Greater Hume Shire

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Greater Hume Operational Environmental Management Plan for Culcairn Wastewater Treatment Plant and Re-Use Scheme

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1	October 2008	First Edition	Manager Water and Sewer	Director Engineering	General Manager
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3	9/05/2014	Format to Style Guide Standard	Manager Water and Sewer	Director Engineering	General Manager

Prepared By:
Greater Hume Shire Council

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1.0 Introduction

This Operational Environmental Management Plan (OEMP) is intended to guide managers and staff of Greater Hume Shire Council's Wastewater Treatment Facility to achieve the environmental protection requirements and deliver an ecologically sustainable system.

The principle objectives of this OEMP are to describe procedures that ensure a sustainable environmental system during the operation of Facility and Re-Use Scheme. The ultimate goal is to enable maintenance of the environment in both the long and short term.

This OEMP will form part of the Operations Manuals for the Greater Hume Shire Council Culcairn Sewerage Treatment Plant.

ACKNOWLEDGEMENT

This Environmental Management Plan is largely based on the model document written by Mr Richard Scott, Senior Environmental Health Officer, NSW Department of Energy, Utilities and Sustainability, titled "Operational Environmental Management Plan – Wastewater Treatment Facility" which itself was derived from Mr Scott's Thesis for a Graduate Diploma of Environmental Management awarded by La Trobe University in 2001.

2.0 Policy

The Council is committed to environmental management and its need to operate a Wastewater Treatment Plant in a responsible and economically sustainable manner.

The Operational Environmental Management Plan (OEMP) is based on the principle of 'Ecologically Sustainable Development' as defined in Australia's National Strategy for Ecologically Sustainable Development (Commonwealth of Australia).

Ecologically Sustainable Development is:

"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". (NSW, NOW, Environmental Guide, for the management of local government water supply, sewerage and drainage services, 1997).

The environment is such a complex web of physical, social, economic, biological and cultural factors that if any of these or all of these parameters are altered dramatically in any way, then a change may be felt in the community.

Greater Hume Shire Council's commitment to the environment is documented forthwith; the following is lifted from council's Management Plan 2008/2011.

"Environmental Management

Activities undertaken by Council to protect environmentally sensitive areas and to promote the ecological sustainability of the shire area.

Council acknowledges the increasingly important profile that matters relating to the environment are assuming within our society. To this end Council has prepared a State of the Environment Report. (Appendix 1)

In an environmental set-up of a town or city, environmental due diligence must be observed in water cycle management, asset management, total catchment management and, above all water resource management. With everyday rising awareness about environmental consequences of various developmental activities, it is well established that ESD (Ecologically Sustainable Development) cannot be realised without a sound statutory framework and active community participation."

3.0 Objectives

The objectives of this OEMP are to:

- Document emergency management procedures in the event of:
    - Power failures
    - Pump failures
    - Chemical leaks
    - Reticulation failure
    - Unexplainable disease outbreak which may be associated with water borne spread disease
    - Performance specification standards (minimum) required for the operation of the W.W.T.P. including treatment and disposal processes
    - Specification of appropriate monitoring and audit programs to check whether performance standards are being achieved
    - Performance specification standards for the operation of the reuse scheme to ensure ecological and economic sustainable procedures are being undertaken
- Monitor microbial indicators of water quality on effluent re-use schemes.
- Minimise unnecessary noise from all aspects of the process.
- Minimise the emission of odours from the plant and subsequent process.
- Improve existing water quality that may be discharged to the riverine environment.
- Ensure minimal impacts on the community in terms of land use and planning.
- Ensure that all work practices are performed in a safe and proper manner.
- Ensure negligible impacts on the geology of the area or the soils on affected areas associated with the plant and re-use areas.
- Comply with NSW Environment Protection Authority Licence conditions No 3727 (APPENDIX 2)

4.0 Environmental Setting

4.1 Locality

The location of the Culcairn Wastewater Treatment Facility and associated re-use scheme are shown on Figure 1 and 2 (Appendix 4 and 5).

4.2 Designated Use

As described in Table 3.8 of Australian Guidelines for Water Recycling, the designated use of the recycled water for the Culcairn Reuse Scheme is ‘Municipal Use with enhanced restrictions on access and application’, which has the following water quality requirements:

- BOD <20 mg/Ld
- SS <30 mg/ Ld
- E. coli <1000 cfu/100 mL

(disinfection may be required to achieve this concentration)

4.3 Access Restrictions

The access restrictions implemented are:

- to restrict public access during irrigation and combinations of:
  - no access after irrigation, until dry (1–4 hours)
  - minimum 25–30 m buffer to nearest point of public access
  - spray drift control, eg through low throw sprinklers (180° inward throw), vegetation screening, or anemometer switching

4.4 Preventative Measures

- The on-site enhanced preventative measures are:
- Continuous online monitoring of disinfection and pH.
- Monthly monitoring of suspended solids and E. coli.
- All staff, Contractors and Stake holders were given on-site training by competent staff from manufacturers who supplied equipment for the project over a period of several days.
- Use of signage, labelling and communication to minimise accidental exposure.

Validation Data and Log Reduction Information

Target for End Use	Theoretical Estimates Log Reduction Viruses	Actual Estimates Log Reduction Viruses 5.0	Theoretical Estimates Log Reduction Protozoa	Actual Estimates Log Reduction Protozoa 3.5	Theoretical Estimates Log Reduction Bacterial Pathogens	Actual Estimates Log Reduction Bacteria 4.0
Secondary Treatment	0.5-2.0	0.5	0.5-1.0	0.5	1.0-3.0	1.0
Lagoon Storage	1.0-4.0	1.0	1.0-3.5	1.0	1.0-5.0	1.0
Filtration	0.5-2.0	0.5	1.5-2.5	1.5	0-1.0	0
Chlorination	1.0-3.0	1.0	0-0.5	0	2.0-6.0	2.0
Total Treatment		**4**		**6**		**6**
4 hours access restriction	1 log					
30m buffer zone	1 log					
Spray drift control	1 log					
Total on-site controls	**3**					

5.0 Statement of Environmental Effects

5.1 Introduction

This proposal reuses tertiary treated waste water for the irrigation of sportsgrounds and school gardens and reduces wastewater discharge to the watercourses.

5.2 Environmental Effects

Natural Environment

Air – This proposal will have no effect on the air quality as odour control will be provided by tertiary filtration, disinfectant and pH adjustment.

Water – Discharge of waste water to natural water courses will be reduced from the Wastewater Treatment Plant. Runoff from irrigation will be minimised by the spray patterns and application rates across the flat sportsgrounds. Any runoff will be collected in spoon drains at the edge of the irrigated area. Due to the low application rates, ground water is not considered to be affected.

Ground Water - The irrigation systems installed at both end user sites are soil-moisture-sensor controlled to prevent waterlogging and/or runoff. This system of irrigation management assists in preventing any degradation to the ground water as per the recommendation in the Management Plan developed within the Specialist Soil and Agronomy Report (Appendix 10).

Soil – With tertiary treatment, monitoring of the irrigation and monitoring the sports ground soils, it is considered there will be little effect on the soil acidity and fauna. Soil monitoring will occur annually in keeping with the EPA Licence requirements.

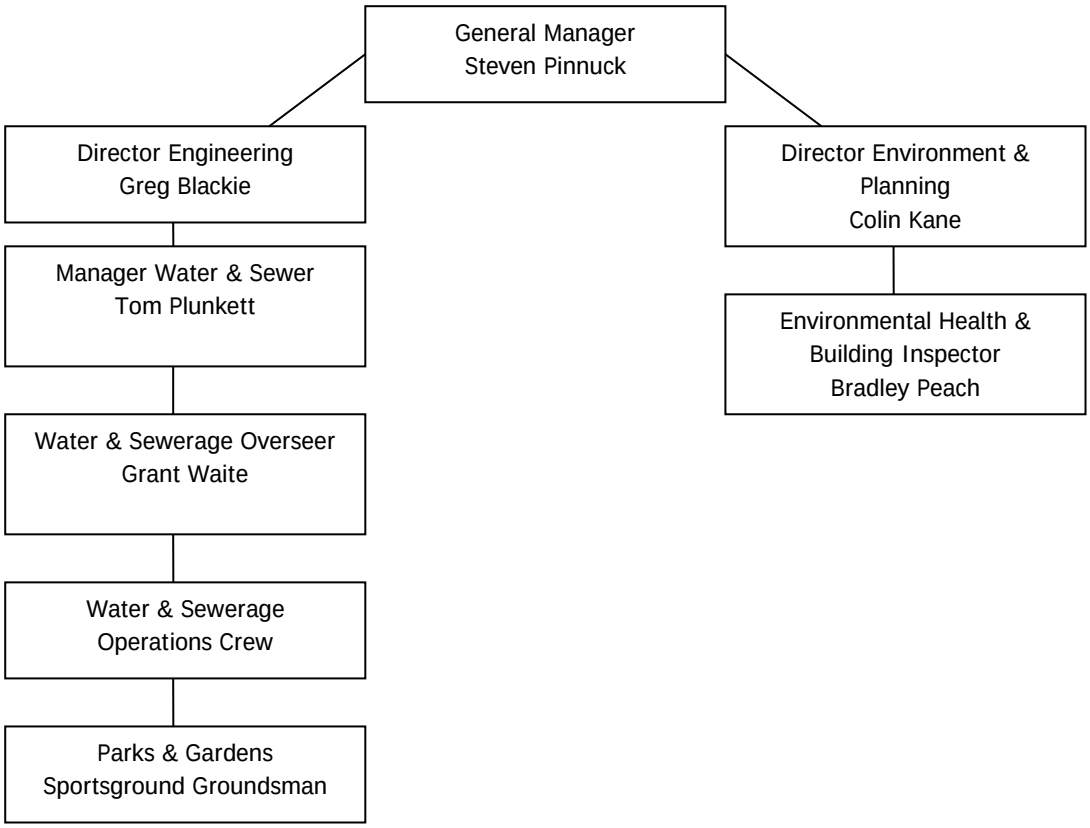
Topography – The town area is flat and runoff is slow with most absorbed into soil. Billabong Creek runs along the southern edge of the town.

The Community

The Public – Irrigation will be carried out in the early hours of the mornings and will close down 4 hours prior to people entering the site.

6.0 Management structure

The Greater Hume Shire Council Environment and Engineering Management Structure



6.1 Operational Management Team & Emergency Contact List

Regulatory Authorities and Relevant Interest Groups

Stakeholders	Contact	Address	Phone
Greater Hume Shire Council	General Manager	PO Box 99 Holbrook NSW 2644	(02)6036 0100
NSW Office of Water	Principal Policy Officer – Recycled Water	GPO Box 3889 Sydney NSW 2001	(02)8281 7305
Dept of Env. & Climate Change	Peter Keep	Sydney	(02)8281 7333
NSW Dept of Health	District Environmental Health Officer	Olive Street Albury NSW 2640	(02)6021 4799
NSW Dept of Agriculture	District Inspector	Olive Street Albury NSW 2640	(02)6041 6500
NSW Work Cover Authority	District Inspector	Suite 5, 1st Floor 429 Swift Street Albury NSW 2640	(02)6042 4600
Local Electricity Supplier	Country Energy	429 Swift Street Albury NSW 2640	13 23 56
Murray CMA	General Manager	C/- DIPNR State Office Block Dean Street Albury NSW 2640	(02)6041 6777
Billabong High School	Principal	Gordon Street Culcairn NSW 2660	(02)6029 8377
NSW Office of Water	Regional Inspector	Albury	0429 308 954
Greater Hume Shire Council	Manager Water & Sewer	PO Box 99 Holbrook NSW 2644	0427 480 915
Greater Hume Shire Council	Water & Sewer Overseer	PO Box 99 Holbrook NSW 2644	0458 058 389
Greater Hume Shire Council	Environmental Health & Building Surveyor	PO Box 99 Holbrook NSW 2644	0428 698 987

6.2 Roles and Responsibilities

Role	Responsibility
Director Engineering (GHSC)	Overall Immediate Responsibility
Senior Wastewater Treatment Plant Operator	Wastewater Plant & Reticulation P/Stations
Manager Country Town Water & Recycling (NOW)	Review/Oversee Urban Water Infrastructure & Policy
District Inspector Urban Water Audit Branch (NOW)	Review/Audit/Advise Councils on Best Practice
District Environmental Health Officer (Dept Health)	Monitor/Review
District DECC	Monitor/Review
District Inspector – Workcover Authority	Monitor/Review

7.0 Risks and Control Measures

7.1 Identified Risks

Potential risks associated with the re-use project have been identified as:

- Soil quality, including soil sodicity
- Groundwater contamination
- Public health
- Vegetation
- Discharge to Environment
- Surface water contamination

7.2 Consideration of Significant Environmental Impacts

Problem	Impact	Risk Assessment	Solution/Remedy
Soil sodicity, Acidity, Salinity	Unsustainable Irrigation Practice	Low – on basis of monitoring of reuse areas	On-going soil monitoring and review of re-use practices
Groundwater Contamination	Environmental damage	Low – on basis of groundwater monitoring	Monitoring of groundwater levels and salinity concentrations
Public health	Community illness, loss of life	Low – with tertiary treatment and disinfection	Continuous monitoring of water quality Management of re-use scheme to prevent cross-connection and unintended use
Vegetation	Vegetation damage and loss	Low	Controlled watering rates. Close monitoring and control of water quality
Discharge to Environment	Effluent discharge to Environment	Low	Programmed maintenance backup
Surface water contamination	Environmental damage	Low	Monitoring and control of water quality

7.3 Operational Impacts and Control Measures

Risk Description	Effect	Consequence	Likelihood	Risk Factor	Proposed Controls
Chlorine level goes too	Poisonous	2	B	Low	Install PH & Chlorine analyser to monitor treated reuse water
High/Low or cuts out	No disinfection				Dosing pump will operate on a set point control range
or dosing tank empty	Untreated water				eg 0.2mg/l - 0.7mg/l free Chlorine below or above this range will activate alarm and shut down pumps
					Low level cut out switch installed in dosing tank
					Daily monitoring of plant & equipment
Raw Chlorine escape	Possible poisoning	2	B	Low	Use Sodium Hypochlorite 12.5% solution instead of gas
Mechanical/Structural	of the environment				Minimal amount of chemical stored on site
failure causing escape	& personal injury				Appropriate PPE will be provided for operators exposed to specific chemicals
to the environment at					Approved Bunding for dosing tank as per AS 4452B1997
STW or personal injury.					Daily monitoring of plant & equipment
Vandalism					Operators trained in MSDS requirements
					Safety shower & eyewash facility located immediately adjacent to Chlorine dosing pump & tank. The shower & eyewash are supplied with water from the site potable water reticulation with a backflow prevention device fitted.
					All dosing equipment and stored chemicals secured behind locked enclosures with external man proof fencing installed around perimeter of site
					Undertake regular maintenance of pipe works/pumps etc to minimise spillage
Acid level goes too	Poisonous	2	B	Low	Install PH & Chlorine analyser to monitor treated reuse water
High/Low or cuts out	No disinfection				Dosing pump will operate on a set point control range
or dosing tank empty	Untreated water				eg PH 7.2 - 8.2 below or above this range will activate alarm and shut down pumps
					Low level cut out switch installed in dosing tank

Risk Description	Effect	Consequence	Likelihood	Risk Factor	Proposed Controls
					Daily monitoring of plant & equipment
Raw Acid escape	Possible poisoning of the environment & personal injury	2	B	Low	Hydrochloric Acid 33% solution
Mechanical/Structural failure causing escape to the environment at STW or personal injury.					Minimal amount of chemical stored on site
					Appropriate PPE will be provided for operators exposed to specific chemicals
					Approved Bunding for dosing tank as per AS 4452B1997
Vandalism					Daily monitoring of plant & equipment
					Operators trained in MSDS requirements
					Safety shower & eyewash facility located immediately adjacent to Acid dosing pump & tank. The shower & eyewash are supplied with water from the site potable water reticulation with a backflow prevention device fitted
					All dosing equipment and stored chemicals secured behind locked enclosures with external man proof fencing installed around perimeter of site
Sand filter blockage	Possible bypass of	1	C	Low	Daily monitoring of plant & equipment
Back wash failure	filter allowing unpolished				Establish a preventative maintenance program for plant & equipment
Poor Maintenance	water to irrigation areas and blocking sprinklers				Install auto backwash facility (head loss or timed zoned whichever comes first)
	More chemical used to disinfect reuse water				Regular inspection of sand in filters Renew sand in filters as per manufactures instructions
Wind	Effecting water quality	2	B	Low	Maintain appropriate buffer distances from waterways & creeks
	of water ways & creeks				Use of low diameter jets in sprinklers

Risk Description	Effect	Consequence	Likelihood	Risk Factor	Proposed Controls
Flooding	Effecting water quality	2	B	Low	Use class 12 pressure pipe for supply lines
	of water ways & creeks				Install high & low pressure switches to immediately shut off pump in the event of a break
					Incorporate isolation valves at critical points to limit the amount of water discharged in the event of an emergency shut off
					Undertake regular pipe pressure test and visual inspections of all supply lines and irrigation areas
					Establish a preventative maintenance program for supply lines as per OEMP 2008
Rain	Effect playing surfaces	1	C	Low	Install soil moisture sensors at each irrigation site.
Run off	grass and plant life				Regular inspections of irrigation sites.
	Ground water logged				
Detention tank	Escape to the	1	B	Low	TWL float switch to turn off pumps.
overflow	environment.				Over flow pipe installed to discharge to 25 ML reuse storage dam
Sprays activated	Individual contaminated	1	B	Low	Override switch
during an event					Available showers at each site for contaminated persons
Loss of PLC programs	Untreated effluent	1	C	Low	Battery back up in PLC
Loss of data					Generator back up
Process					
Pumping failure					

See Appendix 3 for Definitions of Consequence and Likelihood

8.0 Legislation

The following Acts and Regulations apply and are relevant to the Wastewater Treatment Facility Reclaimed Water Supply Scheme:-

