Parameters screened from the Risk Assessment of Bunbury sub-catchment

Parameter Type	**Parameter**	**Reason for Screen**
Pesticide	Aldrin	No Guideline, Limited Data
Pesticide	AMPA	No Guideline, Limited Data
Nutrient	Ammonium (NH_4 as N)	No Data

Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting

Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit

		of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.17.6 DISCUSSION

No water quality data was available in the Bunbury sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

Also based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

Pesticide application presented as a 'high' risk in the Bunbury sub-catchment due to the nature of the application (spraying). This is an issue for investigation.

3.17.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE BUNBURY SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Bunbury sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Bunbury sub-catchment or at a location that is representative of the USE Catchment.

3.18 TAUNTA HUT SUB-CATCHMENT 17

3.18.1 DESCRIPTION OF THE AREA

The Taunta Hut sub-catchment is located between the Bunbury and Watervalley Wetlands sub-catchments and is dominated by the land uses 'grazing modified pastures' and 'nature conservation'. The Taunta Hut drain, which runs south to north through the middle of the sub-catchment, is constructed more or less along the historic flow-path of overflow from the Duck Island Watercourse.

There are many small and medium sized wetlands in the sub-catchment, some of which support open water fringed with Salt Paperbark and others which are dense Paperbark. The Taunta Hut drain transverses wetlands and has been constructed to allow for the manipulation of water levels within the wetland area with downstream weirs (de Jong 2005).

3.18.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Taunta Hut sub-catchment was based on limited data collected through the Water Quality Monitoring Program and some local consultation (see section 2.2).

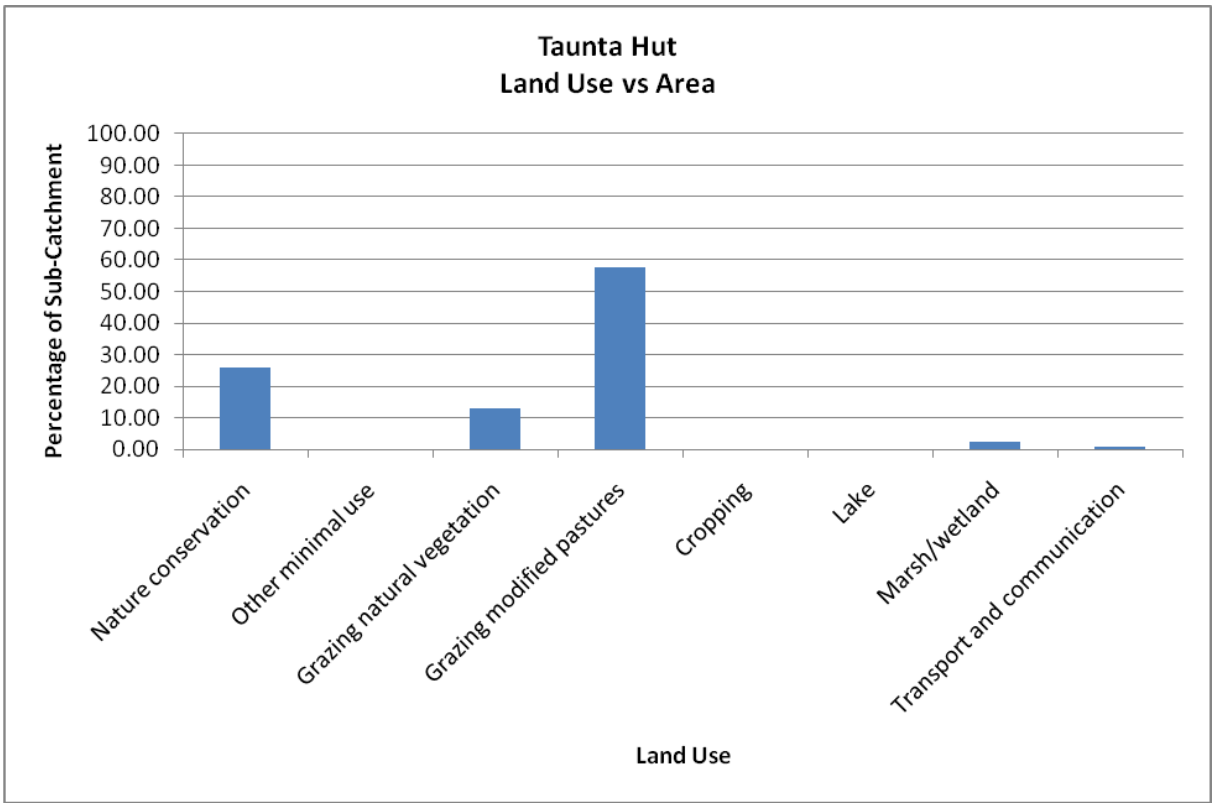


Figure 56. Land use versus area in Taunta Hut sub-catchment

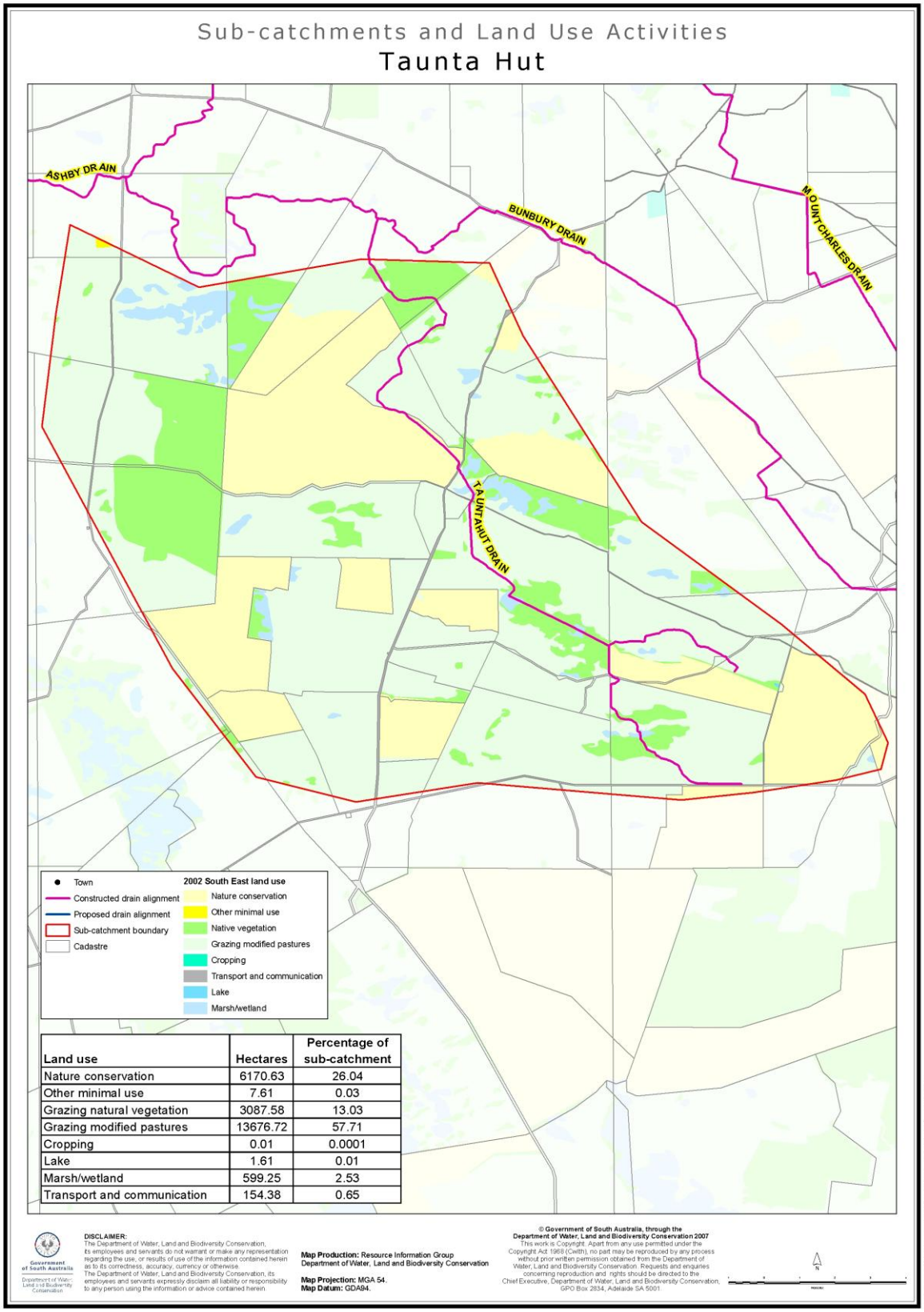
3.18.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Taunta Hut sub-catchment are to:

- Preserve and enhance seasonal and permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.



Land use	Hectares	Percentage of sub-catchment
Nature conservation	6170.63	26.04
Other minimal use	7.61	0.03
Grazing natural vegetation	3087.58	13.03
Grazing modified pastures	13676.72	57.71
Cropping	0.01	0.0001
Lake	1.61	0.01
Marsh/wetland	599.25	2.53
Transport and communication	154.38	0.65

Figure 57. Map of Taunta Hut sub-catchment

3.18.4 RISKS TO WATER QUALITY

3.18.4.1 SALINITY

Several specific salinity risks were identified in the Taunta Hut sub-catchment – one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Taunta Hut sub-catchment (shown in Table 36) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 36. Frequency of identified risk to water quality in Taunta Hut sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	**Total**	**Percentage**
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

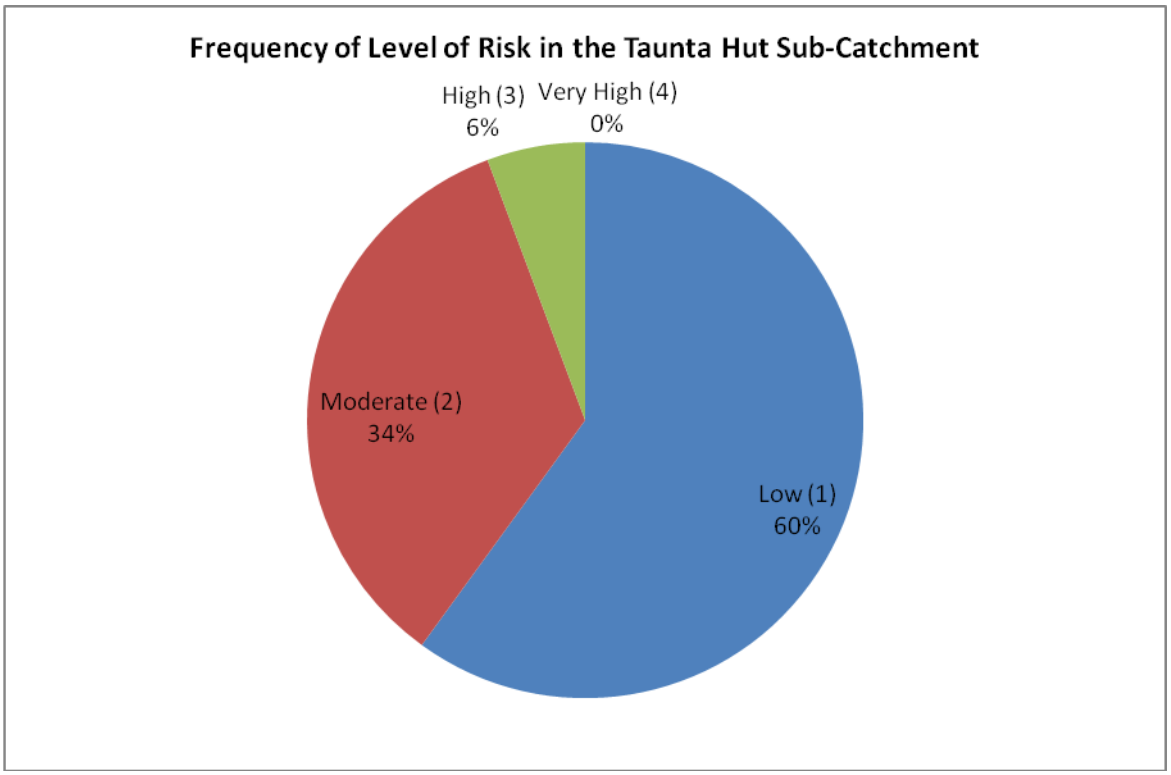


Figure 58. Frequency of risk levels identified in Taunta Hut sub-catchment

3.18.5 DATA RESULTS

Water quality data has only been collected in the Taunta Hut sub-catchment once as part of the Water Quality Monitoring Program in 2005.