- Water Management Act 2000
- Protection of Environment Operation Act, 1997 (NSW)
- Local Government Act 1993
- Public Health Act 1991
- Protection of Environment (Administration) Act, 1991
- Environment Planning and Assessment Act, 1979
- National Environmental Protection Measures (Implementation) Act 1998
- Occupational Health and Safety (OH&S) Act 2000 (NSW)
- Waste Avoidance and Resource Recovery Act 2001

Key Planning Documents:-

- Council's Management Plan
- Council's Financial Plan
- Council's Sewer Fund, Strategic Business Plan
- Water Supply Augmentation Report
- Sewerage Augmentation, Clause 91 Report
- Sewerage Augmentation, Environmental Impact Statement
- Water Business Plan

Other Legal Documents and requirements applying to the scheme are:-

- EPA Licence Requirements

Pollutant	Units of Measure	100% concentration limit
Oil & Grease	Mg/l	10
Total Nitrogen	Mg/l	20
Total Phosphorus	Mg/l	10
BOD	Mg/l	20
Total Suspended Solids	Mg/l	30

- NSW Guidelines for Urban and Residential Use of Reclaimed Water, 1993
- National Water Quality Management Strategy and Guidelines for Sewerage Systems, 2000

9.0 Environmental Objectives and Targets

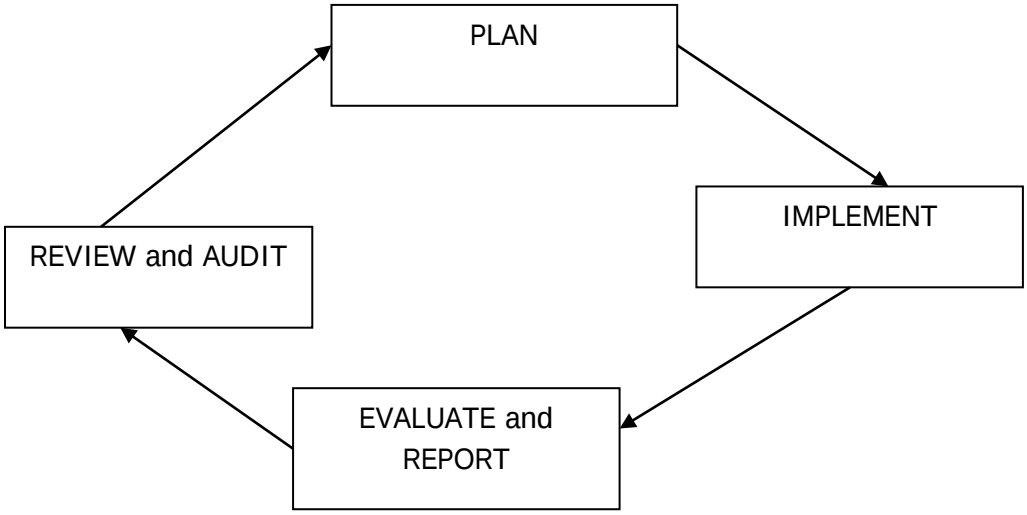
In operating the wastewater facility and subsequent infrastructure, environmental management objectives shall be reviewed.

Potential Environmental Impacts	Objectives	Targets
Groundwater	Ensure any discharge from the WWTP does not degrade the groundwater	Comply with DECC guidelines. Advise NOW of any possible contamination of groundwater.
Public Health	Ensure that the entire scheme contributes to safe re-use procedures to protect the public health requirements of the community	Comply with NOW, Dept Health recommendations; maintain/monitor effluent discharge parameters. Maintain effective disinfection regimes for recycled effluent
Soil Sodicity	Ensure the effluent re-use scheme is operated in an ecological sustainable manner	Monitor recycled effluent characteristics and test soil for unacceptable salt accumulation. Advise NOW
Surface Water	Minimise any impact the reclaimed water may have upon the local surface water, producing the highest quality effluent possible utilising the available technology as it is developed	Comply with DECC guidelines. Comply with NOW recommendations regarding disposal to surface waters.
Noise	Minimise any undue noise, which may be generated from the plant during process phase	Comply with DECC guidelines. Acoustically enclose equipment if required
Odours	Reduce any odours, which may be emitted by the plant during the various processes	Comply with DECC guidelines
Visual Impact	Maintain minimum visual impact and amenity impact to the community, for the entire lifecycle of the plant	Ensure council planning officers are aware that a 400 metre buffer zone is to be maintained around the plant. Continue tree planting around the plant.
Land Use	Planning and land use provisions to ensure minimal impact	The plant will benefit the town allowing for future growth and development
Water Quality	Maintain water quality to highest possible level. Monitor microbial, chemical and sodium levels at irrigation reuse sites	Ensure long term sustainability of effluent reuse scheme microbiologically(Public Health) and long term land use practices

10.0 Implementation

Once the council has formulated its plans to manage their plant and respective infrastructure in an environmental responsible manner the next step is to implement the plan.

10.1 Management Cycle of Continuous Improvement



Reference (NSW, NOW, Environmental Guide, for the management of local government water supply, sewerage and drainage services, 1997)

10.2 Action and Plans to achieve Objectives and Targets

Power Failures – power failure can affect two streams of the process, operation of the W.W.T. Plant and in the transportation system. Aerators at the plant can cease, sludge pumps do not function, effluents decant mechanism cease to operate and the Program Logic Controller can fail or lose its memory. In the transport system pump stations can fail to operate which may flood causing untreated effluent to be discharged to the immediate urban area with an impact on the environment.

The W.W.T Plant can be surveyed for operation with portable electrical generators. The aerators are a large consumer of electricity and should be sized accordingly. Sludge pumps, decant mechanisms on the scheme of things consume relatively small amounts of electricity and would have a small demand on the electricity generating system. Program Logic Controllers should have their batteries changed yearly

Pump stations have the ability to hold and contain at least 8 to 24 hrs of raw effluent according to flow and design. Pumps can be operated manually by portable electric generators, or portable effluent pumps into tankers. This process is very labour intensive and it is preferable to re-instate mains power to the effluent pumps.

Target – Prevent process loss by having standing orders in the Emergency Management Plan that can access alternative power supply within 12 hrs of notification of power loss.

Prevent pump station overflows by having standing orders in the Emergency Management Plan that can access alternative power supply within 12 hrs of notification of power loss.

Pump Failures – failed pumps can cause effluent overflows at pump stations all pump stations which fail to the catchment (ie have no fail safe overflow provision) must be installed with 2 pumps. These pumps must be regularly inspected, tested and serviced. Most newer installations include provision for automatic change over on time or flow basis. Notwithstanding all pump station effluent transportation devices (pumps) require duty change over on a weekly basis.

Target – Prevent pump station overflows by maintaining pumps according to manufacturers specifications. Apply realistic an approach to program maintenance. Program maintenance is an integral part of the systems operation. Shortcuts generally lead to failure.

Decant Mechanism Failure - failure of the decant mechanism either in the up flooded position has the potential to cause process failure or untreated effluent to discharged respectively. Generally the only problem that can befall the decant mechanism is electric motor failure, program logic control failure or flexible decant delivery pipe failure. Most of the issues are considered low risk and unless periodic maintenance has been neglected for a long period the risk of failure is minimal.

Target - Prevent decant mechanism failure by maintaining motors/winched/cables according to manufactures specifications.

Biosolids Spillage – Biosolids (sometimes known as sludge) or the solid component of wastewater is a product that is rich in nutrient, pathogens and toxic chemicals. It is strictly forbidden to dispose of chemicals to the sewerage system however some discharges can be attributed to disposer ignorance of what should be disposed of to the system. Unfortunately there are other disposers to the system who illegally dispose unauthorised products to the system.

The IDEA (Intermitted Decant Extended Aeration) process of wastewater treatment is an efficient process of concentrating most contaminants and chemicals stored on site in (sludge lagoons) and cleaned out on a regular basis. Sludge is the either contained on site or disposed of to a controlled landfill. Liaison with the E.P.A is required by law regarding this procedure.

Spillages of Biosolid component from W.W.T.Ps are rare, if the plant is operated competently. Provision is allowed for at the plants in question for back-up emergency standby storage capacity.

Target – To comply with EPA guidelines with regard to disposal of the Biosolid component associated with the operation of the wastewater treatment plant. Ensure staff understands that the sludge component of the waste is a product that is rich in nutrient may be of odorous nature and may contain a cocktail of undesirable toxic chemicals/heavy metals.

Standard Operational Procedures must be put in place if the sludge is to be moved in a liquid form or if this product is transported in a dry form.

Actively investigate the onsite storage/stabilisation of the biosolid product for subsequent end use within either the W.W.T.P. or ecologically sustainable land application.

Trade Waste – Trade Waste discharges to the sewerage system are to be monitored and all potential discharges are to be surveyed and contracts to be entered into with to ensure both parties (producers and authority) know what their obligations are in respect to discharge requirements.

Target – To identify illegal trade waste discharges to the treatment works and actively encourage pre-treatment facilities are installed prior to any discharge to the sewerage reticulation system.

Actively educate the community with regard to what can and cannot be placed down the sewerage system, ie rate notice handout, chemical musters or presentations to primary/high school students.

Odour - A well operated IDEA plant generally exhibits little or no objectionable odours however odours associated with trade waste and septicity associated with long detention times can be identified and remedied. Biosolid (sludge) Lagoons may emit odours however the practice of keeping at least 500 mm of clear water on the top of the lagoon to act as a water seal/trap can rectify this problem. If the lagoon is experiencing problems with uncontrolled rafting (Biosolids rising to the top of the pond because of methane production and causing an odour problem) previous success has been achieved using surface aerators to maintain high DO levels in the upper layer (approx 500 mm) of the lagoons.

Target – To comply with EPA guidelines, odours can be kept to a minimum if the plant and reticulation system is operated as a complete system and as recommendations as set down by DLWC, Technical Specialists Urban Water Branch.

10.3 Discharge to the Environment

Environmental - In the event of power failure or complete process loss it is considered that there is sufficient capacity within the tertiary pond system (approx 30 days) to hold an untreated overflow 48 hrs max. It is considered unacceptable if this condition extends greater than 48 hrs, if a process loss has occurred then an alternative supply of activated sludge must be accessed as soon as possible. Council has the luxury of two other similar plants which activated sludge can be sourced from to re-seed the process. An uncontrolled discharge to the catchment from the wastewater system is extremely unlikely. Any breach of E.P.A. licence conditions should be investigated as to why the process has failed.

Target – To comply with EPA guidelines for effluent qualities and to ensure the process is maintained at all times. Effluent qualities should not be less than design criteria.

Health – In the event of an uncontrolled discharge of untreated effluent to the local area either through the overflow of a pumping station or total failure of the W.W.T.P and would be a substantial risk of waterborne type disease outbreak within the community. The local councils Environmental Health Officers should advise the community and implement subsequent restrictions and remedial actions. In the event of higher than acceptable incidences of water borne disease in the community the authority is to notify the NSW Centre for Public Health for Technical assistance.

Target – To ensure that the township is serviced by an efficient waste disposal system, the incidence of pump station failure with raw sewage discharged to the town environment should be limited/nil.

All recycled effluent utilised in the irrigation disposal areas should be disinfected to reduce the risk of uncontrolled disease throughout the community. Irrigation Effluent should be sampled at regular intervals. Signage at irrigation reuse areas should be reviewed regularly to ensure that the public fully understands the implications associated with the water used on the irrigation areas.

Fire – The risk of fire is minimal however the amenities building and the electrical switchboard room should be surveyed and a risk assessment performed. The relevant fire extinguishers should be provided and in the event of uncontrolled fire the relevant professional authority should be charged with its control.

Target – To survey and review any procedure at the plant, which may be considered a fire risk. Invite the Towns Fire Brigade Captain to inspect the plant and make suggestions; alternatively discuss with the Fire Brigade Captain the possibility of arranging a fire drill at the plant to make firemen/women familiar with the plant and chemical recycling equipment.

Chemical Spill – Chemicals used at the plant are minimal. In the event of the use of liquid alum for phosphorus reduction the relevant precautions should be followed. If herbicides are used at the plant strict guidelines shall be observed. Herbicides are not to be stored at the plant.

Chlorine if used at the plant for disinfection for the effluent re-use scheme shall be stored and applied as per Australian Standard AS the Chlorine Code. Persons authorised to operate the chlorine dosing equipment shall have the relevant training and shall be trained in the use of remote breathing apparatus. Remote breathing apparatus shall be made available at the plant for the use by the operator in charge of bottle change over and relevant maintenance.

Target – To survey and review any procedure at the plant, which may be considered at risk in the event of a chemical spillage. To store and use chemicals according to Workcover guidelines. This also includes the correct signage and emergency management procedures.

Noise – Noise produced by the plant and subsequent pumping stations would be considered minimal. It would be unlikely that any noise above background would be audible at the boundary to

the W.W.T. Plant (the majority of plants have a minimum buffer zone of 400 metres). The majority of the pumping station equipment in the reticulation system comprises the submersible pump style with little or no noise audible during their operation.

Target – To survey and review noise generated at the plant site if it is considered a risk to the operators acoustic enclosures shall be installed and SPLs (sound pressure levels) taken at the boundaries of the plant to ensure the local community is not unduly affected by the operation of the plant.

Aerator Failure – In the event of an aerator failure the process would be inhibited and alternative arrangements would have to be investigated ASAP. If alternative arrangements could not be made within 12 to 24 hrs the NSW EPA should be notified and informed as to the situation. The NSW Dept of Land & Water Conservation should be contacted at the first instance for technical specialist advice.

Target - To ensure the aerators do not fail due to plant failure of any kind. Programmed maintenance undertaken at plant should identify any problems that may associate with the aerator failure.

Soil Conditions - Areas under irrigation with effluent from the re-use scheme should be monitored (samples taken and analysed) annually to ensure salt accumulation in the irrigated soil is not exceeding Departmental recommendations as per Culcairn Sewerage Treatment Works EPA Licence No. 3727. This schedule of sampling also adequately addresses the monitoring recommendation of the Specialist Soil and Agronomy Report, which only requires 5 yearly sampling (Refer to 4.4.3 of Appendix 10).

Target – Survey irrigation areas for problems associated with waterlogging and salt accumulation. Sample and analyse soils to ensure irrigation practice is sustainable.

10.4 E.S.D. (Ecologically Sustainable Development) Outcomes

Ecologically sustainable development is defined in Australia's National Strategy for Ecologically Sustainable Development (Commonwealth of Australia, 1992) as:

"Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life depends, are maintained, and the total quality of life, now and in the future, can be increased."

The core objectives of Ecologically Sustainable Development are:

- Enhancement of individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations.
- To provide equity within and between generations. To protect biological diversity and maintain ecological processes and life support systems. (ref NSW, DLWC, Environmental Guide, for the management of local government water supply, sewerage and drainage services,1997)

In NSW, four principles of ecologically sustainable development are stated in the Protection of the Environment (Administration) Act 1991 [Section (6)(2), (a)-(d)]:

(1) the precautionary principle – namely, that if 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;

(2) equity – namely that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

(3) conservation of biological diversity and ecological integrity; and

(4) improved valuation and pricing of environmental resources.

(ref. NSW, DLWC, Environmental Guide, for the management of local government water supply, sewerage and drainage services, 1997)

10.5 Actions and Responsibilities

Actions/ Tasks	Responsibility	Outcomes	Targets	Timing
Effluent Disposal Scheme	Director Engineering	Reduce incidence of uncontrolled discharge to catchment.	Nil Discharge to the catchment	Ongoing
Effluent Disposal Scheme	Director Engineering	Reduce amount of raw effluent to system.	Percentage reduction of wastewater to the system	1 to 5 years
Wastewater Treatment Plant	Director Engineering	Ensure optimum efficient operation of plant.	As set by EPA requirements DEUS advice	Ongoing
Effluent Disinfection Equipment	Director Engineering	Ensure all recycled effluent achieves adequate disinfection	As required by DEUS conditions and Dept Health advice	Ongoing
Effluent reuse scheme	Director Engineering	Ensure all effluent is sampled for sustainable operation	As required by DLWC & or CMB.	Ongoing
Effluent reuse scheme	Director Engineering	Ensure effluent is sampled and achieves adequate disinfection	As required by DEUS conditions and Dept Health advice	Ongoing

11.0 Training

11.1 Council Employees (Current Employees)

Operational procedures, operational manuals, equipment operation procedures shall be documented, copied and kept on hand at the Wastewater Treatment Facility. All relevant safety data and equipment should be readily available.

The Activated Sludge Treatment process is a relative robust method of Wastewater Treatment however like any process if it is not closely monitored the process will fail.

All operators of the plant should be adequately trained in the Activated Sludge Wastewater Treatment Process.

It is expected that operators will attend some form of accredited training program within a reasonable timeframe. It is recommended that new operators are sent to accredited training courses or have the capacity to access relevant training courses. (e.g. correspondence courses with residentials)

Workplace training is strongly recommended current workplace rules and regulations are constantly changing it is up to a levels of staff to keep abreast of current rules & regulations. Management is responsible for the safety and well-being of all their staff under their direction.

11.2 Outside Contractors and New Employees

All personnel visiting the plant and scheme to carry out works including subcontractors shall be required to undertake an environmental management induction briefing within 48 hrs of commencement of work. The objectives of the OEMP will be to:

- Introduce the policy to personnel involved with upgrade/maintenance etc.
- Explain the reason why the plans have been developed and what we hope to achieve by implementing the relevant policy.
- Review all relevant environmental issues and controls for the project.
- Personal will be trained to ensure they fully understand why certain practices have changed from practices they may have learned form previous experience. ie certain work practices learnt whilst they were apprentices may be considered incorrect at this juncture in time.

12.0 Monitoring Program

The operational monitoring of the Culcairn Reuse Scheme will be undertaken in accordance with the EPA Licence 3727 and the Management Plan developed within the Specialist Soil and Agronomy Report (Appendix 10). This Management Plan provides guidelines and scheduling for monitoring for the protection of surface water, groundwater, lands and plant and animal health.

Below is the scheduling for monitoring of the Culcairn Reuse Scheme. These monitoring points correlate to the points identified in the flowchart in appendix 6.

12.1 Volume Monitoring

(Monitoring Point #2 as per EPA Licence 3727)

The continuous monitoring of volume of incoming influent to the Culcairn Sewerage Treatment Works. Monitoring samples are for 365 days a year.

EPA Monitoring Sampling:

(Monitoring Point #3 as per EPA Licence 3727)

Pollutant	Unit of Measure	No. of samples required
Conductivity	Microsiemens per centimetre	4 per year
pH	pH	4 per year
Phosphorous (total)	Milligrams per litre	4 per year
Faecal Coliforms	Colony forming units per 100 millilitres	4 per year
Nitrogen (total)	Milligrams per litre	4 per year
Total suspended solids	Milligrams per litre	4 per year
Biochemical oxygen demand	Milligrams per litre	4 per year

12.2 Operational Monitoring

The continuous online monitoring for pH and Chlorine of the reuse effluent in the storage tank at the Culcairn Sewerage Treatment Works. The monthly monitoring for E. Coli and suspended solids in the effluent reuse water. The sampling method is grab sample and is sent to a NATA registered lab for analysis. These samples are collected from the End Users (ie. Billabong High School and Culcairn Recreation Ground).

EPA Monitoring Sampling:

(Monitoring Points #4,5,6 as per EPA Licence 3727)

The annual soil monitoring of Conductivity, Nitrogen, Phosphorous and Sodium Adsorption at the end users sites and the historical discharge point.

Pollutant	Unit of Measure	No. of samples required
Conductivity	Microsiemens per centimetre	1 per year
Phosphorous (total)	Milligrams per litre	1 per year
Nitrogen (total)	Milligrams per litre	1 per year
Sodium Adsorption Ratio	Sodium adsorption ratio	1 per year

12.3 Irrigation Management

Irrigation scheduling is adjusted on an as need basis. However, the general parameters for irrigation of Billabong High School and the Culcairn Recreation Ground is as follows:

- ☐ Summer – 3 times per week
- ☐ Spring, Autumn, Winter – On an as needs basis.

The irrigation systems are soil-moisture-sensor controlled to prevent waterlogging and/or runoff. This system of irrigation management assists in preventing any degradation to the ground water as per the recommendation in the Management Plan developed within the Specialist Soil and Agronomy Report (Appendix 10).

In addition, an audit of the system is required once every three years as per the NSW guidelines for "Management of private recycled water schemes". The audit addresses plumbing maintenance including backflow prevention and cross-connections.

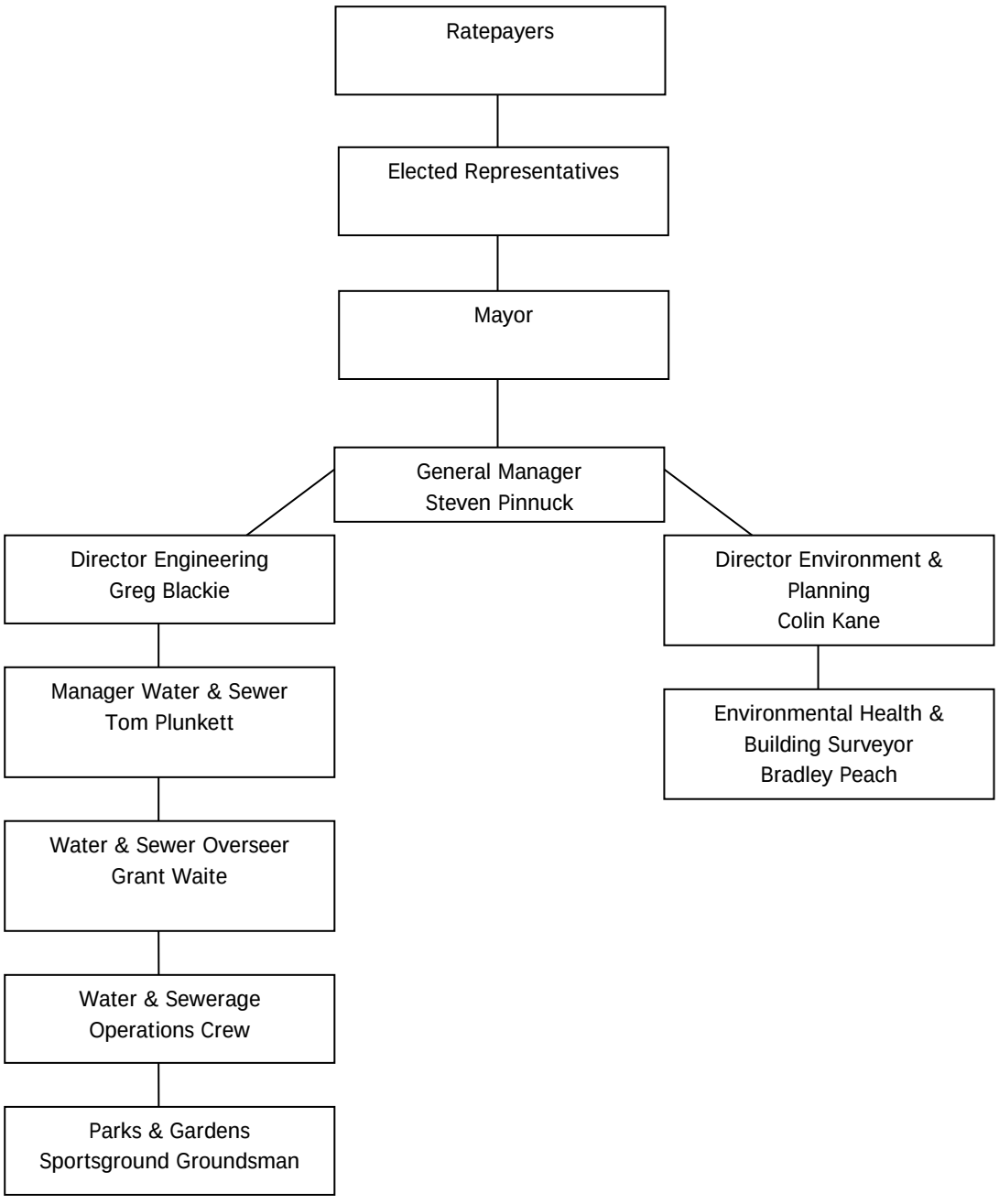
13.0 Documentation

- All associated maintenance and operational procedures for the plant.
- All associated maintenance and operational procedures for the effluent reuse scheme and chlorination equipment.
- Material Safety Data Sheets.
- Wastewater Operators Course Notes.
- Safety Data Sheets for all chemicals used on site.
- Emergency response sheets

14.0 Emergency Response

The following procedures have been documented in an effort to effectively handle environmental incidences and emergencies. These procedures will endeavour to limit/reduce any damage to the environment, which may occur during the operation of the complete facility.

14.1 The Greater Hume Shire Council Organisational Structure



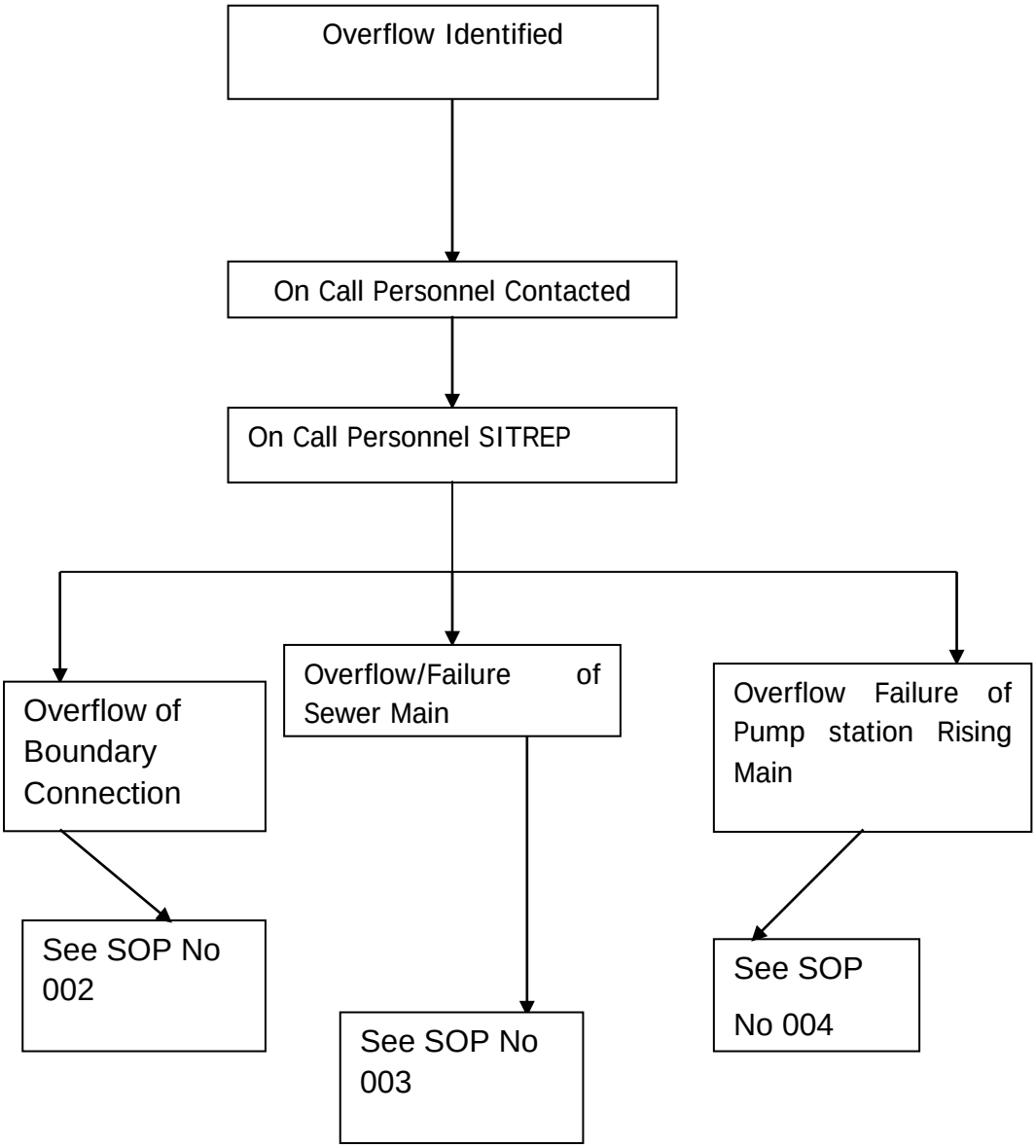
14.2 Emergency Contact List and Priority for Notification of Incident

Name	Position/Organisation	Contact Number	Type of Incident	Notification Priority
Grant Waite	Water & Sewer Overseer	0458 058 389	**Minor**	1
Tom Plunkett	Manager Water & Sewer	0427 480 915	**Minor**	2
Grant Waite	Water & Sewer Overseer	0458 058 389	**Major**	1
Tom Plunkett	Manager Water & Sewer	0427 480 915	**Major**	2
Bradley Peach	Environmental Health & Building Surveyor	0428 698 987	**Major**	3
Pat Freeman	NOW (Office of Water)	0429 308 954	**Major**	4
Brian Wild	DECC/EPA	131 555	**Major**	5

The following emergency response plans are attached to assist staff with step by step procedures to deal with sewage overflow situations. Standard Operational Procedures (SOPs) 001 through 006 are to be followed when an incident is identified as having the potential to cause problems relating to public health and detriment to the catchment.