The Risk Assessment was based on one sample collected in 2005, some local consultation, and by analysing aerial photographs.

The following parameters were found to exceed the ANZECC guidelines (refer Appendix 4).

Table 37. Parameters exceeding Water Quality Guidelines in Taunta Hut sub-catchment

METALS
Aluminium (total)
Copper (total)
Iron (total)
Silver (total)

Quantitative and qualitative information was used in the assessment of Taunta Hut sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Taunta Hut sub-catchment are displayed in Table 38. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 38. Parameters screened from the Risk Assessment of Taunta Hut sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No Guideline, Limited Data
Pesticide	AMPA	No Guideline, Limited Data
Nutrient	Ammonia (NH_3 as N)	No Data
Nutrient	Ammonium (NH_4 as N)	No Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit

		of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Derived Data	Langler Index	No Guideline, all lower than Limit

		of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences
Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline

Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.18.6 DISCUSSION

No available water quality data and very limited consultation results was available in the Taunta Hut sub-catchment, however based on the qualitative risk analysis, pesticides, organic matter and nutrients presented as 'moderate' and 'high' risks.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' was also classed as a nutrient risk, as was the use of fertilisers. This is an issue for investigation.

Pesticide application presented as a 'high' risk in the Taunta Hut sub-catchment, due to the nature of the application (spraying). This is an issue for investigation.

3.18.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE TAUNTA HUT SUB-CATCHMENT

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Taunta Hut sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Taunta Hut sub-catchment or at a location that is representative of the USE Catchment.

3.19 WATERVALLEY SUB-CATCHMENT 18

3.19.1 DESCRIPTION OF THE AREA

The Watervalley sub-catchment is located between the Wongawilli and Winpinmerit sub-catchments and is dominated by the land use 'grazing modified pastures'. The Watervalley drain is prominent in the landscape and runs through the middle of the sub-catchment connecting the Fairview, Bakers Range and East Avenue drains to the Kercoonda drain and eventually the Tilley Swamp drain, which feeds into Morella Basin.

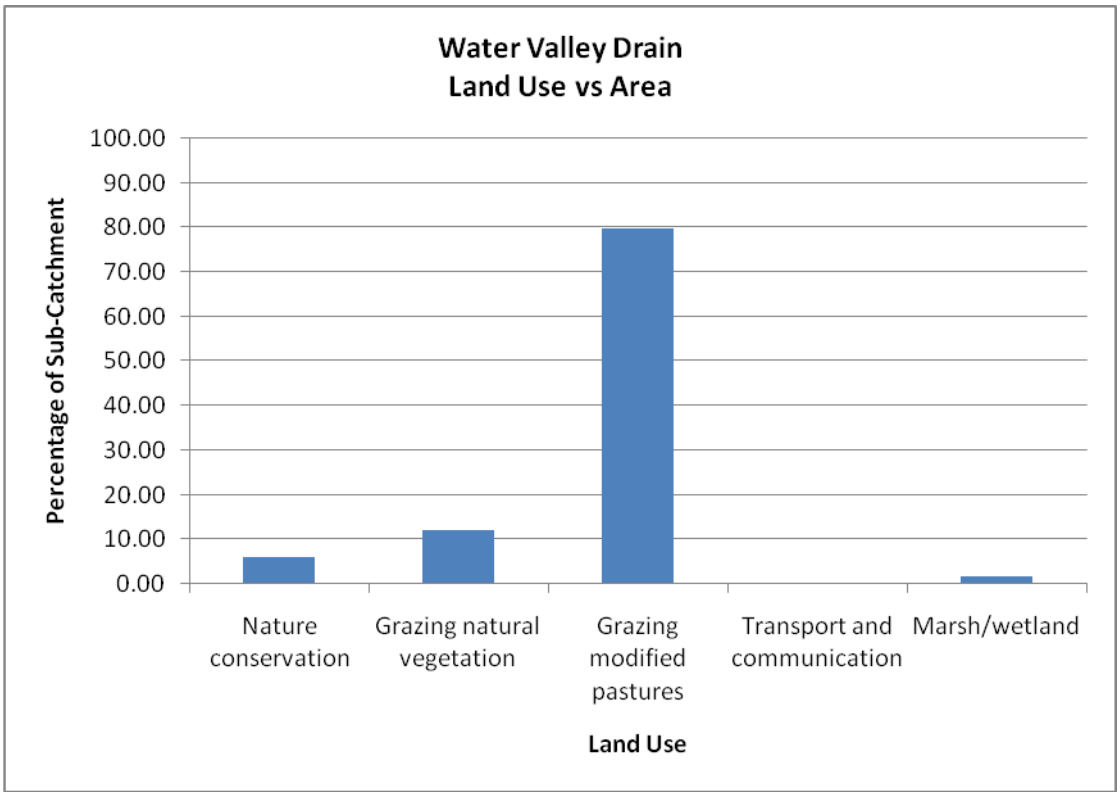
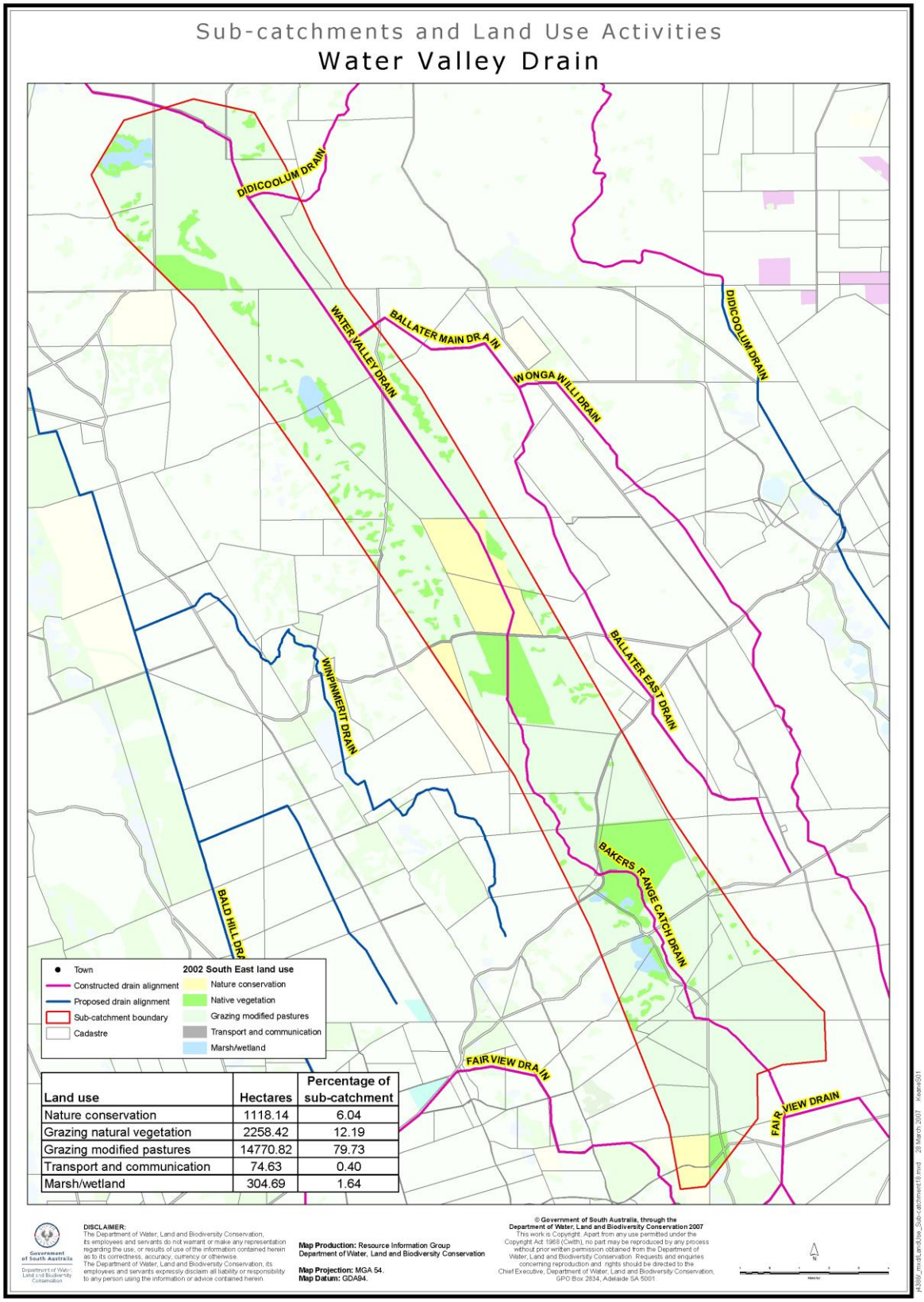


Figure 59. Landuse versus area in Watervalley sub-catchment

3.19.2 HAZARD IDENTIFICATION PROCESS

The hazard identification process for the Watervalley sub-catchment was based on data collected through the Water Quality Monitoring Program and some local consultation (see section 2.2).



Land use	Hectares	Percentage of sub-catchment
Nature conservation	1118.14	6.04
Grazing natural vegetation	2258.42	12.19
Grazing modified pastures	14770.82	79.73
Transport and communication	74.63	0.40
Marsh/wetland	304.69	1.64

Figure 60. Map of Watervalley sub-catchment

3.19.3 ENVIRONMENTAL VALUES

The matrices in Appendix 2 present the Water Quality Objectives for the aquatic ecosystem EVs for each of the 18 sub-catchments, grouped into like catchments in terms of wetland character and WQ management goals.

The management goals for the Watervalley sub-catchment are to:

- Preserve and enhance seasonal and semi-permanent wetlands
- Protect and enhance submerged aquatic vegetation
- Protect and enhance emergent aquatic vegetation
- Maintain environmental flow requirements
- Protect and enhance macro-invertebrate populations
- Preserve waterbird populations.

Each management goal has a list of associated pressures and indicators which can be found in Appendix 2.

3.19.4 RISKS TO WATER QUALITY

3.19.4.1 SALINITY

Several specific salinity risks were identified in the Watervalley sub-catchment – one 'high', two 'moderate', and one 'low'.

The 'high' risk was attributed to 'discharge' where the watertable rises and groundwater is expressed at the surface. Although groundwater levels are mitigated by the drainage system it has been classed as a 'high' risk as it is a naturally occurring, likely event with significant consequences.

The 'moderate' risks were attributed to the hazard 'management/infrastructure failure'. This hazard is caused by two hazard events – one is where there is discharge of saline water into fresh water drains, which is then directed into wetlands; the other is caused by poor decision-making where water of poor quality is deliberately moved into aquatic ecosystems, this could be caused by misinformation or inadequate communication. However, risks caused by poor decision-making are mitigated heavily as the USEDS&FM program have stringent operating rules and open communication channels. This hazard has been classed as a 'moderate' risk as if this was to happen, there would be significant consequences.

The 'low' risk is also attributed to 'management/infrastructure failure' and the hazard event 'event discharge (during rainfall events)'. This risk is caused by interflow, which is the flow of water below the surface but above the watertable, and during high rainfall events water flows through the soil profile and picks up latent salts, these salts are then deposited into sometimes fresh drains. These salt spikes are usually overcome once the soil profile is full enough to cause surface water flow, causing a dilution effect. However, in years of low-flow, the salt spike may have been severe enough to render the water quality unsuitable for aquatic ecosystems. This has a consequential risk of no water for the wetlands.

All other risks identified in the Watervalley sub-catchment (shown in Table 39) were common to all sub-catchments of the USE Catchment (see section 3.1.4).