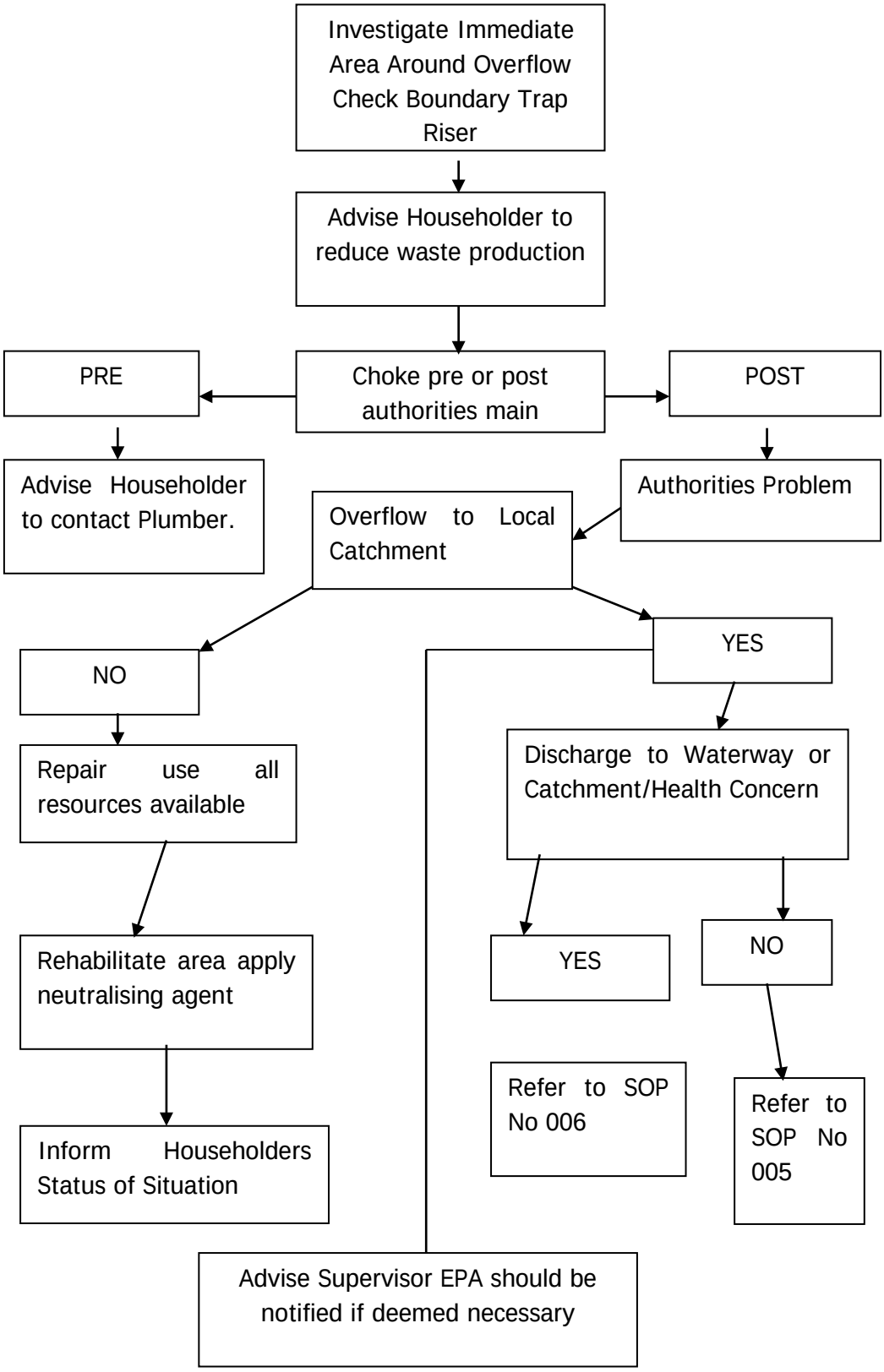
14.3 Overflow Emergency Response Plan

Standard Operational Procedures (SOP) No 001



Standard Operational Procedures (SOP) No 002

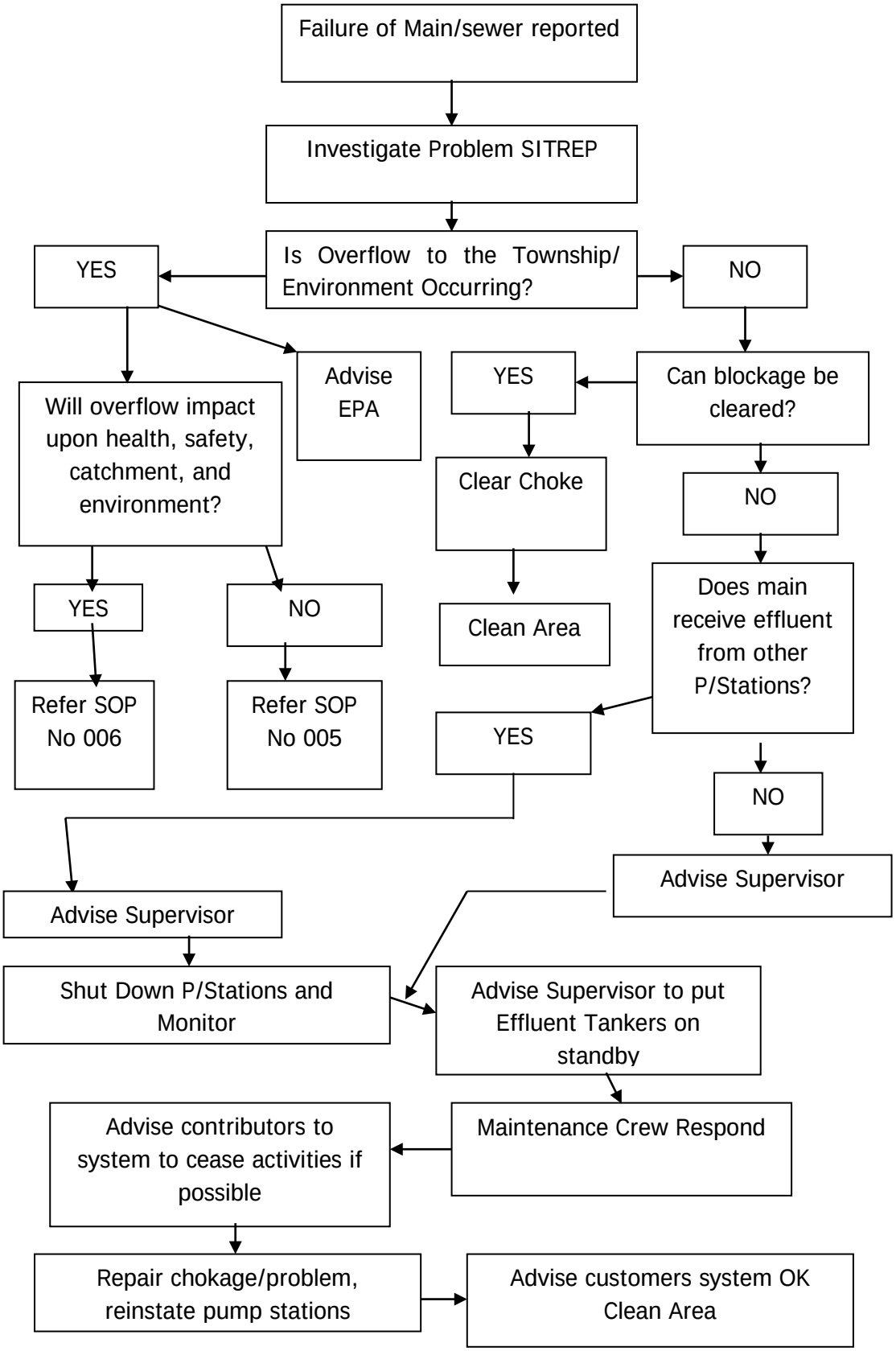
Overflow of Customer Main Connection



SITREP – Situation Report

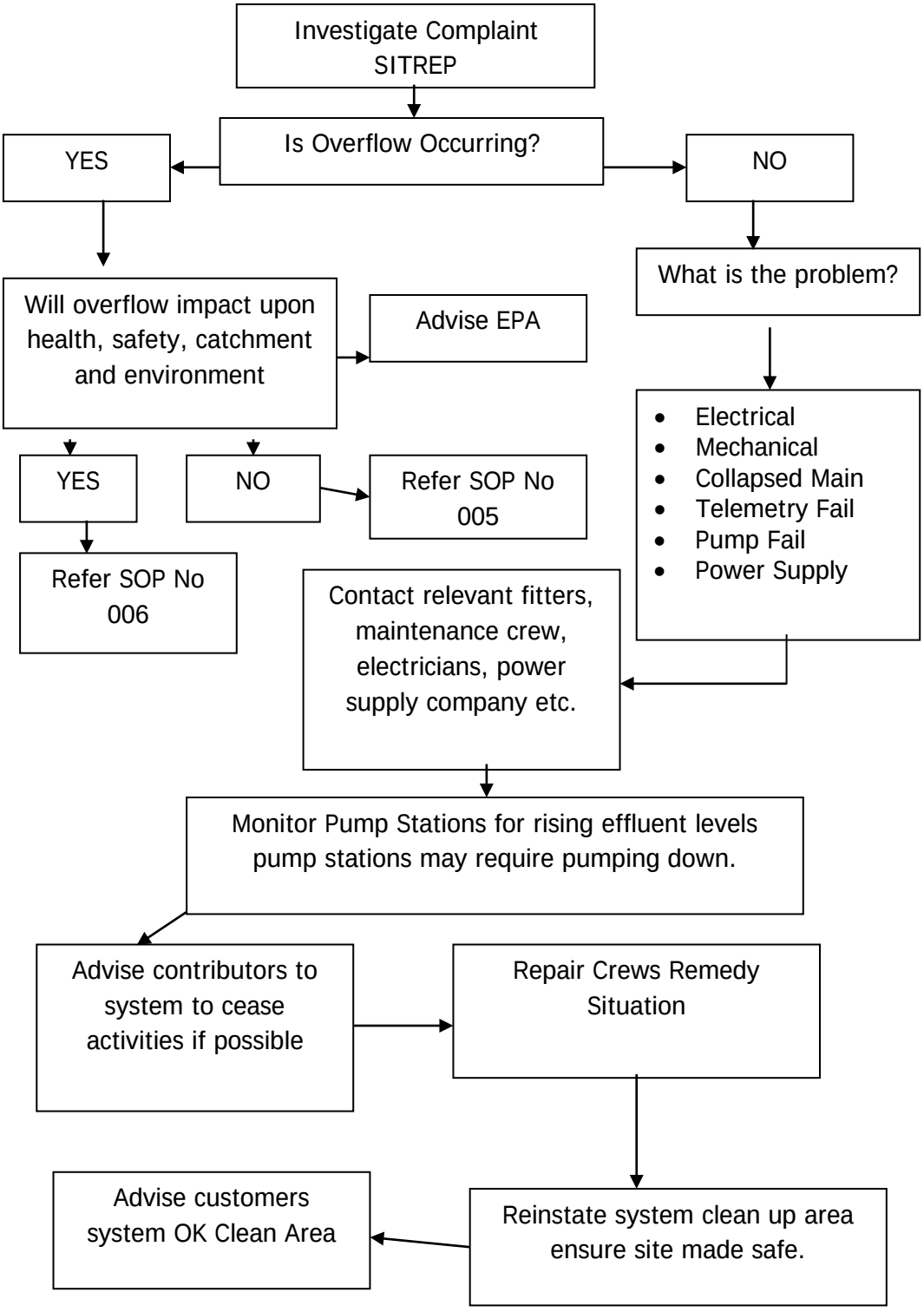
Standard Operational Procedures (SOP) No 003

Overflow/Failure of Gravity Main



Standard Operational Procedures (SOP) No 004

Failure of a Pumping Station or Rising Main



SITTREP – Situation Report

Standard Operational Procedures (SOP) No 005

Minor Overflow Action Statement

Date:	
Location:	
Time:	
Informant:	
Operative:	
Status: i.e. brief description	

Steps	Actions	Time am / pm
1	Advise Water & Sewer Overseer Grant Waite on 0458 058 389 of situation.	
2	Contain spillage.	
3	Advise residents of situation/enlist assistance if required.	
4	Commence rehabilitation work as per SOPs.	
5	Complete rehabilitation work/clean up work areas.	
6	Advise residents of situation.	
7	Advise Manager Water & Sewer Tom Plunkett on 0427 480 915 of situation.	

Miscellaneous:			
Repairs, Work Performed, Stock Used:			
Signature:		Date:	
Name:			

Standard Operational Procedures (SOP) No 006

Major Overflow Action Statement

Date:	
Location:	
Time:	
Informant:	
Operative:	
Status: i.e. brief description	

Steps	Actions	Time am/pm
1	Advise Water & Sewer Overseer Grant Waite on 0458 058 389 of situation	
2	Contain Spillage	
3	Advise Residents of situation/enlist assistance if required.	
4	Commence rehabilitation work as per SOPs.	
5	Call for assistance.	
6	Advise Manager Water & Sewer Tom Plunkett on 0427 480 915 or 0260 448 920 the Integrity of the Environment may have been compromised.	
7	Notify Council's Local Environmental Health Surveyor Bradley Peach 0428 698 987 or 0260 448 910	
8	Notify NSW Office of Water (NOW) District Inspector Pat Freeman 0429 308 954 for advice.	
9	Notify NSW EPA (DECCW) Brian Wild 131 555.	
10	Notify Greater Southern Area Health Service on 0260 808 900 AH ask for Environmental Health Officer from Public Health.	
11	Complete repair work.	
12	Rehabilitate area.	
13	Discuss the problem and formulate preventative measures for future.	
14	Point form problems encountered.	

Miscellaneous:			
Repairs, Work Performed, Stock Used:			
Signature:		Date:	
Name:			

15.0 Management Reporting

The plan will require regular audits in the initial phase to make sure goals and targets are being met and are achievable.

Benchmarks will need to be set and reviewed and goals measured to check for compliance and sustainability.

Factors which may be taken into consideration would be the year's performance reports the amount of effluent treated, quality of effluent, breakdowns, disposed effluent and a cost comparison for all these parameters.

16.0 Records and Information Management

Information for the operation and maintenance of the wastewater treatment plant may include the following weekly reporting sheets.

	Monday	Tuesday	Wednesday	Thursday	Friday
Flow					
PH					
MLSS					
Total P					
Ammonia					
S.Solids					
S.V.I.					
S.S.V.					
Sludge Blanket					
Dissolved O2					
Chlorine Res					
Suspended Solids					

Other information required is particularly site specific and will need to be inserted into this plan at the appropriate review juncture.

Planned works, maintenance, blockages, complaints, hours spent on particular procedures, breakdowns, augmentation, main extensions, water saving protocols, education programs, trade waste surveillance, illegal dumpers, new technology, re-use scheme sustainability.

17.0 Audit and Review

The council will be tasked with reviewing all aspects of the plan on a regular basis. Outside agencies may be called in to assist or consultants engaged to review the plan and respective outcomes.

18.0 References

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20.0 Appendix

No. 1 Greater Hume Shire Council State of the Environment Report, 2006/07

No. 2 Environment Protection Authority (Environment protection Licence No 3727)

No. 3 Definitions of Consequence and Likelihood

No. 4 Regional Location Plan, Figure 1

No. 5 Water Re-Use Scheme Proposed Site Plan, Figure 2

No. 6 Flow Chart

No. 7 Pumping and Filtration System for Re-Use Scheme

No. 8 MSDS Sheets for Sodium Hypochlorite

No. 9 MSDS Sheets for Hydrochloric Acid

No 10 Specialist Soil and Agronomy Report

MURRAY REGION COUNCILS

STATE OF THE ENVIRONMENT

3rd SUPPLEMENTARY REPORT 2006/07

Prepared for Murray Region Organisation of Councils (MROC) by:

Habitat Planning

ALBURY-WODONGA

NOVEMBER 2007

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ACRONYMS & ABBREVIATIONS

Bal	Balranald LGA
Ber	Berrigan LGA
Con	Conargo LGA
Cor	Corowa LGA
CMCC	Central Murray County Council
Cul	former Culcairn LGA
GH	Greater Hume LGA
DEC	Department of Environment & Conservation (now DECC)
DECC	Department of Environment and Climate Change
Den	Deniliquin LGA
DNR	Department of Natural Resources (now DWE)
DPI	Department of Primary Industries
DWE	Department of Water and Energy
EPBC Act	Commonwealth *Environment Protection & Biodiversity Conservation Act 1999*
ERP	Estimated Resident Population
Hol	former Holbrook LGA
Hum	former Hume LGA
Jer	Jerilderie LGA
LEP	Local Environmental Plan
LGA	Local Government Area
MCMA	Murrumbidgee Catchment Management Authority
MIL	Murray Irrigation Limited
MROC	Murray Region Organisation of Councils
Mur	Murray LGA
NSW	New South Wales
RLPB	Rural Lands Protection Board
SLA	Statistical Local Area
SoE	State of the Environment
TSC Act	NSW *Threatened Species Conservation Act 1995*
Wak	Wakool LGA
Wen	Wentworth LGA

TERMS

"the principal report"	the MROC State of the Environment Report 2003/04
"the supplementary report"	the third supplementary SoE report 2006/07
"the area" or" region"	the area addressed by the SoE Report

1. INTRODUCTION

This is a Supplementary Report to the principal State of the Environment (SoE) Report prepared for Murray Region Organisation of Councils (MROC). It is the third Supplementary Report to be prepared following the preparation of the 2003/04 principal report in December 2004.

A State of the Environment (SoE) report represents a review and record of the status of the 'environment' over a particular area. More specifically, and within the context the New South Wales *Local Government Act 1993*, a SoE report provides a summary of the attributes of the environment within which local government functions and the impacts of activities on that environment.

Each Council must prepare a principal SoE report at the end of the year in which a new Council is elected. This report must be comprehensive and address the eight environmental sectors of land, air, water, biodiversity, waste, noise, Aboriginal heritage and non-Aboriginal heritage. For the purposes of the principal SoE report for MROC the environmental sectors of waste, noise, Aboriginal heritage and non-Aboriginal heritage have been collapsed under one heading of 'human settlement' largely due to the lack of data available in each of these categories. Consequently the SoE report addresses five categories and not eight.

Supplementary SoE reports are required to be submitted within five months of each subsequent year (i.e. by November 30th) leading to the next local government election. The purpose of supplementary reports is to identify any new environmental impacts since the last principal SoE report and update any trends in environmental indicators that are important to each environmental sector.

Although each Council in NSW is required to prepare and lodge a SoE report, reporting at the regional level is encouraged by the Department of Local Government. Ten councils within the Murray Region of NSW have opted for the regional approach to SoE reporting under the umbrella of its peak body the Murray Region Organisation of Councils (MROC)[1]. The Council's involved in the SoE report are Balranald, Berrigan, Conargo, Corowa, Deniliquin, Greater Hume, Jerilderie, Murray, Wakool and Wentworth.

There are some limitations to the data and information presented in the third supplementary report that need to be acknowledged, including:

- The amalgamation and realignment of boundaries in 2004 involving the LGA's of Albury, Corowa, Hume, Culcairn, Holbrook and Tumbarumba has complicated data gathering as some of it is based on now redundant LGA boundaries. Where data and information is only available for the area of the former LGA's and consolidation is not possible, it is presented as such.
- For the sake of convenience, some data sets referring to the Greater Hume LGA are represented by the amalgamation of former Hume, Culcairn and Holbrook LGA's. This ignores the fact that parts of the former Hume Shire were acquired by

[1] Wentworth is not a member of MROC. Albury and Hay LGA's are also members of MROC but are not participating in this SoE Report.

the Albury and Corowa LGA's and a small part of the Holbrook LGA by the Tumbarumba Shire. With the passing of time it is expected more data sets will reflect the new LGA boundaries.

- Despite an exhaustive search of databases and information sources across government, non-government and community organisations, there remains a lack of both qualitative and quantitative environmental data for non-metropolitan inland areas of NSW. Data for the purposes of identifying trends (time series) can also difficult to source.
- A lot of data takes time to be made publicly available and as such even information released during 2006/07 can already be up to three years old. Consequently some of the updates provided in this 3rd Supplementary Report are not for the 2006/07 reporting period.
- Although Council's are provided with the same template for the purposes of collecting local data, there are gaps and inconsistencies in the way the data is presented in this report as Council's unintentionally respond in different ways.

2. THE MURRAY REGION

The area addressed in this supplementary report includes most of the member LGA's of Murray Region Organisation of Councils (MROC), namely:

- Balranald
- Berrigan
- Conargo
- Corowa
- Deniliquin
- Greater Hume
- Jerilderie
- Murray
- Wakool
- Wentworth

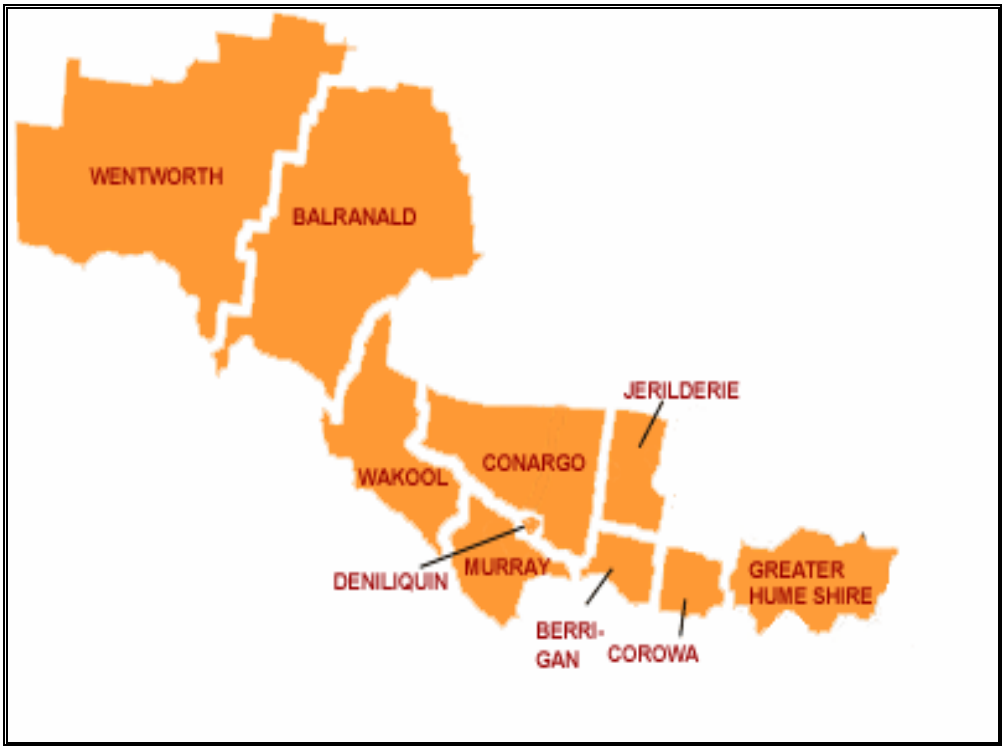
The area extends along much of the state boundary between NSW and Victoria, being the Murray River from Albury to Wentworth (see Figure 1) and represents a 'strip' along the northern side of the river varying in width between 50 and 150km.

The Murray River on the NSW border forms the southern boundary of the region. The terrain varies from flat in the western and central areas to very rugged on the eastern border (Department of Local Government 2001). The area covers approximately 80,000 square kilometres and contains approximately 60,000 people.

Population density is greater in the east as is the frequency of urban settlements with the largest township in Deniliquin, which is central to the area.

The area is largely rural in character and features a range of both dryland and irrigated agricultural activities including cereal and oil crops, sheep and cattle, viticulture, horticulture and rice growing.

Figure 1: Local Government Areas included in the SoE report



(Source: NSW Department of Local Government 2001)

Rainfall increases from west to east and varies between 300mm and 700mm per annum across the area. Although there is little difference in the temperature profiles between LGA's, Greater Hume would have more than twice the average annual rainfall of Wentworth.

Likewise population density generally increases from west to east across the region. With Corowa picking up the township of Howlong at the expense of Greater Hume in the 2003 LGA boundary adjustments, this municipality is now the largest in the region in terms of population. Only Corowa and Greater Hume have populations in excess of 10,000 in the Murray region (see Section 4.5).

3. NEW ENVIRONMENTAL IMPACTS

Council's have advised of the following new environmental impacts affecting their LGA in 2006/07.

Balranald

- An Aboriginal place of significance was identified and gazetted in 2005/06 period, however was not recorded in the 2nd supplementary SoE report.
- A report 'fish kill' was reported in Lake Benanee. Results concluded that the event was due to extreme hot weather and harsh drought conditions.
- Council has complied with the new water restrictions placed on the Murray and Tributaries greater area.
- The Murrumbidgee Catchment Management Authority (MCMA) reported one outbreak of blue-green algae on the Murrumbidgee River at Redbank Weir.

Berrigan

- Council has compiled with Stage 4 water restrictions introduced from 1st July 2007.
- Two new reservoirs constructed at Tocumwal to collect and store stormwater for recycling and reuse at golf course.

Conargo

- A designated development application for a 30,000 head sheep feedlot was approved.

Corowa

- 54 threatened species which are known or predicted to occur in the Shire.
- New sewerage treatment plant proposed for Mulwala. Construction to commence in August 2008.

Deniliquin

- Council has complied with Stage 1 water restrictions between March and July, 2007.

Greater Hume

- Council has compiled with Stage 2 water restrictions between July 2006 and June 2007; Stage 4 water restrictions between July and October 2007 and Stage 3A water restrictions commencing in November 2007.

Jerilderie

- A designated development proposal for the construction of Berrigan Stormwater Escape Channel for the Murray Irrigation Limited (MIL) was approved.
- Council has complied with Stage 1 and Stage 2 water restrictions.

Murray

- Council has complied with water restrictions.

Wakool

- Council has compiled with Stage 3A water restrictions.
- Council has reported numerous outbreaks of blue-green algae.
- Council has experienced 14 wildfires.

Wentworth

- One outbreak of blue-green algae was recorded which lasted for approximately six months.

In addition to these trends, any environmental data that was not previously presented in the principal or first supplementary SoE Report has been sourced for the purposes of the third supplementary report. This data and information is detailed in the following section.

4. TRENDS IN ENVIRONMENTAL INDICATORS

This section of the report is structured along the same lines as that presented in the principal, first and second supplementary SoE report in that data and information is presented under one of the five environmental categories being land, atmosphere, water, biodiversity and human settlement.

It is not the purpose of this supplementary report to reiterate data and information on the environment that has already been presented in the principal, first and second supplementary SoE report. Consequently, where information and/or data presented in the principal, first and second supplementary SoE report cannot be updated, it has not been included in this supplementary report. Therefore the trends in environmental indicators detailed below are based on either:

- updated information and data provided in the principal, first and second supplementary SoE report (i.e. information and data that is available on an annual or regular basis); or
- new data and information that was either not available or not obtained for the purposes of the principal, first or second supplementary SoE report.

4.1 LAND

The land supports us and all terrestrial plant and animal life. The importance of the land to society is perhaps most potently expressed by our reliance on the soil as a medium for production of food, fibre and timber.

Soil, biota and water together comprise a dynamic system, changing with what is put into it and what is taken out. The condition of aspects of these three components can often be a good indication of the overall 'health' of the land.

Soil salinity

Soil salinity is a form of land degradation characterised by increasing concentrations of salt in the soil. It is often first noticed as isolated waterlogged areas, patches of dying trees or other vegetation, crop failure, or changes in the types of plants growing in an area.

The proportion of dryland and irrigation salinity is of interest to SoE reporting because it can indicate a significant decline in the health of the land. Land affected by soil salinity during the 2006/07 period can be found in Table 1.

The salinity of shallow groundwater is monitored by MIL every three years and while there has been some variation, there is no discernable trend. Groundwater quality samples were last collected in July 2006. Figure 2 shows the shallow groundwater salinity in 2006. There were 854,216 hectares with groundwater salinity greater than 5,000 EC, compared to 927,200 hectares in 2003, 872,372 hectares in 2000 and 818,212 hectares in 1997. This presents a significant risk of soil salinisation if watertables are not controlled (MIL 2007).

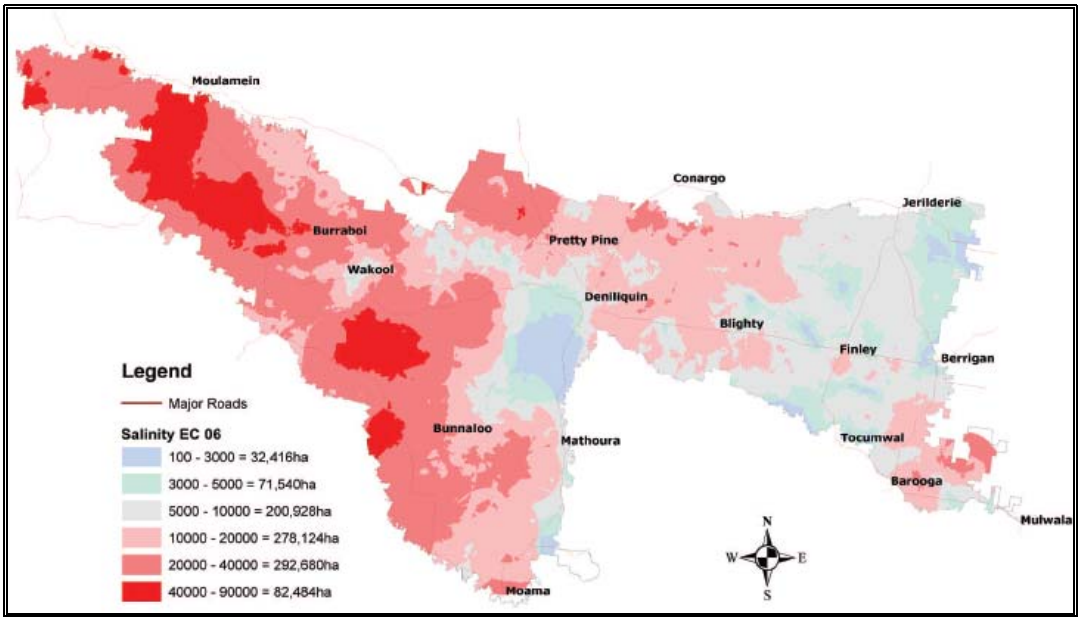
Table 1: LGA's affected by soil salinity

LGA	Land affected by soil salinity during 2006/07	Degree of salinity hazard	Further comment
Balranald	Land affected	Low	No changes or further action from last report.
Berrigan	Land affected	-	MIL and Murray Catchment Management Board currently have salinity measuring sites. Berrigan Shire Council indicated that actions undertaken during 2006/07 to respond to soil salinity have been undertaken by MIL and the Murray Catchment Management Board. This involved the implementation of incentives including improvements to irrigation practices; on-farm water storage; whole farm plans; drainage schemes; recycling systems; and incentives for tree plantings and permanent pasture establishment.
Conargo	Land affected	-	No changes or further action from last report.
Corowa	No new data	-	No changes or further action from last report.
Deniliquin	0.2km^2	Low	No changes or further action from last report.
Greater Hume	Land affected	-	Ten piezometers are located within the Henty Township. Assessment of salinity issues will be addressed in the new Local Environmental Plan (LEP).
Jerilderie	No new data	-	No changes or further action from last report.
Murray	No new data	-	No changes or further action from last report.
Wakool	Land affected	No details	Salinity measuring sites in the Wakool Shire are managed by Murray Irrigation Ltd and the State Water Authority.
Wentworth	Land affected	-	No new data.

(Information sourced from relevant Councils)

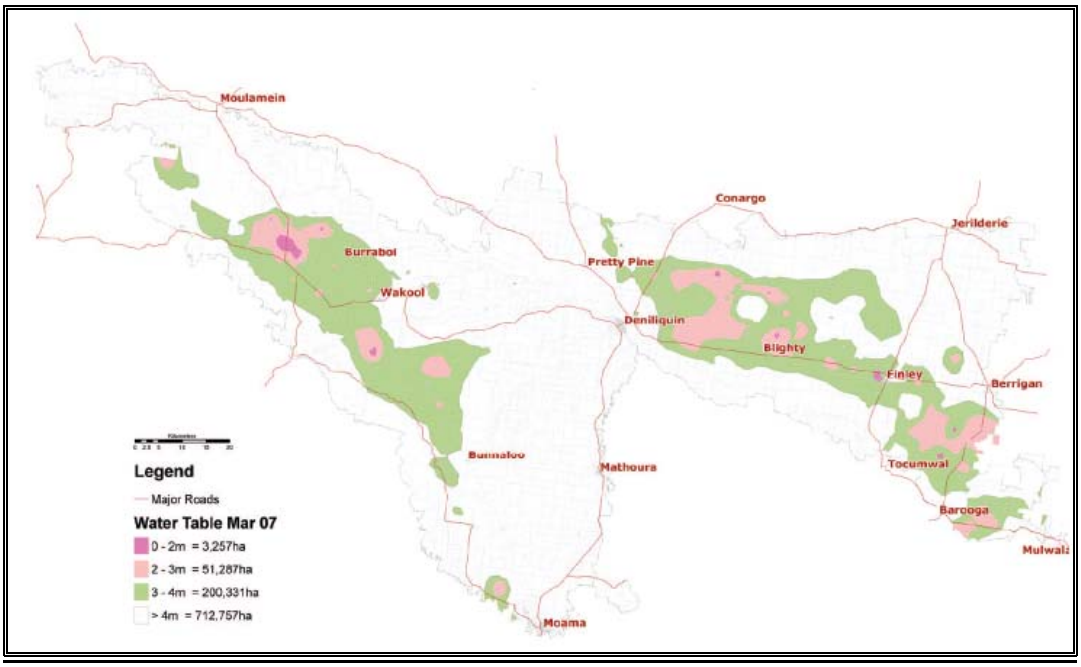
Extensive biannual groundwater monitoring has been undertaken by MIL through a network of 1,500 piezometers which has shown the area affected by shallow watertables in March 2007. A total of 3,257 hectares of land was affected by shallow watertables. This figure increased slightly in August 2007 to 3,747 hectares (see Figure 2). The continuing dry weather sequence and low water allocations have been major factors in the improvement of watertables levels (MIL 2007). Figure 3 shows the depth to watertable area in March 2007 in the MIL region.

Figure 2: Shallow groundwater salinity in the MIL region 2006



(Source: MIL 2007)

Figure 3: Change in depth to watertable area (ha), March 2007



(Source: MIL 2007)

Soil erosion

Soil erosion is the physical loss of soil from an area by wind or water. As for other forms of land degradation, there are generally severe impacts on agricultural productivity, road and building infrastructure and water quality. In general, erosion has occurred as a result of clearing of vegetation on susceptible soils and inappropriate land management practices. Erosion is of interest to SoE reporting because it indicates a significant decline in the health of the land.

Balranald, Greater Hume and Wentworth were the only LGAs to record land affected by sheet and rill erosion during 2006/07. The extent of land affected by erosion was unknown.

It is significant to note that the majority of LGA's within the Murray region actively support their local Landcare Groups. Landcare groups established in each LGA in the 2006/07 reporting period are listed in Table 2.

Table 2: Number of Landcare groups in each LGA

LGA	Landcare Group	Activity
Balranald	Clare Conservation Group	-
Berrigan	No change since last report	-
Conargo	No change since last report	-
Corowa	No change since last report	-
Deniliquin	No change since last report	-
Greater Hume	Alma Park/Pleasant Hills Landcare Group Holbrook Landcare Group Mullengandra Landcare Group Rand, Walbundrie, Billabong Creek Landcare Group Culcairn Landcare Group Carabost Landcare Group Bowna Arm Landcare Group Fowlers/Wagra Creek Landcare Group West Hume Landcare Group	-
Jerilderie	No change since last report	-
Murray	No change since last report	-
Wakool	Western Murray Land Improvement Group Environmental Champions Barham Landcare Group Murrakool Land for Wildlife	-
Wentworth	Darling Junction Landcare Group	-

(Information sourced from relevant Councils)

Land contamination

Land is contaminated when the level of a hazardous substance is greater than that which would naturally occur at the same site. Hazardous substances potentially pose an immediate or long-term risk to the health of humans or the environment.

The location and extent of an area contaminated by identified contaminants is of concern to SoE reporting because it is an indicator of the threat by land contamination to soil and aquatic organisms, vertebrates that might be feeding on contaminated organisms, and ultimately on human health.

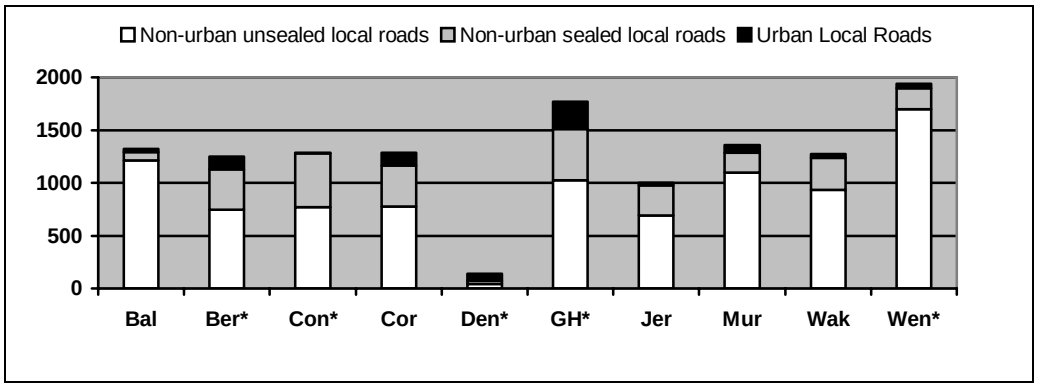
The 10 LGAs within the study area all reported that no change had been recorded during 2006/07 with regard to land contamination within their jurisdiction.

Balranald, Corowa, Deniliquin and Wentworth Shire Councils indicated that they currently maintain a Contaminated Lands Register during the 2006/07 reporting period. No additions were added to the Register.

Road construction & use

There is approximately 12,500 kilometres of local roads within the LGA's participating in this SoE report. Six (6) percent are classified as urban local roads, 22 percent as non-urban sealed roads and 72 percent as non-urban unsealed roads. The breakdown of these roads for each LGA is shown in Figure 4. Generally the larger the area of an LGA, the greater the length of roads within it. Compared to other LGA's in the region, Deniliquin has a short length of local road because the municipality does not extend far beyond the urban area of the city. Wentworth has the greatest length of unsealed local roads, Conargo has the most rural sealed road and Greater Hume the most urban sealed road. With 10 towns and villages within its boundaries, it is not unexpected that Greater Hume would reflect this statistic. Road length and conditions for the 2005/06[2] reporting period is illustrated in Figure 4.

Figure 4: Road length 2005/06 - kilometres



(Source: Department of Local Government 2006) Note: * indicates no change since last report

The following table (Table 3) provides data of only those changes that have occurred to Council maintained and managed roads during 2006/07.

Table 3: Changes to roads within specified LGAs

LGA	New Roads Created	Ongoing maintenance	Other changes impacting traffic/road use
Balranald	4 kms of local sealed rural road.	-	-
Berrigan	1.2 kms of local sealed rural roads. 1.37 kms local sealed urban roads. 3.64 kms local gravel rural roads.	-	-
Conargo	-	-	-
Corowa	0.6 kms of local sealed urban road. Hume Bridge construction.	-	Reconstruction of Hume Street. Daysdale curves alignment.

[2] Released 2006/07

LGA	New Roads Created	Ongoing maintenance	Other changes impacting traffic/road use
Deniliquin	0.25 kms of local sealed rural roads. 0.1 kms of local sealed urban roads.	-	Reconstruction of kerb, gutter and sealed shoulder on Finley Rd. Upgrade pavement and install kerb and guttering of Ross St. Regravel numerous unsealed urban and rural roads such as Hetherington St, Old Racecourse Rd, Lawson Syphon Rd, Yarra St, Augustus St, Box St, Robinson St, Larcome Ln and Ochtertyre St.
Greater Hume	-	-	-
Jerilderie	3 kms of local gravel rural roads.	-	Reconstruct 3 kms of McDonald Road. Shoulder widening on RR323 Oaklands Rd for 6 kms. Heavy patching works on MR 321 Kidman Way.
Murray	2.852 kms of local sealed rural roads. 933 kms of local sealed urban roads. -2.3 kms of local gravel rural roads. -380 kms of local gravel urban roads. Moama Business Park road construction. Roads constructed in Glenferrie Estate.	-	Upgrade of Conargo St, Mathoura. Upgrade of Picnic Point Rd. Upgrade of Caldwell Line Rd. Increased traffic use along Perricoota Rd and Cobb Hwy.
Wakool	1.5 kms of local sealed rural roads. 2 kms of local sealed urban roads.	-	-
Wentworth	-	-	Low Darling Rd gravel resheet for 2 kms. Rufus River Rd gravel resheet for 5 kms. Fletchers Lake Rd shoulder widening for 3 kms. Tapaulin Mail Rd gravel resheet for 5 kms.

(Information sourced from relevant Councils)

The RTA has compiled results of a traffic survey[3] undertaken during 2003 in RTA South Western Region as part of a three year repeating cycle covering the whole of NSW. No updates on traffic counts for each LGA have been undertaken and/or published since this survey was produced. The next traffic survey is due 2006 and was not publicly available at the time of writing.

[3] Source: Traffic Volume Data for South Western Region 2003, RTA.
http://www.rta.nsw.gov.au/trafficinformation/downloads/aadt_data_files/aadtsouthwest2003_i.pdf

Building, subdivision & major development

The future quality of communities is dependent upon on the condition and extent of infrastructure systems. To effectively manage public infrastructure assets it is necessary to develop long-term management plans that incorporate the true cost of developing, maintaining and upgrading infrastructure systems, as well as projecting likely future demand and other factors. It also includes planning for risk, to minimise the likelihood of failure. Inadequate planning can present significant problems for future generations.

BASIX (the building sustainability index) as a new planning requirement that applies to the building of new dwellings, has since been introduced across NSW to improve the energy and water efficiencies in homes. From 1st July 2005 a BASIX certificate is required for a new home, (including new multi unit residential developments) anywhere in NSW. BASIX calls for the reduction in water consumption, a reduction in energy consumption and a pass in the 'thermal comfort' section. All new development application for new dwellings and unit development within all the councils therefore had to be accompanied by a BASIX certificate, which indicate if the subject dwelling was designed in a manner to reduce the water and energy consumption as is required.