Table 39. Frequency of identified risk to water quality in Watervalley sub-catchment

Risk Category	Nutrients - Nitrogen	Nutrients - Phosphorus	Turbidity	Organics	Heavy Metals	Pesticides	Hydrocarbons	Salinity	Total	Percentage
Low (1)	3	4	3	0	0	10	0	1	**21**	**60**
Moderate (2)	3	2	1	0	0	4	0	2	**12**	**34**
High (3)	0	0	0	1	0	0	0	1	**2**	**6**
Very High (4)	0	0	0	0	0	0	0	0	**0**	**0**
Totals	**6**	**6**	**4**	**1**	**0**	**14**	**0**	**4**	35	
Percentage	**17**	**17**	**11**	**3**	**0**	**40**	**0**	**11**	**100**	

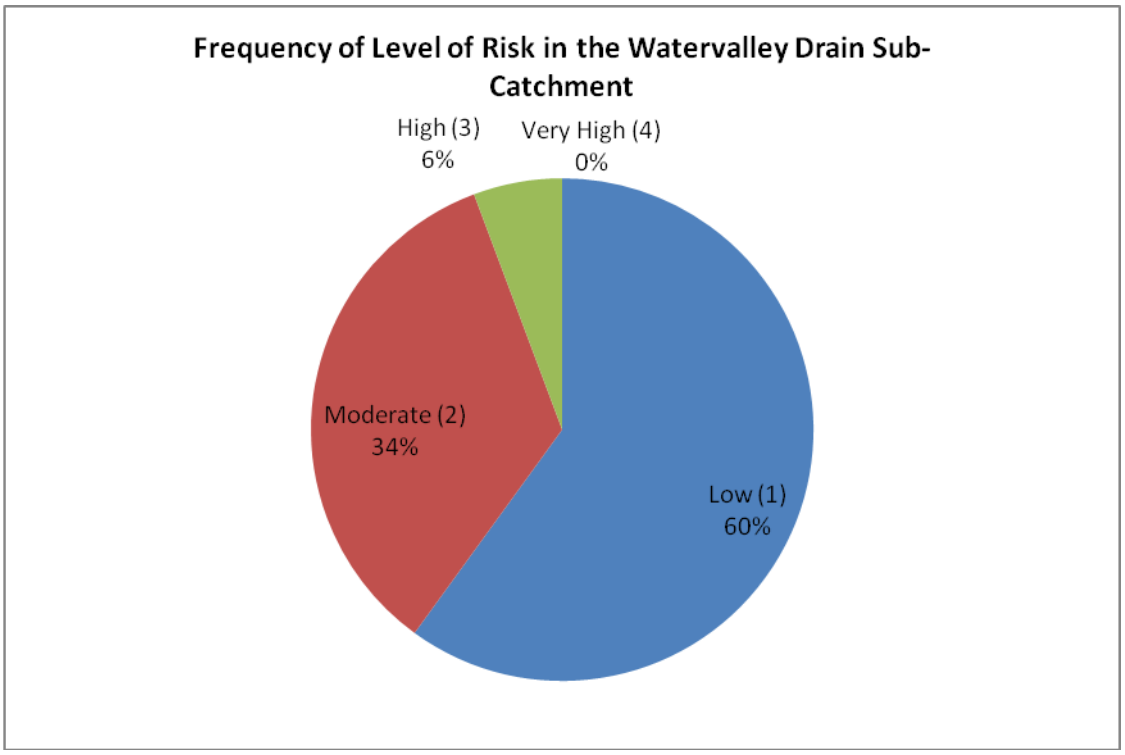


Figure 61. Frequency of risk levels identified in Watervalley sub-catchment

3.19.5 DATA RESULTS

In the Watervalley sub-catchment there are two Water Quality Monitoring sites. At site one data has been collected and analysed between 2000 and 2004. Samples were taken twice in 2000 and once a year between 2001 and 2004. At site two data was collected between 2000 and 2002, samples were collected twice in 2000 and once a year in 2004 and 2005). These sites are currently closed.

The Risk Assessment was based on ten samples collected between May 2000 and May 2004.

Table 40 below shows those parameters which were found to exceed the ANZECC guidelines (refer to Appendix 4).

Quantitative and qualitative information was used in the assessment of Watervalley sub-catchment. Initially the qualitative Risk Assessment was conducted and the hazards identified were verified using the water quality data. This strengthened the understanding of whether a perceived hazard resulted in an impact to water quality.

As mentioned in section 2.5, the Upper South East Catchment Risk Assessment was subjected to a 'certainty level' matrix which defined the confidence level of information/data used in determining the risk level (see Table 4).

All data and information used in this Risk Assessment was classified according to the certainty level matrix and rated at either level 2 or 3. Confidence level 2 is defined as perception-based, with some information on process but not directly relevant to this region, or information applies to regional level but has significant limitations. Confidence level 3 is defined as limited information derived largely from expert knowledge where they may be some differences of opinion. These confidence levels are explained in more detail in Appendix 3 (A.4).

Table 40. Parameters exceeding Water Quality Guidelines in Watervalley sub-catchment

METALS	NUTRIENTS
Aluminium (total)	Nitrate as N
Cadmium (total)	
Chromium (total)	
Iron (total)	
Nickel (total)	
Selenium (total)	
Silver (total)	
Zinc (total)	

As part of the Risk Assessment a data screening process was undertaken (in the sub-catchments where data was present), which screened out parameters that had never exceeded the guideline or had no data. Parameters may also have been screened out if there was no guideline available or if the guideline was lower than the LOR. The parameters which have been screened out for Watervalley sub-catchment are displayed in Table 41. All parameters considered during the Risk Assessment process can be found in Appendix 4.

Table 41. Parameters screened from the Risk Assessment of Watervalley sub-catchment

Parameter Type	Parameter	Reason for Screen
Pesticide	Aldrin	No Guideline, Limited Data
Metal	Aluminium (tot)	No Data
Nutrient	Ammonium (NH_4 as N)	No Data

Pesticide	AMPA	No Guideline, Limited Data
Metal	Antimony (sol)	No Guideline, No Data
Metal	Antimony (total)	Limited Data
Pesticide	Atrazine	Limited Data
Metal	Arsenic (sol)	No Guideline, No Data
Anions	Bicarbonate	No Guideline
Metal	Cadmium (sol)	No Guideline, No Data
Cation	Calcium	No Exceedences
Derived Data	Hardness	No Exceedences
Derived Data	Carbonate Hardness	No Exceedences
Pesticide	Chlordane A	All Lower than Limit of Reporting
Pesticide	Chlordane G	No Guideline, all lower than Limit of Reporting
Anion	Chloride	No Guideline, all lower than Limit of Reporting
Biological	Chlorophyll A and B	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothalonil	No Guideline, all lower than Limit of Reporting
Pesticide	Chlorothal-Dimethyl	No Guideline, all lower than Limit of Reporting
Metal	Chromium (sol)	No Data
Metal	Copper (total and sol)	No Data
Pesticide	DDD	No Guideline, all lower than Limit of Reporting
Pesticide	DDT	No Guideline, all lower than Limit of Reporting
Pesticide	DDE	No Guideline, all lower than Limit of Reporting
Pesticide	Dieldrin	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Oxygen	No Guideline, all lower than Limit of Reporting
Physical	Dissolved Solids	No Guideline, all lower than Limit of Reporting
Pesticide	Endosulfan 1 and 2	No Guideline, all lower than Limit

		of Reporting
Pesticide	Endosulfan Sulphate	No Guideline, all lower than Limit of Reporting
Pesticide	Endrin	No Exceedences
Anion	Fluoride	No Guideline, all lower than Limit of Reporting
Pesticide	Glysphosate	All Lower than Limit of Reporting
Pesticide	Heptachlor	No Exceedences
Pesticide	Heptechlor Epoxide	No Guideline, all lower than Limit of Reporting
Pesticide	Hexachlorobenzene	No Guideline, all lower than Limit of Reporting. Limited Data
Pesticide	Hexazinone	No Guideline, all lower than Limit of Reporting
Derived Data	Ion Balance	No Guideline
Metal	Iron (sol)	No Data
Derived Data	Langler Index	No Guideline, all lower than Limit of Reporting
Metal	Lead (sol)	No Data
Pesticide	Lindane	No Exceedences
Cation	Magnesium	No Guideline
Derived Data	Magnesium hardness	No Guideline
Pesticide	Malthion	No Exceedences
Metal	Mercury (sol)	No Data
Pesticide	Methoxychlor	No Guideline, all lower than Limit of Reporting
Metal	Nickel (sol)	No Data
Nutrients	Nitrate as NO_3	No Guideline or Limit of Reporting
Derived Data	Non-carbonate Hardness	No Guideline or Limit of Reporting
Pesticide	OrganoChloroResidual Scan	No Guideline or Limit of Reporting Very limited data
Pesticide	Parathion-Methyl	No Guideline, all lower than Limit of Reporting
Nutrients	Filtered Reactive Phosphorus	No Exceedences

Nutrients	Phosphorus Total	No Exceedences
Cation	Potassium	No Guideline, all lower than Limit of Reporting
Nutrients	Silica Reactive	No Guideline
Metal	Silver (sol)	No Data
Pesticide	Simazine	No Exceedences
Cation	Sodium	No Guideline
Derived Data	Sodium Adsorption Ration	No Guideline
Derived Data	Sodium /Total Cations Ratio	No Guideline
Anion	Sulphate	No Guideline
Physical	Suspended Solids	No Guideline
Physical	Temperature	No Guideline
Nutrient	TKN	No Guideline
Derived Data	Total Chlorides as NaCl	No Guideline
Physical	TDS by EC	No Guideline
Physical	TDS by Evaporation	No Guideline
Derived Data	Total Hardness ($CaCO_3$)	No Guideline or Limit of Reporting
Nutrients	Total N (TKN + (Nitrate + Nitrite as N (Nox))	No Exceedences
Pesticide	Trifluran	No Exceedences
Pesticide	Vinclozin	Total N (TKN + (Nitrate + Nitrite as N (Nox))

3.19.6 DISCUSSION

Several metals and one nutrient parameter exceeded ANZECC guidelines in the Watervalley sub-catchment. These metals also showed exceedences in several other sub-catchments. The exceedences may be due to the natural presence of these metals in the soil. This is an issue for investigation. Another possible explanation for these metal exceedences is that the guidelines may not necessarily be calibrated for the USE Catchment or the LOR could be higher than the actual guideline itself.

Many parameters initially included in the Risk Assessment were screened out due to insufficient or no data, no past or current exceedences and/or values which were lower than the LOR. This screening process eliminated many pesticides due to no guidelines, however the qualitative risk analysis shows that these pesticides may still be having a negative effect on water quality, hence this is also an issue for further investigation.

As in all sub-catchments, with the exception of Morella Basin, organic matter presented as a 'high' risk. This was attributed to 'stock grazing near watercourses' and is an issue for investigation.

'Stock grazing near watercourses' and the use of fertilisers were also classed as a nutrient risk. This is an issue for investigation.

Pesticide application presented as a 'high' risk in the Watervalley sub-catchment, due to the nature of the application (spraying). This is an issue for investigation.

3.19.7 RECOMMENDATIONS FOR WATER QUALITY MONITORING IN THE WATERVALLEY SUB-CATCHMENT

It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.

It is recommended that an investigation be conducted to review the metal composition of soils in Watervalley sub-catchment and the USE. This should include a determination of actual metals present – not just the limit of reporting. This could be undertaken via sediment sampling.

It is recommended to investigate the presence and level of pesticides in the water of the sub-catchment to determine if they present a risk to the health of aquatic environments. This could be undertaken using passive samplers. Such an investigation could be conducted in the Watervalley sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation into the effect of 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in either the Fairview sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application and at a time when runoff is initially occurring in a sub-catchment. This could be conducted in the Watervalley sub-catchment or at a location that is representative of the USE Catchment.

It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable (such as the above recommendations for a metals analysis).

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 DISCUSSION

The Upper South East Catchment Water Quality Risk Assessment set out to describe the water quality risks in the USE Catchment study area in order to inform a targeted Water Quality Monitoring Plan. The research method used a combination of historical and existing water quality data and information collected through hours of interviews with landholders, locals, and Local and State Government representatives to determine what hazards may pose a risk to water quality in the region.

As the study area is quite large, it was segmented into 18 sub-catchments and a Risk Assessment was carried out for each of those sub-catchments. The main land uses were determined for each of these sub-catchments, and hazards were linked to these land uses. The hazardous events—an event that causes a hazard to occur—for each hazard were also described.

A Risk Analysis was then carried out determining the likelihood of each of these hazards occurring and the consequence of the impact on water quality. Hazards were combined into seven main risks to water quality – nutrients, pesticides, organic matter, turbidity, salinity, heavy metals and hydrocarbons.

No ‘very high’ risks were observed in the Upper South East Catchment. Six percent of risks were in the ‘high’ category, 37% of risks were in the ‘moderate’ category, and 57% of risks were in the ‘low’ category. Pesticides and organic matter yielded the greatest frequency of ‘high’ risks to water quality, whilst nutrients recorded the greatest number of risks.

It is important to realise that all risks described in the USE Catchment Water Quality Risk Assessment are potential and may or not be expressed in the system.