LGA comments regarding the implementation of the BASIX system are listed below.

- Balranald Shire Council has experienced a positive attitude towards the raw river water augmentation in both urban areas. This has been a credit towards garden water usage.
- Berrigan Shire Council has concern over enforcing the limitations on landscaping specified on the BASIX certificate after the house has been occupied, and why BASIX does not apply to relocatable and transportable dwellings.
- BASIX is becoming more accepted in the Conargo Shire and the benefits of energy efficient housing are being recognised by home owners.
- Corowa Shire Council has indicated that BASIX is like a pretend system. Amended certificates are too easily changed and issued.
- Deniliquin Shire Council has indicated that BASIX is generally accepted by the development community with some compliance issues still being experienced.
- BASIX has had no major impact on the Jerilderie Shire with only three dwellings completed during the reporting period. No alterations and additions within the Shire were affected by BASIX.
- Wakool has indicated that BASIX needs drastic revision to make it simpler and more equitable. The system has a very significant financial impact on persons undertaking BASIX which is affecting their building works; has a very poor intercommunication between the BASIX team and Council; and is impractical when enforcing owner commitments in many cases.
- Greater Hume, Murray and Wentworth Shires had no comment.

Table 4 details the number of subdivisions approved by each Council during 2006/07, the number of new lots created by the approved subdivisions and the number of new dwellings approved.

Table 4: Number of subdivisions, new lots and new dwellings approved in 2006/07

LGA	Subdivisions approved 2006/07	Number of new lots created	New dwellings approved 2006/07
Balranald	18	108	10
Berrigan	23	117	74
Conargo	2	4	7
Corowa	11	154	77
Deniliquin	17	62	9
Greater Hume	39	86	47
Jerilderie	1	2	4
Murray	36	192	103
Wakool	21	43	10
Wentworth	21	68	46

(Information sourced from relevant Councils)

Greater development activity occurs in townships along the Murray River such as Howlong, Corowa, Mulwala, Barooga, Tocumwal and Moama than further to the north. This growth might also be the result of the increased employment opportunities in towns across the river in the Victorian towns which in turn stimulate growth in the 'border' towns in NSW. Also greater development activity tends to occur in the eastern part of the region possibly because of the proximity to Albury-Wodonga and shorter distance to Melbourne. A total of three Councils approved a designated development in the 2006/07 reporting period (see Table 5).

Table 5: Designated development approved during 2006/07

LGA	Development	Other information
Murray	Marina	Moama Waters Pty. Ltd.
Jerilderie	Berrigan Stormwater Escape Channel	Murray Irrigation Limited
Conargo	30,000 head sheep feedlot	-

(Information sourced from relevant Councils)

Public open space

Land in towns is used for residential, commercial and industrial uses as well as urban green space. The amount of land used for each affects the nature and extent of impacts of urbanisation on the environment and the demands for infrastructure such as energy and water supply systems. The way land is used in urban areas also impacts on the quality of life for residents as it affects the amount of privacy, space and noise experienced by the residential population, resulting in a range of effects on human health.

The area of urban green space should be further disaggregated into the area of urban land devoted to native vegetation, parks, gardens, recreation and other open spaces,

relative to the total urban area and whether this green space is accessible to the public. This is because urban green space that is not easily accessible for all does not contribute as much to the overall quality of life for an urban population.

No changes to the public open space controlled by the LGA's within the study region were reported for 2006/07.

4.2 ATMOSPHERE

The atmosphere is no respecter of human boundaries and any division of it into jurisdictional regions is artificial and unhelpful. The air in the region forms part of the great global movements of air that drive the climate system and re-distribute heat around the planet - in the process moving pollutants too. Clearly areas are subjected to deteriorations in the state of the atmosphere caused by actions elsewhere and this must be borne in mind when reading any material in this theme.

In this theme, we report on the condition of the atmosphere in the region including rainfall and temperature statistics.

Also of importance to human health, although little monitored, is the quality of air inside buildings.

Pollution complaints

The data available on the Department of Environment and Climate Change (DECC) website has not been updated since the principal SoE report and consequently there is no data to present in addition to that in the principal SoE report.

Table 6 provides some data supplied by each LGA from their own complaints records.

Table 6: Pollution complaints received during 2006/07

LGA	Complaints Register?	Number of Complaints 2006/07	Details/nature of complaint
Balranald	Yes	1	A reported fish kill on Lake Benanee which resulted in confirmation that the event was due to extreme hot weather and drought conditions.
Berrigan	Yes	11	Drums/chemical smell Sewer system odour Backyard burning Juice factory effluent odour
Conargo	No	0	-
Corowa	No	3	Dust
Deniliquin	Yes	9	x5 odour emitting from sewer treatment plant x4 noise related matters
Greater Hume	Yes	5	-
Jerilderie	Yes	0	-
Murray	Yes	10	Most pollution complaints were regarding rubbish/litter.

Wakool	Yes	2	Building waste from a demolition site in neighbouring Shire dumped on floodplain. Air pollution from a feedlot.
Wentworth	Yes	16	x3 air x1 chemical x1 noise x3 pesticide x8 water

(Information sourced from relevant Councils)

Motor vehicle use

Whilst providing an important means of transport, motor vehicles are a source of air pollution and are therefore relevant to SoE reporting. Table 7 below provides information of the kilometres travelled by Council owned vehicles within each LGA as well as the volume of fuel consumed.

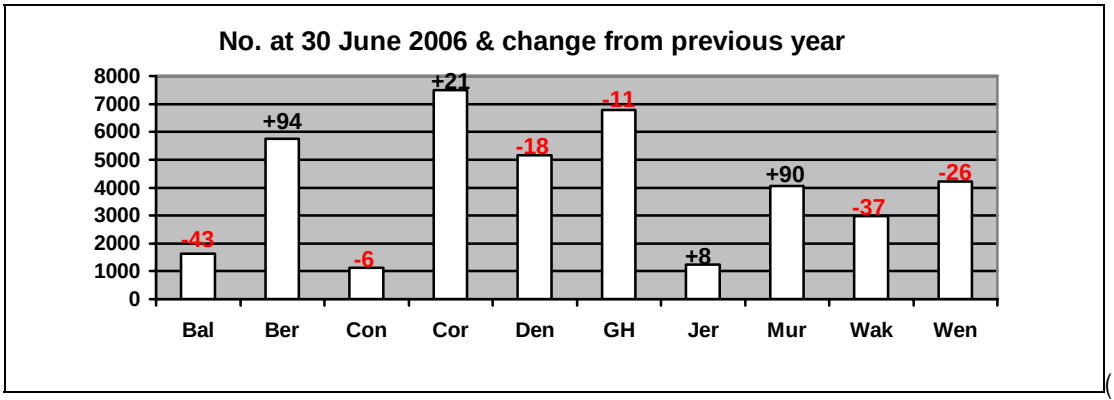
Table 7: Kilometres travelled & fuel consumed by Council vehicles in 2006/07

LGA	Kilometres travelled by Council vehicles during 2006/07	Litres of fuel used by Council vehicles during 2006/07
Balranald	500,000	60,000
Berrigan	-	-
Conargo	610,000	400,000
Corowa	-	69,700 ULP 252,000 distillate
Deniliquin	1,200,000	250,000
Greater Hume	2,500,000	511,000
Jerilderie	-	330,000
Murray	1,750,000	550,000
Wakool	-	278,539
Wentworth	472,493	348,527

(Information sourced from relevant Councils)

Figure 5 and Figure 6 presents the data available from the RTA in regards to vehicles and drivers in 2006. Figure 5 shows the number of licensed drivers in each LGA and reveals that most LGA's experienced a small decrease.

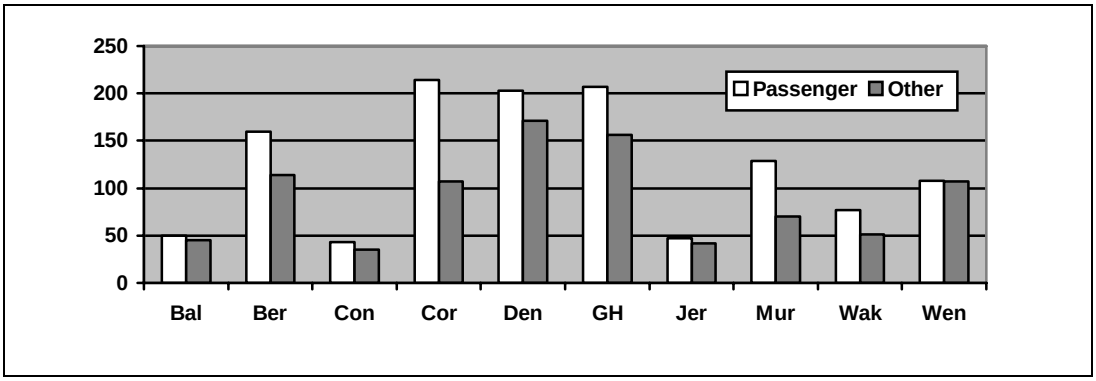
Figure 5: Licensed drivers 2006



(Source: RTA 2006)

Figure 6 shows the number of new vehicles registered in each LGA in 2006. Corowa had by far the most new passenger vehicle registrations with Greater Hume and Deniliquin all around the 200 mark. Deniliquin experienced the most non-passenger vehicle registrations.

Figure 6: New vehicles registered 2006



(Source: RTA 2006)

Temperature

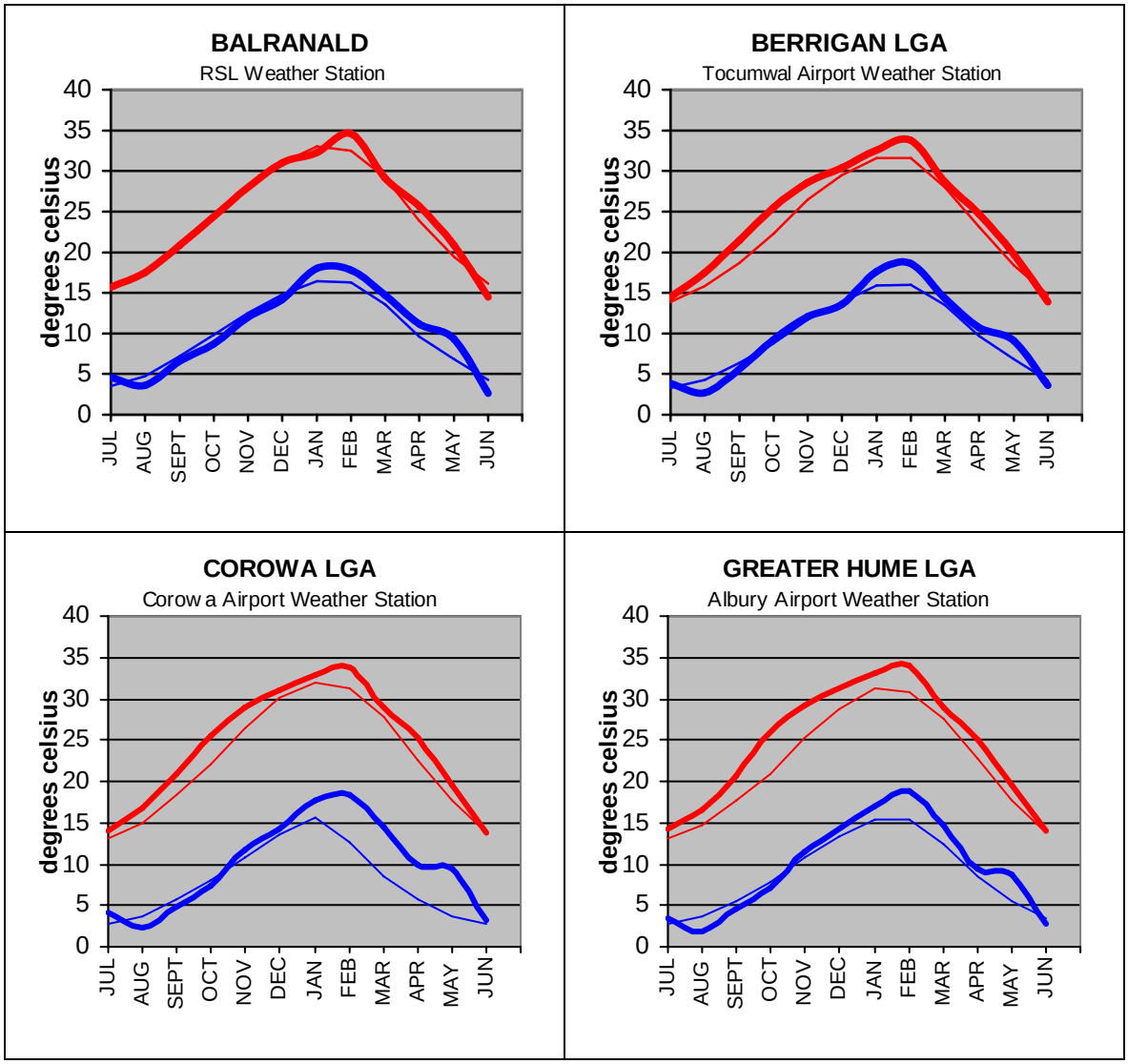
Temperature, along with rainfall, is one of the main factors that influence the nature and species composition of ecosystems, as well as the types of agricultural activities that can be carried out in the region. It is the temperature extremes that are of most interest, as longer-term averages are slow to change in response to climate changes, both natural and human induced such as the enhanced so-called 'greenhouse' effect. For example, many crops are vulnerable to an unseasonably late frost, or an extremely hot day at specific stages in crop growth.

Temperature also affects human comfort and this is reflected in energy usage, as many dwellings and places of work require some heating in the coldest winter months, and/or cooling in the hottest summer months.

Figure 7 charts the mean minimum and monthly temperatures experienced across the region in 2006/07 compared to the historical average. The charts show that across the region the spring of 2006 was slightly cooler than average, the summer hotter than

average (significantly hotter in January and February), and the autumn and winter of 2007 being cooler than average.

Figure 7: Mean minimum and maximum monthly temperature – 2006/07 vs historical



Note: The red lines refer to the mean maximum temperature and the blue lines refer to the mean minimum. The thicker line represents the 2006/07 data and the thinner line the historical record for each month. (Source: BOM 2007)

Smoke

The amount of particles in our atmosphere can result in a loss of visibility because of haze, as well as increases in the number of people affected by respiratory problems like asthma and bronchitis. This is the reason for including air borne particles as an indicator in the SoE report.

Within the study area the two primary sources of smoke are, firstly, stubble burning of agricultural paddocks that have generally been sown with cereal crops and secondly, during the winter months where the use of solid fuel heaters contributes to the particulate count. Table 8 below displays the data received from the LGAs.

Table 8: Permits and approvals for each LGA for stubble burning and solid fuel heaters during 2006/07

LGA	Number of permits for stubble burning 2006/07 during restricted periods	Number of permits for solid fuel heaters 2006/07
Balranald	0	0
Berrigan	0	1
Conargo	0	1
Corowa	0	6
Deniliquin	0	0
Greater Hume	0	3
Jerilderie	0	0
Murray	0	0
Wakool	37	3
Wentworth	118 Agricultural permits	2

(Information sourced from relevant Councils)

Environment Protection Licences

Environment Protection Licences are issued by the DECC for scheduled premises. Table 9 lists all licences currently in place across the LGA's included in this SoE report. A total of four new licences were either issued or appending. New licences issued in the reporting period are highlighted.

Table 9: DECC issued Environment Protection Licences for Scheduled Premises

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
BALRANALD				
Balranald Gypsum Pty	White Plains Gypsum Ivanhoe Road Balranald	Mining (Other than Coal)		
Balranald Gypsum Pty Ltd	Paxtons Mine Lease Ivanhoe Road Hatfield	Mining (Other than Coal)		
Balranald Gypsum Pty Ltd	Norm's Mine Ivanhoe Road Hatfield	Mining (Other than Coal)	S 58 Licence Variation 19/01/07 S 58 Licence Variation 24 Jan 07	
Balranald Shire Council	Balranald Water Treatment Works 36 Court Street Balranald	Misc Licensed Discharge to Waters (any)	S 58 Licence Surrender 27/7/07 S 80 Surrender Licence 8/8/07	
BERRIGAN				
Berrigan Shire Council	Finley Sewage Treatment Plant Dales Road, Finley	Sewage Treatment - small plants	S 58 Licence Variation 15/10/07	-
Collins; David Eric George, D & M Collins	"Claremont", Cruikshanks Road, Berrigan	Pig Production		
Equity Park Enteprises Pty. Ltd	Equity Park Enterprises Pty Ltd, Piney Road, Berrigan	Pig Production		
Kydd, N. J. & I. R. Pty Ltd	Hornemans Road, Finley	Milking Facilities		
McGrath, M.W. & M. L. Pty. Ltd	"Lynton", RMB 1620 Langunyah Road, Tocumwal	Pig Production		
McPherson; Allan S J ASJ McPherson & Co McPherson; Geoffrey ASJ McPherson & Co McPherson; Valda M ASJ McPherson & Co	"Avalon Park" RMB 1630 Langunyah Road Tocumwal	Pig Production		

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Mossgiel Nominees Pty Ltd	Ruwolts Road, Mulwala	Milking Facilities		
Perryman's Knackery Pty Ltd	Perryman's Knackery Mardinora Road Tocumwal	Other Livestock Processing		
Ricegrowers' Co-Operative Limited	Rice Marketing Board Finley Storage Facility Rice Mill Road Finley	Other Agricultural Crop Processing (3)		
CONARGO				
Aldebaran Pastoral Co Pty Ltd	"Lynbrae" Monimail Road, Deniliquin	Feedlot Production	New licence issued 7/3/07	
Ricegrowers' Co-Operative Limited	Blighty Rice Storage Sheds Riverina Highway Blighty	Other Agricultural Crop Processing (3)		
COROWA				
ADI Limited	ADI Limited Bayly Street Mulwala	Chemical Storage - Other Chemical Storage Explosive or Pyrotechnics Production Hazardous, Industrial or Group A Waste P Other Chemical Processing	Licence variation approved 30/8/05.	Monitoring Point (MP) 4: NOx & SO3 exceeded limit MP30: NOx exceeded limit MP2: NOx (2), TSS (4), Total Nitrogen (7), Conductivity (2), Oil & Grease, BOD exceeded limit (No. of Incidents = 1) MP 14, 29, 36 & 37 - air emissions monitoring not conducted during licence period. (No of incidents = 4)
Baird; Heidi J. & Baird; Innes	Hopefield Piggery Hopefield Road Corowa	Pig Production		
Boral Resources (Vic) Pty Limited	Corowa Sand & Gravel Riverina Highway Howlong	Other Land-Based Extraction		
Corowa Shire Council	Mulwala Sewage Treatment Works Bayly Street Mulwala	Sewage Treatment - small plants	Licence variation approved 15/10/07. Licence variation approved 1/8/06.	BOD - plant overloaded - constructing new plant (No. of incidents = 9) nitrogen - plant overloaded - constructing new plant (No of incidents = 1) suspended solids total - plant overloaded - constructing new plant (No of incidents = 8) Point 3, A minimum of 0.5mg/L chlorine (No of incidents = 1)
Corowa Shire Council	Mulwala Filtration Plant Gulai Road Mulwala	Misc Licensed Discharge to Waters (any)		

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Corowa Shire Council	Corowa Sewage Treatment Works 27 Nixon Street Corowa	Sewage Treatment - small plants	Licence variation approved 15/10/07. Licence variation approved 1/8/06	Volume/day. (No of incidents = 9)
Corowa Shire Council	Corowa Garbage Depot Albury Road Corowa	Environmentally Sensitive or Inappropriate Land filling	Licence variation approved 4/9/07. Licence variation approved 13/8/07.	
Corowa Shire Council	Corowa Saleyards 449-471 Honour Avenue Corowa	Saleyards		
Hanson Construction Materials Pty Ltd	Pioneer Construction Materials Pty Ltd Posiedon Road Corowa	Concrete Batching		
Hughes, Adrian Kevin	Lot 2 Almond Lane Corowa	Composting and Related Reprocessing		
ICM Farm Products Australia Pty Ltd	Kunanadgee Station Spring Drive Corowa	Milking Facilities		
Melban Pty Limited Cool - Off	Melban Pty Ltd Jude Road Howlong	Other Livestock Processing		
Mills; Donald James Rosedale Nominees Pty Ltd Mills; John Rosedale Nominees Pty Ltd	"Kardinia" Balldale Coreen Road Corowa	Pig Production		
Mooroola Pty Ltd	Mooroola Pty Ltd "Wangamong" Oaklands	Pig Production		
Nagle; Rodney David I & R Nagle	I & R Nagle "Wongalea" Berrigan Roadside Corowa	Pig Production		
QAF Feeds Pty Ltd	QAF Feeds Pty Ltd Albury Road Corowa	Other Agricultural Crop Processing (3)	Licence variation approved 29/8/07.	
QAF Meat Industries Pty Ltd	QAF Meat Industries Pty Ltd Redlands Road Corowa	Animal Slaughtering Pig Production	Licence variation approved 26/3/07.	
Ridley Agriproducts Pty Ltd	Ridley Agriproducts Whitehead Street Corowa	Other Agricultural Crop Processing (3)		

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
DENILIQUIN				
Deniliquin Council	Deniliquin Sewage Treatment System Calimo Street Deniliqui	Sewage Treatment - small plants	Licence variation approved 11/10/07. Licence variation approved 31/7/07.	Faecal coliforms exceeded once and Nitrogen exceeded once for the 100 percentile concentration limit. (No. of incidents = 1).
Deniliquin Council	Deniliquin Waste Disposal Depot Hay Road Deniliquin	Solid Waste Land filling		Analysis of monitoring data - Second six monthly sample results had not been received at time of doing Annual Report. This prevented finalisation of annual monitoring report. (No of incidents = 1) Quarterly reporting of Waste Received Form not submitted for previous 12 months.(No of incidents = 1)
Deniliquin Council	Deniliquin Saleyards Saleyards Road Deniliquin	Saleyards		
Famicorp Pty Ltd	Famicorp Pty Ltd Abattoir Road Deniliquin	Animal Slaughtering	Licence variation approved 18/10/07.	
Four Seas (NSW) Limited	Charlie Carp Fertiliser Lot 2 Saleyards Road Deniliquin	Rendering or Fat Extraction		
Greater Murray Area Health Service	Deniliquin Hospital 40 Charlotte Street Deniliquin	Hazardous, Industrial or Group A Waste G		
Murray Irrigation Limited	Murray Irrigation Area of operations within Shires of Wakool, Windouran, Corowa, Berrigan, Jerilderie, Conargo, Murray & Deniliquin	Irrigated Agriculture		
Ricegrowers' Co-Operative Limited	Deniliquin Rice Mill Sale Yards Road Deniliquin	Other Agricultural Crop Processing (3)		
GREATER HUME				
Albury Galvanizing Pty Ltd	Albury Galvanizing Pty Ltd Lot 9 Davis Drive Jindera	Hazardous, Industrial or Group A Waste G	Licence variation approved 27/4/06.	
Bald Hill Quarry Pty Ltd	"Cromer" Hume Highway, Holbrook	Hard-Rock Gravel Quarrying	New licence approved 25/10/07.	
Barwondale Feedlot Pty Ltd	Cookardinia Road, Henty	Feedlot Production		Parameter 4 Sigma theta (No of incidents =1)

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Boral Bricks Pty Ltd	Boral Bricks Pty Ltd Hueske Road Jindera	Ceramics Production Crushing/Grinding/Separating Other Land-Based Extraction		
Boral Resources (Vic) Pty Limited	Weeamera Road Culcairn	Hard-Rock Gravel Quarrying		
Greater Hume Shire Council	Comer Street Henty	Sewage Treatment - small plants	Licence variation approved 16/10/07 Licence variation approved 31/7/06	
Greater Hume Shire Council	Cemetery Road Culcairn	Sewage Treatment - small plants	Licence variation approved 16/10/07 Licence variation approved 31/7/06	
Greater Hume Shire Council	Klemke Avenue Walla Walla	Sewage Treatment - small plants	Licence variation approved 16/10/07 Licence variation approved 31/7/06	
Greater Hume Shire Council	Bath Street Holbrook	Sewage Treatment - small plants	Licence variation approved 16/10/07 Licence variation approved 31/7/06	ADP004 effluent quality monitoring discharge point - Suspended Solids readings recorded 52mg/L on 20/12/07. (No. of incidents = 1).
Hyne & Son Pty Limited	21 Bond Street Holbrook	Wood or Timber Milling	Licence variation approved 7/5/07	Water quality monitoring not undertaken. revision of requirements for pollutant monitoring, frequency and sampling method agreed in principle from the DEC. revised licese to be provided by the DEC. (No. of incidents = 4).
Geelong Leather Pty Ltd	116 Schnaars Road Culcairn	Tanning or Fellmongery		Monitoring not undertaken as required by Condition M2. (No. of incidents = 1).
Leighton Contractors Pty Ltd	Yarra Yarra Road N4 Batching Plant, Intersection Hume Hwy & Yarra Yarra Road, Little Billabong	Concrete Batching	New licence approved 1/10/07.	

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
QAF Meat Industries Pty Ltd	Bungowannah Piggery Riverina Highway Bungowannah	Composting and Related Reprocessing Pig Production		
Regmont Pty. Limited	Back Henty Road Culcairn	Feedlot Production		Chemical analysis of runoff and flows during the reporting period not undertaken, as no run off and insufficient flow (No. of incidents = 1) Quantity of solid waste applied not monitored during the reporting period, as no manure was applied (No. of incidents = 1).
Wyanga Holdings Pty Ltd	Hume Highway, Table Top	Hard-Rock Gravel Quarrying	New licence approved 18/5/07.	
JERILDERIE				
Jerilderie Shire Council	Jerilderie Sewage Treatment Works Wilson Road Jerilderie	Sewage Treatment - small plants	Licence variation approved 16/10/07 Licence variation approved 31/7/06	
Ricegrowers' Co-Operative Limited	Hogan Rice Storage Sheds Cnr Newell Highway & Berrigan Road Jerilderie	Other Agricultural Crop Processing (3)		
MURRAY				
Associated Feedlots Pty. Ltd.	Amaroo Park Sollys Road Mathoura	Feedlot Production		
Boral Resources (Vic.) Pty. Limited	Boral Resources (Vic) Pty Limited 8 Eddy Avenue Moama	Concrete Batching		
Bunnaloo Pastoral Company Pty Ltd	"Lenian" Nolan Road Bunnaloo	Feedlot Production	Licence variation approved 24/7/07 Licence variation approved 10/8/06	
Camboon Pty Ltd	Ballyrogan Road, Bunnaloo	Pig Production		
Closter's Group Pty Ltd	Moama Wastewater Treatment Works Hillside Road Moama	Hazardous, Industrial or Group A Waste P		
Deep Creek Marina Pty Ltd	Deep Creek Marina Perricoota Road Moama	Other Vessel Construction/Maintenance		

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Kempen; Sheila G & S Kempen	"Birchfield" Fitzpatrick Lane Womboota	Pig Production		
Future Fuels Australia Pty Ltd	Moama Refinery Hillside Lane Moama	Petroleum Refining	S 91 Clean up notice issued 24/9/07 S 91 Clean up notice issued 5/9/07 Licence variation approved 24/7/07 Licence variation approved 10/8/06	
Murray Shire Council	Moama Solid Waste Depot Centre Road, Moama Moama	Solid Waste Land filling		
Murray Shire Council	Moama Sewage Treatment Plant Hillside Road Moama	Sewage Treatment - small plants	Licence variation approved 6/11/07 Licence variation approved 31/7/06	
Ricegrowers' Co-Operative Limited	Caldwell Rice Storage Sheds Rosella Street Caldwell	Other Agricultural Crop Processing (3)		
Ritchie; Richard Michael	Drums Go Round 6 Eddy Avenue Moama	Drum or Container Reconditioning Hazardous, Industrial or Group A Waste P		
Symons; Robert Wesley	Old Moama Slipway 1 Forbes Street Moama	Other Vessel Construction/Maintenance		
WAKOOL				
Council of the Shire of Wakool	Murray Downs Sewage Treatment System, Lot 11 DP836391, Murray Downs	Sewage Treatment - small plants	S 80 Surrender Licence 27/7/07 Licence variation approved 31/7/06.	

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Garrison Cattle Feeders Pty Ltd	'Garrison' Moulamein Road Murray Downs	Feedlot Production		Closing month stock numbers exceeded the limit of 5,000 head on two separate occassions. (No. of incidents = 1). Chemical analysis of representative groundwater sample monitoring not carried out at MP 1. (No. of incidents = 1).
QAF Meat Industries Pty Ltd	Brooksbank Properties Pty Ltd "Balpool Station" Via Moulamein	Composting and Related Reprocessing Other Agricultural Crop Processing (3) Pig Production		
Ricegrowers' Co-Operative Limited	Burraboi Rice Storage Sheds Wakool Road Burraboi	Other Agricultural Crop Processing (3)		
Ricegrowers' Co-Operative Limited	Moulamein Rice Storage Sheds Corner of Hay & Tchelery Roads Moulamein	Other Agricultural Crop Processing (3)		
Tasman Group Services Pty. Ltd.	Yambinya Station Jimaringle Road Burraboi	Feedlot Production	S 58 Licence variation approved 23/3/06.	Causing the generation of unacceptable quantities of dust. (No. of incidents = 1).
WENTWORTH				
Bemax Resources NL	Snapper Mine NOB Road , Pooncarie	Land-Based Extraction	Application pending 19/10/07	
Arumpo Bentonite Pty Limited	On Arumpo Station Wentworth	Mining (Other than Coal)		
Bemax Resources NL	Ginkgo Mineral Sands Project , Nob Road Wentworth	Land-Based Extraction - Other Mining (Other than Coal) Non-Ferrous Production (excluding Aluminium) - Secondary Waste Generation or Storage - Hazardous, Industrial or Group A	S 58 Licence variation approved 12/10/06.	Monitoring Point 8 - Monthly monitoring of standing water level and TDS required. Monitoring of TDS not able to be undertaken due to inability to collect sample from bore. (No. of incidents = 4).
Hardy Wine Company Limited	Silvercity Highway Mourquong	Wine or Spirit Processing	S 58 Licence variation approved 2/8/06.	
Ilinga Pty Ltd	30 River Drive Buronga	Other Vessel Construction/Maintenance		

LICENCE HOLDER	PREMISES	ACTIVITY	CHANGE FROM 2005/06	NON-COMPLIANCE 2006/07
Larmon Pty. Ltd	Arumpo Road Mourquong	Mining (Other than Coal)		
Mawson E.B. & Sons Pty Ltd	Cnr Silver City Highway & Corbett Avenue Buronga	Concrete Batching	S 58 Licence variation pending 27/7/07.	
Simeon Wines Limited	1031 Silver City Highway Buronga	Wine or Spirit Processing		Exceed conductivity quality limit. (No. of incidents = 1). Monitoring Point 6 - there were at times peaks of high and low pH flows recorded. (No. of incidents = 1). Monitoring Point 7 - Waste acid volume monitoring was not recorded. (No. of incidents = 1). Report on monitoring results not submitted. (No. of incidents = 1).
Wentworth Shire Council	Kookaburra Drive Dareton	Sewage Treatment - small plants	S 58 Licence variation pending 7/8/07.	
Wentworth Shire Council	Alcheringa Drive Gol Gol	Sewage Treatment - small plants	S 58 Licence variation pending 7/8/07.	
Wentworth Shire Council	Pooncarie Road Wentworth	Sewage Treatment - small plants	S 58 Licence variation pending 7/8/07.	
Wentworth Shire Council	Lagoon Road Off Cadell Street Wentworth	Sewage Treatment - small plants	S 58 Licence variation pending 7/8/07.	
Western Murray Irrigation Ltd	- Dareton 4659	Irrigated Agriculture		

(Source: DECC 2007a)

4.3 WATER

It is a generally accepted common goal that water should support healthy communities of plants and animals, as well as meeting the direct requirements of humans in production of harvested plants and animals, in recreational activities such as swimming, fishing, and in the provision of aesthetic surroundings.

Within the region, various types of water resources are to be found including major rivers within the Murray-Darling Basin such as the Murray, Murrumbidgee and Darling, man-made lakes and reservoirs of a wide range of sizes, groundwater systems, and areas which cross between land and water, the wetlands.

In fresh water systems humans are now realising the significance of biological flow as a constraint to amount of water that can be withdrawn from river systems for irrigation or for industrial or community purposes. Given that it is estimated that 81% of the available divertible waters of the Murray-Darling Basin are already utilised for human purposes, it is anticipated that water management factors will be a particularly significant component of natural resources management and sustainable development.

There is often a perception of the quality of water and the ecosystem that does not accord with the natural variability of these systems. Recreational amenity of lakes and streams is measured in terms of their water clarity, freedom from visible turbidity and scums, and visible evidence of aquatic life. Similarly, the quality of a water supply is judged in terms of its reliability and aesthetics.

However, for Australian inland streams, the stream flow and associated water quality naturally vary. Conditions may swing from low flows to floods. Native organisms have not only adapted to this variability, they may even require it.

Until recently, there has been a European-based approach to managing water resources in a manner consistent with maintaining urban amenity and agricultural productivity. The substantial exploitation of available water supplies has meant the end of the old approach of simply building more dams to sustain the water supply. In its place, a demand management and risk-based management approach is now emerging.

There has also been an attitude of preservation that fails to recognise natural change. For example, some wetlands are lakes in transition to terrestrial plains; or, occasionally, fauna may be severely stressed by natural events - but this may be helpful in an evolutionary sense. In the same vein, the occasional incidence of algal blooms is a natural phenomenon. Of course, changes in land use and waste discharges have resulted in a substantial increase in both the severity and frequency of algal blooms, and could affect the dominant algal species when blooms do occur.

Rainfall

The Department of Primary Industries (DPI) in NSW releases a new drought map each month. The drought maps are prepared from information provided by the 48 Rural Lands Protection Boards (RLPB) around the state, rainfall details from the Bureau of Meteorology (BoM) and reports from DPI regional staff.

Drought classification of an area takes into account the following factors:

- a review of historic rainfall records for the area
- pasture availability
- climatic events such as frosts
- seasonal factors such as pasture growing seasons.

NSW Government assistance measures require that a RLPB district be in the drought-affected category for six (6) months before landholders are eligible for financial assistance.

The monthly drought status for each of the RLPB districts in the MROC region (see map opposite) for the reporting period is shown in Figure 8. Generally, seasonal conditions are more favourable in the eastern part of the region than the west. However, for the last reporting period the whole of the region was classed as being 'in drought' – while it was only 'in drought' for about half of the previous year.