There are three main ways that potential risk can be managed:

1. In sub-catchments that have yielded ‘high’ risks, a monitoring program can be set up to monitor for expression of those risks
2. Risks can be mitigated using adaptive management programs and investigative programs in the system – i.e. the ‘If it turns up, we’ll deal with it’ approach
3. Programs can be put in place to prevent the risk from occurring

This project has considered the first two management options – monitoring for expression and investigation/adaptive management programs. The key is to be aware of the risks and monitor for the expression of the risk. If the risk does express, then the monitoring and management programs will change to reflect this. Recommendations for an adaptive management monitoring program can be found in section 4.2.

4.2 RECOMMENDATIONS

As mentioned in the previous section, all risks described in the USE Water Quality Risk Assessment are potential until they are backed up with water quality data. An adaptive monitoring program is needed so that if risk does occur, the water quality monitoring program can be changed to reflect this. However, if a 'high' risk exists but current data tells us it is not occurring, it is important to continue to monitor for this risk or undertake a targeted investigative program.

Below is a list of recommendations for an adaptive water quality monitoring program in the Upper South East.

- It is recommended that a brief feasibility study be undertaken to determine if it would be appropriate to derive Water Quality Guidelines specific to the USE Catchment.
- It is recommended that an investigation be conducted, reviewing the metal composition of soils in the USE. This should be a determination of actual metals present – not just the limit of reporting.
- It is recommended that an investigation be conducted into the correct analysis of pH and consequent analysis of ammonia as NH_3. This could include investigation of a method of accurately measuring pH in highly saline conditions.
- It is recommended to investigate the presence and level of pesticides in the USE to determine if they cause a risk to the health of aquatic environments. This could be undertaken using passive samplers.
- It is recommended that the Water Quality Monitoring Program be scaled back due to many parameters not exceeding or coming close to exceeding Water Quality Guidelines. It is recommended that only physical parameters should be monitored, and targeted investigations be undertaken where risks present as 'high', results exceed guidelines, or when guidelines are unavailable.
- It is recommended that an investigation into the effect of the land use 'stock grazing near watercourses' (including its contribution to nutrient loads) be conducted in the USE Catchment.
- It is recommended that an investigation be carried out into the contribution of fertiliser to nutrient exceedences. This could involve sampling before fertiliser application, after fertiliser application, and at a time when runoff is initially occurring in a sub-catchment.
- It is recommended that a regular monitoring program for Naracoorte Creek be instigated, which should include nutrient and heavy metal sampling.

APPENDICES

APPENDIX 1: LEGISLATIVE FRAMEWORK

ENVIRONMENT PROTECTION (WATER QUALITY) POLICY 2003

The Environment Protection (Water Quality) Policy 2003, South Australia was developed to manage water quality in SA. The policy applies to inland surface water, groundwater and marine water and addresses the following:

- Water quality
- Management and control of point and diffuse sources of pollution
- What people who conduct an activity are obliged to do
- Water quality criteria, discharge limited and listed pollutants
- Potential for establishing codes of practice to minimise water quality risks.

WATER RESOURCES ACT 1997

An objective of the Water Resources Act is to protect the ecosystems of the state's water resources. This Act has now been incorporated into the Natural Resources Management (NRM) Act 2004.

NATURAL RESOURCES MANAGEMENT (NRM) ACT 2004

The Natural Resource Management Act combines legislation currently dealing with water resource management, pest animal and plant control and soil conservation and Landcare. The principal objective of the NRM Act is to achieve ecologically sustainable development by establishing a framework for the integrated use and management of natural resources. A single Natural Resource Management (NRM) Board is to be established for each NRM region. Each Board is required to prepare a regional NRM plan.

UPPER SOUTH EAST DRYLAND SALINITY AND FLOOD MANAGEMENT ACT 2002

An Act to provide for the delivery of the Upper South East Dryland Salinity and Flood Management Plan and Program Phase III

SOUTH EASTERN WATER CONSERVATION AND DRAINAGE ACT 1992

An Act to provide for the conservation and management of water and prevention of flooding on rural lands in the South East of South Australia

APPENDIX 2: AQUATIC ECOSYSTEM ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
1 Morella	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	50000 EC	50000 EC
			P – Drainage	Flow Volume (P)	20 NTU	20 NTU
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals – Cadmium	Total Cadmium (P)	TC 0.0003	TC 0.0003
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TP 0.0034 SP 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Mercury	Total Mercury (P)	TM 0 .0006	TM 0 .0006
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	TS 0.011
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	50000 EC	50000 EC
			P – Turbidity	Turbidity	20 NTU	20 NTU
			P – pH	pH	pH 9	pH 9
			P – Metals	Metals	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	50000 EC	50000 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH	pH 9	pH 9
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides	?	?

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	N/a 50000 EC	N/a 50000 EC
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance the Small Mouth Hardyhead Population			
			P – Lack of flows	Flow Volume (V)	N/a	N/a
			P – Increasing surface water salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P - Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – pH (not known if important)	pH (P)	pH 9	pH 9
			P – Metals	Metals (P)	As above	As above
			MG – Protect and enhance macroinvertebrate populations			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			MG – Preserve Waterbird Populations			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034
			P – Herbicide/Pesticide - consult			

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
2 Tilley Swamp 3 Taratap 7 Keilira 16 Bunbury 19 Mount Rough	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	10000 EC	10000 EC
			P – Drainage	Flow Volume (P)	N/a	N/a
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	10000 EC	10000 EC
			P – Turbidity	Turbidity	20 NTU	20 NTU
			P – pH	pH	pH 9	pH 9
			P – Metals	Metals	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	10000 EC	10000 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH	pH 9	pH 9
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	N/a	N/a
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance macroinvertebrate populations			

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
6 Winpinmerit 9 Bakers Range 10 Fairview 11 Marcollat 13 Gum Lagoon 14 Rosemary Downs 18 Watervalley Drain	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal and semi-permanent wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Drainage	Flow Volume (P)	N/a	N/a
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – Nutrients - Phosphorus	Total P and Soluable P (PV)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – pH	PH (P)	pH 9	pH 9
			P – Metals	Metals (P)	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides (P)	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH (P)	pH 9	pH 9

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	N/a	N/a
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance macroinvertebrate populations			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			MG – Preserve Waterbird Populations			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034
			P – Herbicide/Pesticide	Herbicide/Pesticide	??	??

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
5 West Avenue	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal and semi-permanent wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P- Lack of flow	Flow Volume (V)	N/a	
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – pH	pH (P)	pH 9	pH 9

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P – Metals	Metals (P)	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides (P)	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH (P)	pH 9	pH 9
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	6500 EC	6500 EC
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance the Yarra Pygmy Perch Population			
			P – Lack of flows	Flow Volume (V)	N/a	N/a
			P – Increasing temperature with falling water level	Temperature (V)	24 degrees	24 degrees
			P – Increasing surface water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients - Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P - pH	pH (P)	pH 9	pH 9
			MG – Protect and enhance the Southern Bell Frog Population			
			P – Lack of flows	Flow Volume (V)	N/a	N/a
			P – Increasing surface water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Metals	As above	As above	As above
			MG – Protect and enhance macroinvertebrate populations			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			MG – Preserve Waterbird Populations			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034
			P – Herbicide/Pesticide - consult			

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
12 Wongawilli (no wetlands in this sub-catchment)	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – To Supply Watervalley wetlands in sub-catchment 18 with no greater than 6000 EC**			
			P – Increasing salinity	Electrical Conductivity (P)	6000 EC	6000 EC
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	TS 0.011
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
15 Mount Charles 17 Taunta Hut	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal and permanent wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	N/a	
			P – Drainage	Flow Volume (P)	20 NTU	20 NTU
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	50000 EC	50000 EC
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – pH	pH (P)	pH 9	pH 9
			P – Metals	Metals (P)	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides (P)	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH (P)	pH 9	pH 9
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	N/a 50000 EC	N/a 50000 EC
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance macroinvertebrate populations			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			MG – Preserve Waterbird Populations			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034
			P – Herbicide/Pesticide - consult			

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
4 Watervalley Wetlands	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Preserve and enhance seasonal and semi-permanent wetlands**			
			P – Increasing salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Drainage	Flow Volume (P)	N/a	N/a
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P- Lack of flow	Flow Volume (V)	N/a	N/a
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Protect and enhance submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P – pH	pH (P)	pH 9	pH 9
			P – Metals	Metals (P)	As above	As above
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Herbicides	Herbicides (P)	?	?
			MG – Protect and enhance emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P - Increasing surface and ground water salinity	Electrical Conductivity (P)	6500 EC	6500 EC
			P – Turbidity	Turbidity (P)	NTU 20	NTU 20
			P – pH	pH (P)	pH 9	pH 9
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Maintain Environmental Flow Requirements			
			P - Lack of available surface water flows of a suitable salinity	Flow Volume (V) Salinity (P)	N/a 6500 EC	N/a 6500 EC
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Protect and enhance macroinvertebrate populations			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Pesticides	Pesticides (P)	N/a	N/a
			P – Increasing Salinity	Electrical Conductivity (P)	50 000 EC	50 000 EC
			P – Nutrients -Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			MG – Preserve habitat for waterbird refuge			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034
			P – Herbicide/Pesticide - consult	Herbicide/Pesticide (P)	??	??
			MG – Preserve habitat for colonial nesting waterbirds			
			P – Metals - Lead	Lead (P)	TL 0.0034 SL 0.0034	TL 0.0034 SL 0.0034

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
			P – Declining water level	Water level (PV)	N/a	N/a
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P – Declining macro-invertebrate food source	Macro-invertebrates (V)	N/a	N/a

Grouping of Sub-Catchments /Wetlands	Environmental Value	Level of Protection	Management Goals and Associated Pressures	Indicators (specify pressure indicators or value/use indicators)	Guideline Value	Draft Water Quality Objective
8 East Avenue	Aquatic ecosystems	Slightly and moderately disturbed systems – 95% of species	**MG – Restore and enhance seamsonal wetlands**			
			P – Drainage	Flow Volume (P)	N/a	N/a
			P – Turbidity	Turbidity (P)	20 NTU	20 NTU
			P- Lack of flow	Flow Volume (V) Salinity (P)	N/a 5500 EC	N/a 5500 EC
			P – Nutrients - Phosphorus	Total P and Soluable P (P)	TP 0.5; PFR 0.1	TP 0.5; PFR 0.1
			P – Nutrients - Nitrogen	Total N (PV)	TN 5	TN 5
			P – Nutrients – Ammonia	Ammonia (P)	NH3 0.01	NH3 0.01
			P – Metals - Chromium	Total and Soluable Chromium (P)	TC 0.001 SC 0.001	TC 0.001 SC 0.001
			P – Metals – Iron	Total Iron (PV)	TI 0.001	TI 0.001
			P – Metals – Lead	Total and Soluable Lead (P)	TL 0.0034 SL 0.0034	TP 0.0034 SP 0.0034
			P – Metals – Copper	Total and Soluable Copper (P)	TC 0.0014 SC 0.0014	TC 0.0014 SC 0.0014
			P – Metals – Nickel	Total and Soluable Nickel (P)	TN 0.011 SC 0.011	TN 0.011 SC 0.011
			P – Metals – Selenium	Total Selenium (P)	TS 0.011	
			P – Metals – Silver	Total and Soluable Silver (P)	TS 0.00005 SS 0.00005	TS 0.00005 SS 0.00005
			P – Metals – Zinc	Total and Soluable Zinc (P)	TZ 0.008 SZ 0.008	TZ 0.008 SZ 0.008
			MG – Restore submerged aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P – Herbicides	Herbicides (P)	?	?
			MG – Restore emergent aquatic vegetation			
			P – Lack of flow	Flow Volume (V)	N/a	N/a
			P- Nutrients – Total Nitrogen and affiliates	Total Nitrogen (P)	TN 5	TN 5
			P - Herbicides	Herbicides (P)	??	??
			MG – Restore Environmental Flow Requirements			
			P – Diverted surface water flows	Flow Volume (V)	N/a	N/a
			P - Drainage	Flow Volume (V)	N/a	N/a
			MG – Restore breeding habitat for waterbirds			
			P – Lack of flow	Flow Volume (P)	N/a	N/a
			P – Pasture Improved and grazed	Pasture (P)	N/a	N/a
			MG – Restore macro-invertebrate population			
			P – Lack of flow	Flow Volume (P)	N/a	N/a

APPENDIX 3: CATCHMENT RISK ANALYSIS INFORMATION

Table A.1. Likelihood Matrix (adapted from Standards Australia 2004, EPA 2006)

Level	1	2	3	4	5
Likelihood	Rare	Unlikely	Possible	Likely	Almost certain
Description (qualitative)	Occurs only in exceptional circumstances	Could occur, but not expected	Could occur	Will probably occur in most circumstances	Is expected to occur in most circumstances
Frequency (indicative time scale)	Less often than 10 yearly	Yearly	Monthly	Weekly	Daily

Table A.2 Consequence Matrix – Environmental Values (adapted from ANZECC 2000, Billington 2005, EPA 2006)

Level	Consequence		Qualitative Consequence Measures
1	Insignificant	No discernable impact on aquatic ecosystem health	No discernable effects on aquatic ecosystem or impact is so small to be considered trivial It would be unlikely that there would be any exceedance of aquatic ecosystem water quality criteria at the discharge point, and if there was an exceedance it would be minor and temporary
2	Minor	Minor localised impacts on aquatic ecosystem health	Aquatic ecosystem health temporarily compromised over a localised[1] area Possible minor changes in species abundance and community structure but these could be mistaken for being due to seasonal changes or natural variation Recovery would likely occur within a short time frame Impact likely to result from a localised and minor exceedance[2] of aquatic ecosystem water quality criteria that does not persist over time
3	Moderate	Significant localised impact on aquatic ecosystems health	Aquatic ecosystem health compromised in a localised area for a long time period OR temporarily over a wider area May result in significant changes in native species abundance and community structure AND/OR major habitat loss AND/OR triggering of algal/nuisance species growth Recovery may take several years Impact likely to result ffrom an exceedance[2] of aquatic ecosystem water quality criteria that persists in a localised area
4	Major	Major and widespread impacts	Aquatic ecosystem health compromised over a wide area for a moderate term

[1] A localised spatial scale was considered to be less than approximately 20 m radius from the discharge point

[2] Or further exceedance where the current ambient water quality exceeds ANZECC guideline levels (e.g. for

[2] Or further exceedance where the current ambient water quality exceeds ANZECC guideline levels (e.g. for turbidity)

		on aquatic ecosystem health	May result in major changes in native species abundance and community structure AND/OR major habitat loss AND/OR triggering of algal/nuisance species growth Recover may take several years Impact likely to result from a sustained moderate exceedance[2] of aquatic ecosystem water quality criteria over a wide area OR short-term major exceedance over a small area
5	Catastrophic	Extreme and widespread impacts on aquatic ecosystem health	Aquatic ecosystem health severely compromised over a wide area and for long-term May result in extensive losses of aquatic organisms and habitat with the potential for whole ecosystem destruction Recover may not occur within a generation Impact likely to result from an extreme and wide-scale exceedance of aquatic ecosystem water quality criteria due to the release of a large volume of contaminants into the receiving water body

Table A.3 Risk Matrix (adapted from Standards Australia 2004, EPA 2006)

Likelihood	**Insignificant 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
5 (almost certain)	Low	Moderate	High	Very high	Very high
4 (likely)	Low	Moderate	High	Very high	Very high
3 (possible)	Low	Moderate	High	Very high	Very high
2 (unlikely)	Low	Low	Moderate	High	Very high
1 (rare)	Low	Low	Moderate	High	High

Table A.4 Certainty Level Matrix (source: Billington 2005, EPA 2006)

Level of Confidence or Certainty	**Description**
1	Perception only, no information or knowledge forms the basis of the opinion
2	Perception based, some information on process but not directly relevant to region, or information at a regional level has significant limitations
3	Limited information is known, expert knowledge would lead to this outcome – may be some differences in opinion
4	Information known; process has been described and documented at a regional level, experts can verify this position
5	Information is known and well represents the specific nature of the process; described and documented at a regional level and experts would agree on this position

APPENDIX 4: SCREENING RISK ANALYSIS INTERIM WATER QUALITY GUIDELINE OBJECTIVES

Parameter	Unit	Guideline Threshold	Guideline Source
Physical			
DO	mg/L	n/a	n/a
EC	uS/cm	n/a	n/a
TDS	mg/L	n/a	n/a
TDS by Evap	mg/L	n/a	n/a
pH	pH units	9.0	EPP - Fresh
Turbidity	NTU	20.0	EPP - Fresh
Temperature	deg C	n/a	n/a
Suspended Solids	mg/L	n/a	n/a
Dissolved Solids	mg/L	n/a	n/a
Cations			
Calcium	mg/L	n/a	n/a
Magnesium	mg/L	n/a	n/a
Potassium	mg/L	n/a	n/a
Sodium	mg/L	n/a	n/a
Anions			
Bicarbonate	mg/L	n/a	n/a
Carbonate	mg/L	n/a	n/a
Chloride	mg/L	n/a	n/a
Sulphate	mg/L	n/a	n/a
Fluoride	mg/L	n/a	n/a
Nutrients			
Total N	mg/L	5	EPP - Fresh
Nitrate	mg/L	n/a	n/a
Nitrate + Nitrite as N (Nox)	mg/L	0.5	EPP - Fresh
TKN	mg/L	n/a	n/a
Ammonia (NH3 as N)	mg/L	0.01	EPP - Fresh
Ammonia (total as N)	mg/L	0.5	EPP - Fresh
Ammonium (NH4 as N)	mg/L	n/a	
Total P	mg/L	0.5	EPP - Fresh
Filtered Reactive Phosphorus	mg/L	0.1	EPP - Fresh
Silica - Reactive	mg/L	n/a	n/a
Nitrate + Nitrite as N03	mg/L	n/a	n/a

Metals			
Aluminium - Soluble	mg/L	0.055	ANZECC Fresh Water
Aluminium - Total (in > pH 6.5)	mg/L	0.055	ANZECC Fresh Water
Antimony - Soluble	mg/L	n/a	Not Available
Antimony - Total	mg/L	0.03	EPP
Arsenic - Inorganic	mg/L	0.024	ANZECC Fresh Water
Arsenic - Soluble	mg/L	0.024	ANZECC Fresh Water
Cadmium - Soluble	mg/L	0.0003	ANZECC Fresh Water
Cadmium - Total	mg/L	0.0003	ANZECC Fresh Water
Chromium - Soluble	mg/L	0.001	ANZECC Fresh Water
Chromium - Total	mg/L	0.001	ANZECC Fresh Water
Copper - Soluble	mg/L	0.0014	ANZECC Fresh Water
Copper - Total	mg/L	0.0014	ANZECC Fresh Water
Iron - Soluble	mg/L	n/a	Not Available
Iron - Total	mg/L	0.001	EPP
Lead - Soluble	mg/L	0.0034	ANZECC Fresh Water
Lead - Total	mg/L	0.0034	ANZECC Fresh Water
Mercury - Soluble	mg/L	0.0006	ANZECC Fresh Water
Mercury - Total	mg/L	0.0006	ANZECC Fresh Water
Nickel - Soluble	mg/L	0.011	ANZECC Fresh Water
Nickel - Total	mg/L	0.011	ANZECC Fresh Water
Selenium - Soluble	mg/L	n/a	ANZECC Fresh Water
Selenium - Total	mg/L	0.011	ANZECC Fresh Water
Silver - Soluble	mg/L	0.00005	ANZECC Fresh Water
Silver - Total	mg/L	0.00005	ANZECC Fresh Water
Zinc - Soluble	mg/L	0.008	ANZECC Fresh Water
Zinc - Total	mg/L	0.008	ANZECC Fresh Water
Biological			
Chlorophyll *a*	mg/L	n/a	n/a
Chlorophyll b	mg/L	n/a	n/a
Derived Data			
Alkalinity as calcium carbonate		n/a	n/a
Langelier Index		n/a	n/a
Sodium adsorption ratio		n/a	n/a
Total hardness as CaC03		n/a	n/a
Carbonate hardness as CaC03		n/a	n/a
Noncarbonate hardness as CaC03		n/a	n/a
Calcium hardness as CaC03		n/a	n/a

Magnesium hardness as CaC03		n/a	n/a
Free carbon dioxide		n/a	n/a
Total chlorides as NaCl		n/a	n/a
sodium / total cations ratio		n/a	n/a
Ion balance		n/a	n/a
Pesticides			
Aldrin	mg/L	n/a	Not Available
Chlorthal-Dimethyl (Dacthal)	mg/L	n/a	Not Available
Dieldrin	mg/L	n/a	Not Available
Endosulfan 1	mg/L	0.0002	ANZECC Fresh Water
Endosulfan 2	mg/L	n/a	Not Available
Chlorothalonil	mg/L	n/a	Not Available
Chlorpyrifos	mg/L	0.00001	ANZECC Fresh Water
DDD (TDE)	mg/L	n/a	Not Available
DDE	mg/L	n/a	Not Available
DDT	mg/L	0.00001	ANZECC Fresh Water
Simazine	mg/L	0.0032	ANZECC Fresh Water
Endosulfan Sulphate	mg/L	n/a	Not Available
Atrazine	mg/L	0.013	ANZECC Fresh Water
Lindane	mg/L	0.0002	ANZECC Fresh Water
Azinphos-Methyl	mg/L	0.00002	ANZECC Fresh Water
Heptachlor	mg/L	0.00009	ANZECC Fresh Water
Diazinon	mg/L	0.00001	ANZECC Fresh Water
Heptachlor Epoxide	mg/L	n/a	Not Available
Fenitrothion	mg/L	0.0002	ANZECC Fresh Water
Trifluralin	mg/L	0.0044	ANZECC Fresh Water
Hexazinone	mg/L	n/a	Not Available
Chlordane-a	mg/L	0.00008	ANZECC Fresh Water
Malathion	mg/L	0.00005	ANZECC Fresh Water
Chlordane-g	mg/L	n/a	Not Available
Parathion	mg/L	0.000004	ANZECC Fresh Water
Endrin	mg/L	0.00002	ANZECC Fresh Water
Parathion-Methyl	mg/L	n/a	Not Available
Methoxychlor	mg/L	n/a	Not Available
Prometryne	mg/L	n/a	Not Available
Vinclozolin	mg/L	n/a	Not Available
Glyphosate	mg/L	1.2	ANZECC Fresh Water
Hexachlorobenzene	mg/L	n/a	Not Available
AMPA	mg/L	n/a	
OrganoChloroResidual Scan	mg/L	n/a	

UNITS OF MEASUREMENT

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
gigalitre	GL	10^6 m^3	volume
gram	g	10^{-3} kg	mass
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
kilogram	kg	base unit	mass
kilolitre	kL	1 m^3	volume
kilometre	km	10^3 m	length
litre	L	10^{-3} m^3	volume
megalitre	ML	10^3 m^3	volume
metre	m	base unit	length
microgram	μg	10^{-6} g	mass
microlitre	μL	10^{-9} m^3	volume
milligram	mg	10^{-3} g	mass
millilitre	mL	10^{-6} m^3	volume
millimetre	mm	10^{-3} m	length
minute	min	60 s	time interval
second	s	base unit	time interval
tonne	t	1000 kg	mass
year	y	365 or 366 days	time interval

GLOSSARY

Act (the) — In this document, refers to the *Natural Resources Management (SA) Act 2004,* which supercedes the *Water Resources (SA) Act 1997*

Adaptive management — A management approach often used in natural resource management where there is little information and/or a lot of complexity, and there is a need to implement some management changes sooner rather than later. The approach is to use the best available information for the first actions, implement the changes, monitor the outcomes, investigate the assumptions, and regularly evaluate and review the actions required. Consideration must be given to the temporal and spatial scale of monitoring and the evaluation processes appropriate to the ecosystem being managed.

Algal bloom — A rapid accumulation of algal biomass (living organic matter) that can result in deterioration in water quality when the algae die and break down, consuming the dissolved oxygen and releasing toxins

Ambient — The background level of an environmental parameter (eg. a measure of water quality such as salinity)

Ambient water monitoring — All forms of monitoring conducted beyond the immediate influence of a discharge pipe or injection well, and may include sampling of sediments and living resources

Ambient water quality — The overall quality of water when all the effects that may impact upon the water quality are taken into consideration

Anabranch — A branch of a river that leaves the main channel

Annual adjusted catchment yield — Annual catchment yield with the impact of dams removed

Anurans — Frogs and toads; strictly amphibians of the order Anura, characterised by the lack of a tail

ANZECC — Australia New Zealand Environmental Consultative Council

APCB — Animal and Plant Control Board

Aquatic community — An association of interacting populations of aquatic organisms in a given water body or habitat

Aquatic ecosystem — The stream channel, lake or estuary bed, water, and/or biotic communities, and the habitat features that occur therein

Aquatic habitat — Environments characterised by the presence of standing or flowing water

Aquatic macrophytes — Any non-microscopic plant that requires the presence of water to grow and reproduce

Aquiclude — In hydrologic terms, a formation that contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring

Aquifer — An underground layer of rock or sediment that holds water and allows water to percolate through

Aquifer, confined — Aquifer in which the upper surface is impervious (see 'confining layer') and the water is held at greater than atmospheric pressure; water in a penetrating well will rise above the surface of the aquifer

Aquifer test — A hydrological test performed on a well, aimed to increase the understanding of the aquifer properties, including any interference between wells, and to more accurately estimate the sustainable use of the water resources available for development from the well

Aquifer, unconfined — Aquifer in which the upper surface has free connection to the ground surface and the water surface is at atmospheric pressure

Aquitard — A layer in the geological profile that separates two aquifers and restricts the flow between them

ASR — Aquifer Storage and Recovery; involves the process of recharging water into an aquifer for the purpose of storage and subsequent withdrawal; also known as aquifer storage and retrieval

Arid lands — In South Australia, arid lands are usually considered to be areas with an average annual rainfall of less than 250 mm and support pastoral activities instead of broadacre cropping

ARMCANZ — Agriculture and Resource Management Council of Australia and New Zealand

Artesian — An aquifer in which the water surface is bounded by an impervious rock formation; the water surface is at greater than atmospheric pressure, and hence rises in any well which penetrates the overlying confining aquifer

Artificially dry wetland — Water source cut off or wetland drained (Harding, 2006)

Artificial recharge — The process of artificially diverting water from the surface to an aquifer; artificial recharge can reduce evaporation losses and increase aquifer yield; see also 'natural recharge', 'aquifer'

AusRivAS — Australian River Assessment System; a national river and stream health assessment program run by the Australian Government

AWQC — Australian Water Quality Centre

AWQMP — Ambient Water Quality Monitoring Program; run by the South Australian Environment Protection Authority (EPA) since 1996

AWS — Automatic Weather Station

Barrage — Specifically any of the five low weirs at the mouth of the River Murray constructed to exclude seawater from the Lower Lakes

Barrier — A key location in the water supply system where control can occur. Control may take the form of a preventative measure. For the purposes of this study the term 'barrier' has also been given to key monitoring locations, such as the inlet to water treatment plants

Baseflow — The water in a stream that results from groundwater discharge to the stream; often maintains flows during seasonal dry periods and has important ecological functions

Basin — The area drained by a major river and its tributaries

Benchmark condition — Points of reference from which change can be measured

Benthic zone — The lowest level of a body of water, such as an ocean or a lake; inhabited mostly by organisms that tolerate cool temperatures and low oxygen levels, called benthos or benthic organisms

Bioassessment — An evaluation of the biological condition of a water body by using biological surveys and other direct measurements of a resident biota in surface water

Biodiversity — (1) The number and variety of organisms found within a specified geographic region. (2) The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems

Biological diversity — See 'biodiversity'

Biological integrity — Functionally defined as the condition of the aquatic community that inhabits unimpaired water bodies of a specified habitat as measured by community structure and function

Biomonitoring — The measurement of biological parameters in repetition to assess the current status and changes in time of the parameters measured

Biota — All of the organisms at a particular locality

BoM — Bureau of Meteorology, Australia

Bore — See 'well'

Buffer zone — A neutral area that separates and minimises interactions between zones whose management objectives are significantly different or in conflict (eg. a vegetated riparian zone can act as a buffer to protect the water quality and streams from adjacent land uses)

^{14}C — Carbon-14 isotope (percent modern Carbon; pmC)

Catchment — That area of land determined by topographic features within which rainfall will contribute to run-off at a particular point

Catchment Risk Assessment — The process of identifying sources of pollution which contribute to high priority risks within the water supply system, includes land assessment and sanitary survey

Catchment Water Management Board — A statutory body established under the Act whose prime function is to implement a catchment water management plan for its area

Catchment water management plan — The plan prepared by a CWMB and adopted by the Minister in accordance with the Act

Codes of practice — Standards of management developed by industry and government, promoting techniques or methods of environmental management by which environmental objectives may be achieved

Coliform — Several types of aqueous bacteria, characteristic of faecal pollution from warm-blooded animals, can indicate sewage pollution in waters; see also 'FC'

Compliance monitoring — A type of monitoring done to ensure the meeting of immediate statutory requirements, the control of long-term water quality, the quality of receiving waters as determined by testing effluents, or the maintenance of standards during and after construction of a project

Cone of depression — An inverted cone-shaped space within an aquifer caused by a rate of groundwater extraction that exceeds the rate of recharge; continuing extraction of water can extend the area and may affect the viability of adjacent wells, due to declining water levels or water quality

Confining layer — A rock unit impervious to water, which forms the upper bound of a confined aquifer; a body of impermeable material adjacent to an aquifer; see also 'aquifer, confined'

Conjunctive use — The utilisation of more than one source of water to satisfy a single demand

Consequence — The outcome of an event expressed qualitatively or quantitatively, being a loss, injury or disadvantage

Contaminant — A material added by humans or natural activities that may, in sufficient concentrations, render the environment unacceptable for biota; the presence of these materials is not necessarily harmful

COAG — Council of Australian Governments; a council of the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association which exists to set national policy directions for Australia

Critical habitat — Those areas designated as critical for the survival and recovery of threatened or endangered species

CSIRO — Commonwealth Scientific and Industrial Research Organisation

CWMB — Catchment Water Management Board

δ**D** — Hydrogen isotope composition, measured in parts per thousand ($^{o}/_{oo}$)

Dams, off-stream dam — A dam, wall or other structure that is not constructed across a watercourse or drainage path and is designed to hold water diverted or pumped from a watercourse, a drainage path, an aquifer or from another source; may capture a limited volume of surface water from the catchment above the dam

Dams, on-stream dam — A dam, wall or other structure placed or constructed on, in or across a watercourse or drainage path for the purpose of holding and storing the natural flow of that watercourse or the surface water

Dams, turkey nest dam — An off-stream dam that does not capture any surface water from the catchment above the dam

Data comparability — The characteristics that allow information from many sources to be of definable or equivalent quality, so that this information can be used to address program objectives not necessarily related to those for which the data were collected. These characteristics need to be defined but would likely include detection limit precision, accuracy, bias, etc

Decision support system — A system of logic or a set of rules derived from experts, to assist decision-making. Typically they are constructed as computer programs

Deep water habitats — Permanently flooded lands that lie below the deep-water boundary of wetlands

DEH — Department for Environment and Heritage (Government of South Australia)

DES — Drillhole Enquiry System; a database of groundwater wells in South Australia, compiled by the South Australian Department of Water, Land and Biodiversity Conservation (DWLBC)

DHS — Department of Human Services (Government of South Australia)

Disinfection — The elimination of pathogenic organisms from water, usually achieved by chlorination, UV exposure, etc

District Plan (District Soil Conservation Plan) — An approved soil conservation plan under the repealed *Soil Conservation (SA) Act 1989*. These plans are taken to form part of the relevant regional NRM plans under the Act

Diversity — The distribution and abundance of different kinds of plant and animal species and communities in a specified area

DO — Dissolved Oxygen

DOC — Dissolved Organic Carbon

Domestic purpose — The taking of water for ordinary household purposes; includes the watering of land in conjunction with a dwelling not exceeding 0.4 hectares

Domestic wastewater — Water used in the disposal of human waste, for personal washing, washing clothes or dishes, and swimming pools

Drain – An open cut channel, for the purpose of reducing dryland salinity by removing saline groundwater and lowering the watertable level and mitigating flooding.

Dryland salinity — The process whereby salts stored below the surface of the ground are brought close to the surface by the rising watertable. The accumulation of salt degrades the upper soil profile, with impacts on agriculture, infrastructure and the environment.

d/s — Downstream

DSS — Dissolved suspended solids

DWLBC — Department of Water, Land and Biodiversity Conservation (Government of South Australia)

EC — Electrical conductivity; 1 EC unit = 1 micro-Siemen per centimetre (µS/cm) measured at 25°C; commonly used as a measure of water salinity as it is quicker and easier than measurement by TDS

Ecological indicators — Plant or animal species, communities, or special habitats with a narrow range of ecological tolerance; for example, in forest areas, such indicators may be selected for emphasis and monitored during forest plan implementation because their presence and abundance serve as a barometer of ecological conditions within a management unit

Eluent — A substance used as a solvent in separating materials in elution

ESD — Ecologically sustainable development; using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased

Ecological processes — All biological, physical or chemical processes that maintain an ecosystem

Ecological values — The habitats, natural ecological processes and biodiversity of ecosystems

Ecology — The study of the relationships between living organisms and their environment

Ecosystem — Any system in which there is an interdependence upon, and interaction between, living organisms and their immediate physical, chemical and biological environment

Ecosystem services — All biological, physical or chemical processes that maintain ecosystems and biodiversity and provide inputs and waste treatment services that support human activities

EDMS — Environmental Database Management System, administered by the Environment Protection Authority of South Australia (EPA)

Effectiveness monitoring — Documents how well management practices meet intended objectives for the riparian area. Monitoring evaluates the cause and effect relations between management activities and conditions of the riparian-dependent resources. Terrestrial and in-stream methods constitute monitoring that evaluates and documents the total effectiveness of site-specific actions.

Effluent — Domestic and industrial wastewater

EIP — Environment Improvement Program

Emerging environmental problems — Problems that may be new and/or are becoming known because of better monitoring and use of indicators

Endangered species — Any species in danger of extinction throughout all or a significant portion of its range

Endemic — A plant or animal restricted to a certain locality or region

Entitlement flows — Minimum monthly River Murray flows to South Australia agreed in to the Murray-Darling Basin Agreement 1992

Environmental values — Particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and that require protection form the effects of pollution, water discharges and deposits. Several environmental values may be designated for a specific waterbody

Environmental water provisions — That part of environmental water requirements that can be met; what can be provided at a particular time after consideration of existing users' rights, and social and economic impacts

Environmental water requirements — The water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

EPA — Environment Protection Authority (Government of South Australia)

Ephemeral streams or wetlands — Those streams or wetlands that usually contain water only on an occasional basis after rainfall events. Many arid zone streams and wetlands are ephemeral.

Episodic wetland — Only contains water at infrequent and irregular intervals (<1 year in 10) (Harding, 2006)

Erosion — Natural breakdown and movement of soil and rock by water, wind or ice; the process may be accelerated by human activities

ESD — Ecologically sustainable development

Estuaries — Semi-enclosed water bodies at the lower end of a freshwater stream that are subject to marine, freshwater and terrestrial influences, and experience periodic fluctuations and gradients in salinity

Estuarine habitat — Tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater run-off from the land

Eutrophication — Degradation of water quality due to enrichment by nutrients (primarily nitrogen and phosphorus), causing excessive plant growth and decay. See also algal bloom

Evapotranspiration — The total loss of water as a result of transpiration from plants and evaporation from land, and surface water bodies

EWS — Engineering and Water Supply Department (Government of South Australia); now 'SA Water'

Exceedence — The frequency at which an objective in not meet, a quantification of likelihood

FC — Faecal Coliform; a minute mirco-organism occurring in the intestines of warm-blooded animals; used as an indicator of faecal contamination of water; see also ‘coliform’

FIB — Faecal Indicator Bacteria

Filtration — Numerous methods of filtering a water sample or supply to remove suspended sediment and the larger animal and plant life

Fishway — A generic term describing all mechanisms that allow the passage of fish along a waterway. Specific structures include fish ladders (gentle sloping channels with baffles that reduce the velocity of water and provide resting places for fish as they ‘climb’ over a weir) and fishlifts (chambers, rather like lift-wells, that are flooded and emptied to enable fish to move across a barrier).

Fixed-station monitoring — The repeated long-term sampling or measurement of parameters at representative points for the purpose of determining environmental quality characteristics and trends

Floodout — An area where channelised flow ceases and floodwaters spill across adjacent alluvial plains

Floodplain — Of a watercourse means: (1) floodplain (if any) of the watercourse identified in a catchment water management plan or a local water management plan; adopted under the Act; or (2) where (1) does not apply—the floodplain (if any) of the watercourse identified in a development plan under the *Development (SA) Act 1993*; or (3) where neither (1) nor (2) applies—the land adjoining the watercourse that is periodically subject to flooding from the watercourse

Flow bands — Flows of different frequency, volume and duration

Flow regime — The character of the timing and amount of flow in a stream

Fresh — A short duration, small volume pulse of streamflow generated by a rainfall event that temporarily, but noticeably, increases stream discharge above ambient levels

FS — Faecal streptococci

Fully-penetrating well — In theory this is a wellhole that is screened throughout the full thickness of the target aquifer; in practice, any screen that is open to at least the mid 80% of a confined aquifer is regarded as fully-penetrating

Geological features — Include geological monuments, landscape amenity and the substrate of land systems and ecosystems

Geomorphic — Related to the physical properties of the rock, soil and water in and around a stream

Geomorphology — The scientific study of the landforms on the Earth’s surface and of the processes that have fashioned them

GIS — Geographic Information System; computer software linking geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis

Greenhouse effect — The balance of incoming and outgoing solar radiation which regulates our climate. Changes to the composition of the atmosphere, such as the addition of carbon dioxide through human activities, have the potential to alter the radiation balance and to effect changes to the climate. Scientists suggest that changes would include global warming, a rise in sea level and shifts in rainfall patterns.

Greywater — Household wastewater excluding sewage effluent, wastewater from kitchen, laundry and bathroom

Groundwater — Water occurring naturally below ground level or water pumped, diverted and released into a well for storage underground; see also ‘underground water’

Habitat — The natural place or type of site in which an animal or plant, or communities of plants and animals, live

Hazard — A biological, chemical, physical or radiological agent that has the potential to cause harm

Hazard event — An incident or situation that can lead to the presence of a hazard (what can happen and how)

Hazard identification — The process of recognising that a hazard exists and defining its characteristics ((AS/NZS 4360:1999)

Heavy metal — Any metal with a high atomic weight (usually, although not exclusively, greater than 100), for example mercury, lead and chromium. Heavy metals have widespread industrial uses, and many are released into the biosphere via air, water and solids pollution. Usually these metals are toxic at low concentrations to most plant and animal life.

Hydraulic conductivity (K) — A measure of the ease of flow through aquifer material: high K indicates low resistance, or high flow conditions; measured in metres per day

Hydric — Having or characterised by excessive moisture (eg: 'hydric soil')

Hydrogeology — The study of groundwater, which includes its occurrence, recharge and discharge processes, and the properties of aquifers; see also 'hydrology'

Hydrography — The discipline related to the measurement and recording of parameters associated with the hydrological cycle, both historic and real time

Hydrology — The study of the characteristics, occurrence, movement and utilisation of water on and below the Earth's surface and within its atmosphere; see also 'hydrogeology'

Hydrometric — Literally relating to water measurement, from the Greek words 'hydro' (water) and metrikos (measurement); see also DWLBC fact sheet FS1 <http://www.dwlbc.sa.gov.au/assets/files/fs0001_hydrometric_surface_water_monitoring.pdf>

Hydrophytic — Of or related to a hydrophyte, a plant adapted to growing in water, waterlogged soil or on a substrate that becomes inundated on a regular basis

Hydstra — A time series data management system that stores continuously recorded water-related data such as water level, salinity and temperature; it provides a powerful data analysis, modelling and simulation system; contains details of site locations, setup and other supporting information; sometimes incorrectly referred to as Hydsys

Hyporheic zone — The wetted zone among sediments below and alongside rivers; it is a refuge for some aquatic fauna

Impact — A change in the chemical, physical, or biological quality or condition of a water body caused by external sources

Impairment — A detrimental effect on the biological integrity of a water body caused by impact that prevents attainment of the designated use

Implementation monitoring — Documents whether or not management practices were applied as designed; project and contract administration is a part of implementation monitoring

Indigenous species — A species that occurs naturally in a region

Industrial wastewater — Water (not being domestic wastewater) that has been used in the course of carrying on a business (including water used in the watering or irrigation of plants) that has been allowed to run to waste or has been disposed of or has been collected for disposal

Infrastructure — Artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

Injection well — An artificial recharge well through which water is pumped or gravity-fed into the ground

Instrument detection limit (IDL) — 3.14 times the standard deviation of the seven consecutive blank samples

Integrated catchment management — Natural resources management that considers in an integrated manner the total long-term effect of land and water management practices on a catchment basis, from production and environmental viewpoints

Intensive farming — A method of keeping animals in the course of carrying on the business of primary production in which the animals are confined to a small space or area and are usually fed by hand or mechanical means

Interflow — The flow of water below the surface, but above the watertable

Intermittent wetland — Floods regularly (Harding, 2006)

Irrigation — Watering land by any means for the purpose of growing plants

Irrigation season — The period in which major irrigation diversions occur, usually starting in August–September and ending in April–May

Knowledge certainty — A measure of the adequacy of the current state of knowledge that exists in the values of parameters measured (based on NRMC, 2004). The combined likelihood and consequence result

Lake — A natural lake, pond, lagoon, wetland or spring (whether modified or not) that includes part of a lake and a body of water declared by regulation to be a lake. A reference to a lake is a reference to either the bed, banks and shores of the lake or the water for the time being held by the bed, banks and shores of the lake, or both, depending on the context.

Land — Whether under water or not, and includes an interest in land and any building or structure fixed to the land

Land capability — The ability of the land to accept a type and intensity of use without sustaining long-term damage

LCMP — Land Condition Monitoring Program(s)

Leaching — Removal of material in solution such as minerals, nutrients and salts through soil

Licence — A licence to take water in accordance with the Act; see also 'water licence'

Licensee — A person who holds a water licence

Likelihood — A qualitative description of probability or frequency (AS/NZS 4360:1999)

Limit of quantitation (LOQ) — 10 times the standard deviation at the method detection limit

Limit of reporting (LOR) — The rounded value of the limit of quantitation

LMWL — Local meteoric water line

Local water management plan — A plan prepared by a council and adopted by the Minister in accordance with the Act

Macro-invertebrates — Aquatic invertebrates visible to the naked eye including insects, crustaceans, mollusks and worms that inhabit a river channel, pond, lake, wetland or ocean

m AHD — Defines elevation in metres (m) according to the Australian Height Datum (AHD)

MAT — Management Action Targets

MDBC — Murray–Darling Basin Commission

Metadata — Information that describes the content, quality, condition, and other characteristics of data, maintained by the Federal Geographic Data Committee

Method comparability — The characteristics that allow data produced by multiple methods to meet or exceed the data quality objectives of primary or secondary data users. These characteristics need to be defined but would likely include data quality objectives, bias, precision, information on data comparability, etc

Method detection limit (MDL) — 5 times the standard deviation of the instrument detection limit

Model — A conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

Molar (M) — A term describing the concentration of chemical solutions in moles per litre (mol/L)

Monitoring — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals, and other living things

NATA — National Association of Testing Authorities

National Pollutant Discharge Elimination System — A permit program under the *Clean Water Act* that imposes discharge limitations on point sources by basing them on the effluent limitation capabilities of a control technology or on local water quality standards

Native species — Any animal and plant species originally in Australia; see also 'indigenous species'

Natural recharge — The infiltration of water into an aquifer from the surface (rainfall, streamflow, irrigation etc). See also recharge area, artificial recharge

Natural resources — Soil, water resources, geological features and landscapes, native vegetation, native animals and other native organisms, ecosystems

NRHP — National River Health Program

NRM — Natural Resources Management; all activities that involve the use or development of natural resources and/or that impact on the state and condition of natural resources, whether positively or negatively

NHMRC — National Health and Medical Research Council

NHT — Natural Heritage Trust

NLWRA — National Land and Water Resource Audit; 'The Audit'

Non-point-source pollution — A contributory factor to water pollution that cannot be traced to a specific location, for example, pollution that results from water run-off from urban areas, construction sites, agricultural and silvicultural operations, etc

NPWSA — National Parks and Wildlife South Australia; a division of the Department for Environment and Heritage

NRHP — National River Health Program

NVC — Native Vegetation Council

NWQMS — National Water Quality Management Strategy

NYNRM — Northern and Yorke Natural Resources Management (region)

δ^{18}**O** — Oxygen isotope composition, measured in parts per thousand ($^{o}/_{oo}$)

Observation well — A narrow well or piezometer whose sole function is to permit water level measurements

Obswell — Observation Well Network

Occupier of land — A person who has, or is entitled to, possession or control of the land

OCWMB — Onkaparinga Catchment Water Management Board

Owner of land — In relation to land alienated from the Crown by grant in fee simple — the holder of the fee simple; in relation to dedicated land within the meaning of the *Crown Lands Act 1929* that has not been granted in fee simple but which is under the care, control and management of a Minister, body or other person — the Minister, body or other person; in relation to land held under Crown lease or licence — the lessee or licensee; in relation to land held under an agreement to purchase from the Crown — the person entitled to the benefit of the agreement; in relation to any other land — the Minister who is responsible for the care, control and management of the land or, if no Minister is responsible for the land, the Minister for Environment and Heritage.

Palaeochannels — Ancient buried river channels in arid areas of the state. Aquifers in palaeochannels can yield useful quantities of groundwater or be suitable for ASR

Pasture — Grassland used for the production of grazing animals such as sheep and cattle

Penetrating well — See 'fully-penetrating well'

Percentile — A way of describing sets of data by ranking the dataset and establishing the value for each percentage of the total number of data records. The 90th percentile of the distribution is the value such that 90% of the observations fall at or below it.

Perennial streams — Permanently inundated surface stream courses. Surface water flows throughout the year except in years of infrequent drought.

Permanent wetland — Contains water throughout the year, although may vary in level (Harding, 2006)

Permeability — A measure of the ease with which water flows through an aquifer or aquitard, measured in m^2/d

Personal property — All forms of property other than real property, for example, shares or a water licence

Phreatophytic vegetation — Vegetation that exists in a climate more arid than its normal range by virtue of its access to groundwater

Phytoplankton — The plant constituent of organisms inhabiting the surface layer of a lake; mainly single-cell algae

Piezometer — A narrow tube, pipe or well; used for measuring moisture in soil, water levels in an aquifer, or pressure head in a tank, pipeline, etc

PIRSA — Primary Industries and Resources South Australia (Government of South Australia)

Pluviometer — An automated rain gauge consisting of an instrument to measure the quantity of precipitation over a set period of time

Pollution, diffuse source — Pollution from sources such as an eroding paddock, urban or suburban lands and forests; spread out, and often not easily identified or managed

Pollution, point source — Pollution discharged through a pipe or some other discrete source from municipal water treatment plants, factories, confined animal feedlots, or combined sewers

Population — (1) For the purposes of natural resources planning, the set of individuals of the same species that occurs within the natural resource of interest. (2) An aggregate of interbreeding individuals of a biological species within a specified location

Potable water — Water suitable for human consumption such as drinking or cooking water

Potentiometric head — The potentiometric head or surface is the level to which water rises in a well due to water pressure in the aquifer, measured in metres (m); also known as piezometric surface

Precautionary principle — Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation

Prescribed area, surface water — Part of the state declared to be a surface water prescribed area under the Act

Prescribed lake — A lake declared to be a prescribed lake under the Act

Prescribed watercourse — A watercourse declared to be a prescribed watercourse under the Act

Prescribed water resource — A water resource declared by the Governor to be prescribed under the Act, and includes underground water to which access is obtained by prescribed wells. Prescription of a water resource requires that future management of the resource be regulated via a licensing system.

Prescribed well — A well declared to be a prescribed well under the Act

Preventative measure — Any planned action, activity or process that is used to prevent hazards from occurring or reduce them to acceptable levels

Production well — The pumped well in an aquifer test, as opposed to observation wells; a wide-hole well, fully developed and screened for water supply, drilled on the basis of previous exploration wells

Property right — A right of ownership or some other right to property, whether real property or personal property

Proponent — The person or persons (who may be a body corporate) seeking approval to take water from prescribed water

PWA — Prescribed Wells Area

PWCA — Prescribed Watercourse Area

PWRA — Prescribed Water Resources Area

Quickflow — Also known as direct run-off or event flow, refers to that portion of streamflow generated during a storm event that enters the watercourse via direct run-off. It is defined as that volume of total observed streamflow for a given day that remains following subtraction of the volume identified as baseflow by the digital baseflow filter.

Ramsar Convention — This is an international treaty on wetlands titled *The Convention on Wetlands of International Importance Especially as Waterfowl Habitat*. It is administered by the International Union for Conservation of Nature and Natural Resources. It was signed in the town of Ramsar, Iran in 1971, hence its common name. The convention includes a list of wetlands of international importance and protocols regarding the management of these wetlands. Australia became a signatory in 1974.

Raw risk — The risk that occurs if all preventative measures fail

Raw water — Water in its natural state, prior to any treatment; or the water entering the first treatment process of a water treatment plant

RCT — Resource Condition Targets; This is the terminology used by NAP/NHT for water quality objectives

Recharge area — The area of land from which water from the surface (rainfall, streamflow, irrigation, etc.) infiltrates into an aquifer. See also artificial recharge, natural recharge

Rehabilitation (of water bodies) — Actions that improve the ecological health of a water body by reinstating important elements of the environment that existed prior to European settlement

Remediation (of water bodies) — Actions that improve the ecological condition of a water body without necessarily reinstating elements of the environment that existed prior to European settlement

Residual risk — The risk remaining after consideration of existing preventive measures

Restoration (of water bodies) — Actions that reinstate the pre-European condition of a water body

Reticulated water — Water supplied through a piped distribution system

Riffles — Shallow stream section with fast and turbulent flow

Riparian — Of, pertaining to, or situated or dwelling on the bank of a river or other water body

Riparian areas — Geographically delineable areas with distinctive resource values and characteristics that comprise the aquatic and riparian ecosystems

Riparian-dependent resources — Resources that owe their existence to a riparian area

Riparian ecosystems — A transition between the aquatic ecosystem and the adjacent terrestrial ecosystem; these are identified by soil characteristics or distinctive vegetation communities that require free or unbound water

Riparian habitat — The transition zone between aquatic and upland habitat. These habitats are related to and influenced by surface or subsurface waters, especially the margins of streams, lakes, ponds, wetlands, seeps, and ditches

Riparian landholder — A person whose property abuts a watercourse or through whose property a watercourse runs

Riparian rights — These were old common law rights of access to, and use of, water. These common law rights were abolished with the enactment of the Act, which now includes similar rights under s. 7. Riparian rights are therefore now statutory rights under the Act. Where the resource is not prescribed or subject to restrictions, riparian landholders may take any amount of water from watercourses, lakes or wells without consideration to downstream landholders, if it is to be used for stock or domestic purposes. If the capture of water from watercourses and groundwater is to be used for any other purpose then the right of downstream landholders must be protected. Landholders may take any amount of surface water for any purpose without regard to other landholders, unless the surface water is prescribed or subject to restrictions.

Riparian zone — That part of the landscape adjacent to a water body that influences and is influenced by watercourse processes. This can include landform, hydrological or vegetation definitions. It is commonly used to include the in-stream habitats, bed, banks and sometimes floodplains of watercourses

Risk — The likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm

Risk analysis — The process of using available monitoring data and catchment information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequences (adapted from AS/NZS 4360:1999)

Risk Assessment — The overall process of using available information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequences (adapted from AS/NZS 4360:1999)

Risk evaluation — The result of modifying the risk analysis value on the basis of qualitative risk information

Risk knowledge — Qualitative knowledge on processes that drive the risk being assessed or preventative management strategies that affect the risk's likelihood or consequence

Risk management — The systematic evaluation of the water supply system to identify hazards and hazardous events, leading to the assessment of risks, and the development and implementation of preventive strategies to manage the risks

Risk minimisation objective — A prescribed tolerance that must be met to ensure that a barrier effectively minimises a potential hazard at that location; a criterion that separates acceptability from unacceptability

Risk removal objective — Prescribed tolerance that must be met to remove a potential hazard at that location; a criterion that separates acceptability from unacceptability

Riverine habitat — All wetlands and deep-water habitats within a channel, with two exceptions — wetlands dominated by trees, shrubs, persistent emergent mosses or lichens, and habitats with water that contains ocean-derived salt in excess of 0.5 parts per thousand

RMCWMP — River Murray Catchment Water Management Plan

SA Geodata — A collection of linked databases storing geological and hydrogeological data, which the public can access through the offices of PIRSA. Custodianship of data related to minerals and petroleum, and groundwater, is vested in PIRSA and DWLBC, respectively. DWLBC should be contacted for database extracts related to groundwater

SARDI — South Australian Research and Development Institute, a division within PIRSA

SA Water — South Australian Water Corporation (Government of South Australia)

Seasonal watercourses or wetlands — Those watercourses or wetlands that contain water on a seasonal basis, usually over the winter–spring period, although there may be some flow or standing water at other times; floods and dries in most years (Harding, 2006)

Semi-permanent wetland — Contains water throughout the year but dries out in dry years (e.g. 1 year in 10) (Harding, 2006)

Sensitive species — Those plant and animal species for which population viability is a concern

SEWCDB —South East Water Conservation and Drainage Board

SOP — Standard operating procedure

Specific storage (S_s) — Specific storativity; the amount of stored water realised from a unit volume of aquifer per unit decline in head; it is dimensionless

Specific yield (S_y) — The volume ratio of water that drains by gravity, to that of total volume of the porous medium. It is dimensionless

State Water Plan — Policy document prepared by the Minister that sets the strategic direction for water resource management in the State and policies for achieving the objects of the *Natural Resources Management (SA) Act 2004*

Stock use — The taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act)

(S) — Storativity; storage coefficient; the volume of groundwater released or taken into storage per unit plan area of aquifer per unit change of head; it is dimensionless

Stormwater — Run-off in an urban area

Sub-catchment — The area of land determined by topographical features within which rainfall will contribute to run-off at a particular point

Surface water — (a) water flowing over land (except in a watercourse), (i) after having fallen as rain or hail or having precipitated in any another manner, (ii) or after rising to the surface naturally from underground; (b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir

Surface Water Archive — An internet-based database linked to Hydstra and operated by DWLBC. It contains rainfall, water level, streamflow and salinity data collected from a network of surface water monitoring sites located throughout South Australia

Sustainability — The ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time

SWMCC — State Water Monitoring Coordination Committee (1999–2005)

T — Transmissivity; a parameter indicating the ease of groundwater flow through a metre width of aquifer section (taken perpendicular to the direction of flow), measured in m^2/d

Taxa — General term for a group identified by taxonomy, which is the science of describing, naming and classifying organisms

TDS — Total dissolved solids, measured in milligrams per litre (mg/L); a measure of water salinity

Tertiary aquifer — A term used to describe a water-bearing rock formation deposited in the Tertiary geological period (1–70 million years ago)

Threatened species — Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

Threatened waters — Waters that fully support their designated uses, but may not support uses in the future unless pollution control action is taken because of anticipated sources or adverse pollution trends

TKN — Total Kjeldahl Nitrogen; the sum of aqueous ammonia and organic nitrogen; used as a measure of probable sewage pollution

TN — Total nitrogen

TOC — Total organic carbon

To take water — From a water resource includes (a) to take water by pumping or siphoning the 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 from the watercourse; (d) to release water from a lake; (e) to permit water to flow under natural pressure from a well; (f) to permit stock to drink from a watercourse, a natural or artificial lake, a dam or reservoir

Toxic — Relating to harmful effects to biota caused by a substance or contaminant

TP — Total phosphorus

Transfer — A transfer of a licence (including its water allocation) to another person, or the whole or part of the water allocation of a licence to another licensee or the Minister under Part 5, Division 3, s. 38 of the Act, the transfer may be absolute or for a limited period

Transmissivity (T) — A parameter indicating the ease of groundwater flow through a metre width of aquifer section

Tributary — A river or creek that flows into a larger river

Turbidity — The cloudiness or haziness of water (or other fluid) caused by individual particles that are too small to be seen without magnification, thus being much like smoke in air; measured in Nephelometric Turbidity Units (NTU)

Underground water (groundwater) — Water occurring naturally below ground level or water pumped, diverted or released into a well for storage underground

u/s — Upstream

USGS — United States Geological Survey

Viable population — A population that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its existing range in the planning area

Volumetric allocation — An allocation of water expressed on a water licence as a volume (eg. kilolitres) to be used over a specified period of time, usually per water use year (as distinct from any other sort of allocation)

Water affecting activities — Activities referred to in Part 4, Division 1, s. 9 of the Act

Water allocation — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under s.11 means the maximum quantity of water that can be taken and used pursuant to the authorisation

Water allocation, area based — An allocation of water that entitles the licensee to irrigate a specified area of land for a specified period of time usually per water–use year

WAP — Water Allocation Plan; a plan prepared by a CWMB or water resources planning committee and adopted by the Minister in accordance with the Act

Water body — Includes watercourses, riparian zones, floodplains, wetlands, estuaries, lakes and groundwater aquifers

Water column — a section of water extending from the surface of a body of water to its bottom. In the sea or ocean, it is referred to as ‘pelagic zone’

Watercourse — A river, creek or other natural watercourse (whether modified or not) and includes: a dam or reservoir that collects water flowing in a watercourse; a lake through which water flows; a channel (but not a channel declared by regulation to be excluded from the this definition) into which the water of a watercourse has been diverted; and part of a watercourse

Water-dependent ecosystems — Those parts of the environment, the species composition and natural ecological processes, that are determined by the permanent or temporary presence of flowing or standing water, above or below ground; the in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

Water hardness — A measure of the amount of metallic salts (normally Ca and Mg) found in water; hard water can inhibit the action of some surfactants and reduce the effectiveness of the cleaning process

Water licence — A licence granted under the Act entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area; this grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water; a water licence confers a property right on the holder of the licence and this right is separate from land title

Water plans — The State Water Plan, catchment water management plans, water allocation plans and local water management plans prepared under Part 7 of the Act

Water quality criteria — comprised of both numerical criteria and narrative criteria. Numerical criteria are scientifically derived ambient concentrations developed by the EPA (Commonwealth Government of Australia) or the states for various pollutants of concern, so that human health and aquatic life can be protected. Narrative criteria are statements that describe the desired water quality goal.

Water quality data — Chemical, biological, and physical measurements or observations of the characteristics of surface and groundwaters, atmospheric deposition, potable water, treated effluents, and wastewater, and of the immediate environment in which the water exists

Water quality information — Derived through analysis, interpretation, and presentation of water quality and ancillary data

Water quality monitoring — An integrated activity for evaluating the physical, chemical, and biological character of water in relation to human health, ecological conditions, and designated water uses

Water quality monitoring site —A location within the landscape where samples are taken and analysed for the purpose of testing the quality of the water. Locations defined by the Water Quality Monitoring Program.

Water quality objective/threshold — A numerical concentration limit or narrative statement that has been established to support and protect the designated uses of water at a specific site; It is based on scientific criteria or water quality guidelines but may be modified by other inputs such as social or political constraints; For the USE Program the guideline or threshold value refers to the water quality at the time of diversion and is the upper limit/threshold in the wetland at **full supply level;** It is accepted that evapo-concentration will cause an increase in salinity as depth and volume reduce; Water quality objective can also be referred to as 'water quality guideline objectives'

Water quality standard — A law or regulation that consists of the beneficial designated use or uses of a water body, the numerical and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an anti-degradation statement

Water resource monitoring — An integrated activity for evaluating the physical, chemical, and biological character of water resources, including (1) surface waters, groundwaters, estuaries, and near-coastal waters; and (2) associated aquatic communities and physical habitats, which include wetlands

Water resource quality — (1) The condition of water or some water-related resource as measured by biological surveys, habitat-quality assessments, chemical-specific analyses of pollutants in water bodies, and toxicity tests. (2) The condition of water or some water-related resource as measured by habitat quality, energy dynamics, chemical quality, hydrological regime, and biotic factors

Water service provider — A person or corporate body that supplies water for domestic, industrial or irrigation purposes or manages wastewater

Watershed — The land area that drains into a stream, river, lake, estuary, or coastal zone

Water supply system — The catchment, streams and infrastructure used to supply drinking water. Usually associated to a treatment plant; e.g. Anstey Hill water supply system

Water-use year — The period between 1 July in any given calendar year and 30 June the following calendar year; also called a licensing year

WDE — Water dependent ecosystem

Well — (1) An opening in the ground excavated for the purpose of obtaining access to underground water. (2) An opening in the ground excavated for some other purpose but that gives access to underground water. (3) A natural opening in the ground that gives access to underground water

Wetlands — Defined by the Act as a swamp or marsh and includes any land that is seasonally inundated with water. This definition encompasses a number of concepts that are more specifically described in the definition used in the Ramsar Convention on Wetlands of International Importance. This describes wetlands as areas of permanent or periodic to intermittent inundation, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tides does not exceed six metres.

WMO — World Meteorological Organisation

w/v — Abbreviation. Weight in volume. Used to indicate that a particular weight of a solid is contained in a particular volume of solution

w/w — Abbreviation. Weight in weight. Used especially to indicate that a particular weight of a gas is contained in a particular weight of liquid solution

WWTP — Wastewater Treatment Plant

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