Figure 8: Seasonal conditions 2006/07

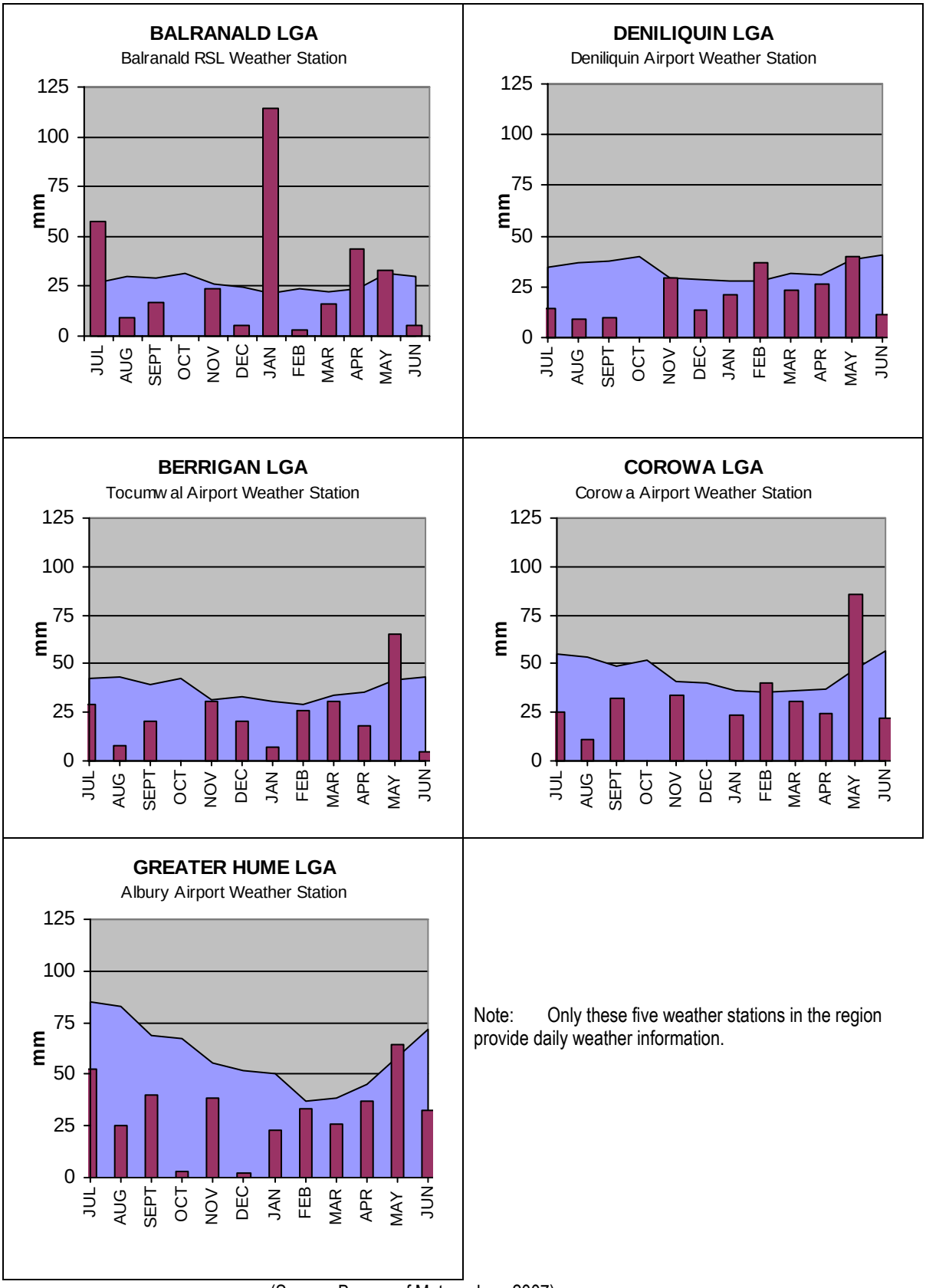
RLPB DISTRICT	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Wentworth												
Balranald												
Riverina												
Murray												
Hume												

RED = In drought ORANGE = Marginal GREEN = Satisfactory

(Source: Department of Primary Industries 2007)

Figure 9 shows most areas across the region experienced average or above rainfall in May and July of 2007 but lower than average for the remainder of the reporting period. This is consistent with the drought status chart at Figure 8. In particular, all regions experienced very dry springs.

Figure 9: Monthly rainfall 2006/07 against the historical average



Note: Only these five weather stations in the region provide daily weather information.

(Source: Bureau of Meteorology 2007)

Water use

Water is taken from streams and groundwater for a large number of purposes such as domestic use, agricultural use and industrial uses.

The amount of water used is of concern to SoE reporting because the impact on stream flow can be significant, placing pressure of aquatic ecosystems and limiting the amount of water available for downstream users. The need to ensure adequate flow for aquatic ecosystems is the reason that environmental flow regulations have been enacted in most jurisdictions.

Total water consumption tends to increase as human population increases. This can require the construction of extra water supply reservoirs to meet the increased demand for water, thus placing further pressure on the natural environment. Where this is not possible, it is necessary to investigate alternative sources of water, reduce per capita consumption of water, or to introduce water restrictions, typically the case in the summer months in some areas.

The following table displays data from the 10 LGA's in the region indicating their approach to the points raised in the previous paragraph.

Table 10: Water consumption & charges

LGA	Water Restrictions Imposed	Excess Water Charges and Calculations	Average Annual Household Water Consumption	Increase In Water Supply
Balranald	Yes Council complied with restrictions placed on the Murray and its tributaries of the greater area.	22 cents/kl for unfiltered water in excess of 200kl and 60 cents/kl for filtered water	900kl	No
Berrigan	No Stage 4 Water Restrictions introduced from 1st July 2007	No allowance – full user pays system introduced 30/06/2006. Barooga, Berrigan and Finley - Filtered water $0.90/kl Raw water $0.45/kl Tocumwal $0.60/kl	472kl filtered potable =150kl unfiltered garden = 322kl	Yes Finley Tower + 5.4ML Tocumwal Tower + 4ML Berrigan Earth Tank = 48ML
Conargo	No	$30/100kl after allocation of 700kl in Conargo and 1000kl in Wanganella.	Wanganella 528kl Conargo 419kl	No
Corowa	Yes	No allowance - $0.55/kl		No
Deniliquin	Yes Stage 1 from 12/3/2007 til 15/7/2007	No	444kl	No

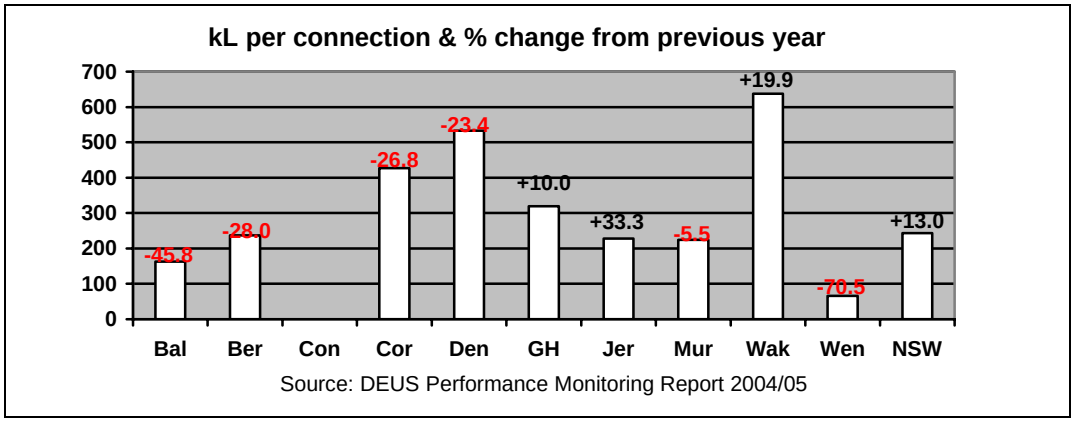
LGA	Water Restrictions Imposed	Excess Water Charges and Calculations	Average Annual Household Water Consumption	Increase In Water Supply
Greater Hume	Yes Stage 2 from July 2006 to June 2007. Stage 4 from July 2007 to October 2007. Stage 3A from November 2007.	Culcairn < 200kl = 60c/kl > 200kl = 80c/kl Villages < 200kl = $1/kl > 200kl = $1.30/kl		No
Jerilderie	Yes Stage 1 & Stage 2 restrictions Stage 1– limiting outside watering to 6hrs per day Stage 2 limiting outside watering to 4hrs per day	No allowance –user pays system introduced. Filtered water 0-250kl = $1.00/kl > 250kl = $1.50/kl Non-residential = $1.00/kl Raw water = $0.45/kl	200kl	No
Murray	Yes Council operated an odds and even system of water restrictions during the 2006/07 year. Watering was restricted between 10am and 5pm		350kl	No
Wakool	Yes Stage 1 through to 3A water restrictions.	Water allowance per household of 600kl on user pays system. Potable water = 75c/kl for the first 600kl & then $1.20/kl Raw water is not metered, so unlimited use applies indoors and restrictions apply for outdoor watering depending on what stage Council applies (currently on Stage 3A Water Restrictions).	-	No

LGA	Water Restrictions Imposed	Excess Water Charges and Calculations	Average Annual Household Water Consumption	Increase In Water Supply
Wentworth	No	$2.60/kl over 250kl of filtered water (<250kl at $1.10/kl) $0.60/kl over 700kl raw water (<700kl at $0.35/kl)	172kl filtered water 525kl raw water	No

(Information sourced from relevant Councils)

Figure 10 displays the potable water consumption by LGA for the region for the year 2004/05. Six LGA's achieved a reduction in 2004/05 consumption over the previous year (2003/04) while Jerilderie made the biggest gain. Wakool now had the highest rate of consumption in the region after a significant increase in usage and an equally significant reduction in Deniliquin. Wentworth had a huge reduction of 70.5%. Most LGA's are comparable to the average consumption rate achieved by NSW as a whole although Corowa, Deniliquin and Wakool are all considerably higher and Wentworth is significantly lower.

Figure 10: Potable water consumption 2004/05



Source: DEUS Performance Monitoring Report 2004/05

Potable water quality

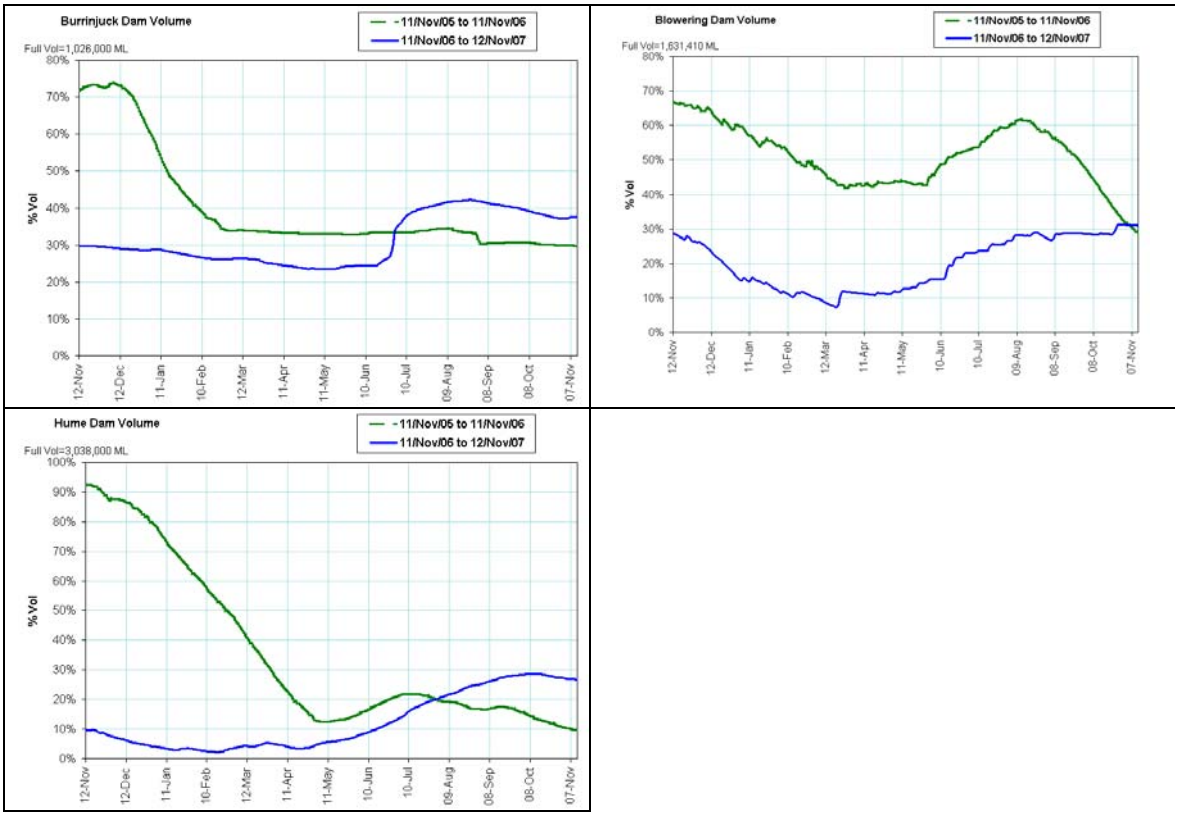
According to the latest DEUS Performance Monitoring Report (2004/05), most Councils achieved a 100% success rate for all potable water samples tested for physical and chemical water quality standards. Wakool achieved the physical chemical standard on about 90% of their samples. *E.coli* contamination is the primary health-related indicator for water and all Councils achieved 100% in this regard during 2004/05 with the exception of Jerilderie and Deniliquin which achieved about 90%.

These results are similar to those achieved in the previous year.

Water storage

The three major water storages servicing the irrigation areas of the Murray region are Hume, Burrinjuck and Blowering (see map opposite). Figure 11 shows that all three storages commenced the year with significantly lower levels than the year before but by the end of the reporting period (November 2007) the storage levels in Burrinjuck and Hume were slightly above than the corresponding period the year before.

Figure 11: Levels of water storages servicing the region 2005/06



(Source: Waterinfo 2005)

River quality

Algae are the simplest form of plant life. A count of all the algae present (as measured by chlorophyll-a levels) is used to indicate the productivity of aquatic systems. In conditions of warm, poorly mixed, nutrient rich waters, algal counts may grow to extremely high densities. The table below details the number of reported algae outbreaks for each LGA. The amounts of algae and blue-green algae are of interest to SoE reporting because these reflect the impact of human activity and other environmental factors on the aquatic environment, and also the suitability of water for

continued use by humans and other species. Blue-green outbreaks during the 2006/07 are illustrated in Table 11.

Table 11: Outbreaks of blue-green algae during 2006/07

LGA	Were there blue-green algae outbreaks	How many outbreaks	Duration of outbreak
Balranald	Yes	1	-
Berrigan	Yes	1	8 weeks
Conargo	No	-	-
Corowa	Yes	3	12 weeks
Deniliquin	No	-	-
Greater Hume	No	-	-
Jerilderie	Yes	1	8 weeks
Murray	Yes	1	8 weeks
Wakool	Yes	numerous	several weeks
Wentworth	Yes	1	6 months

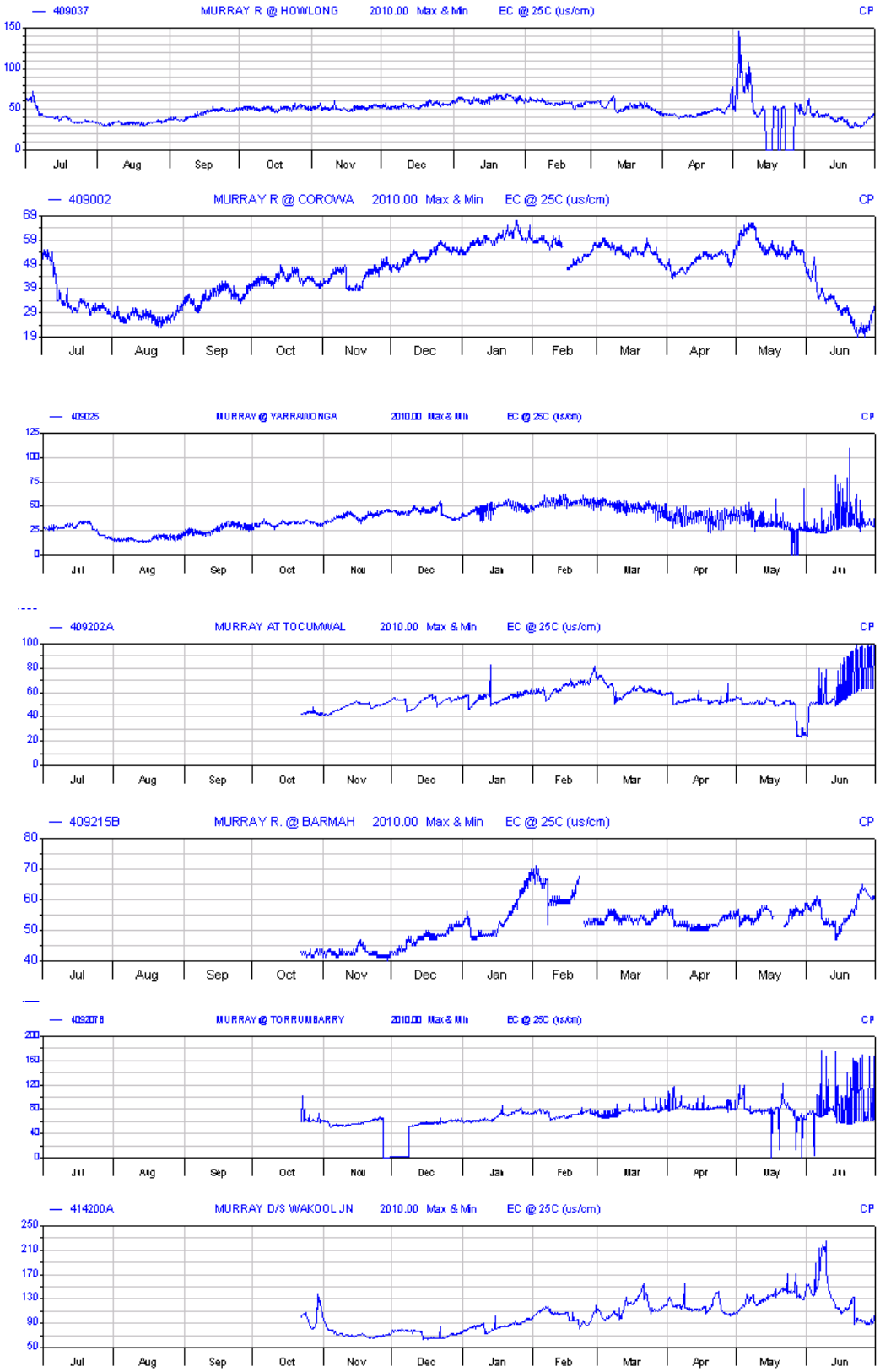
(Information sourced from relevant Councils)

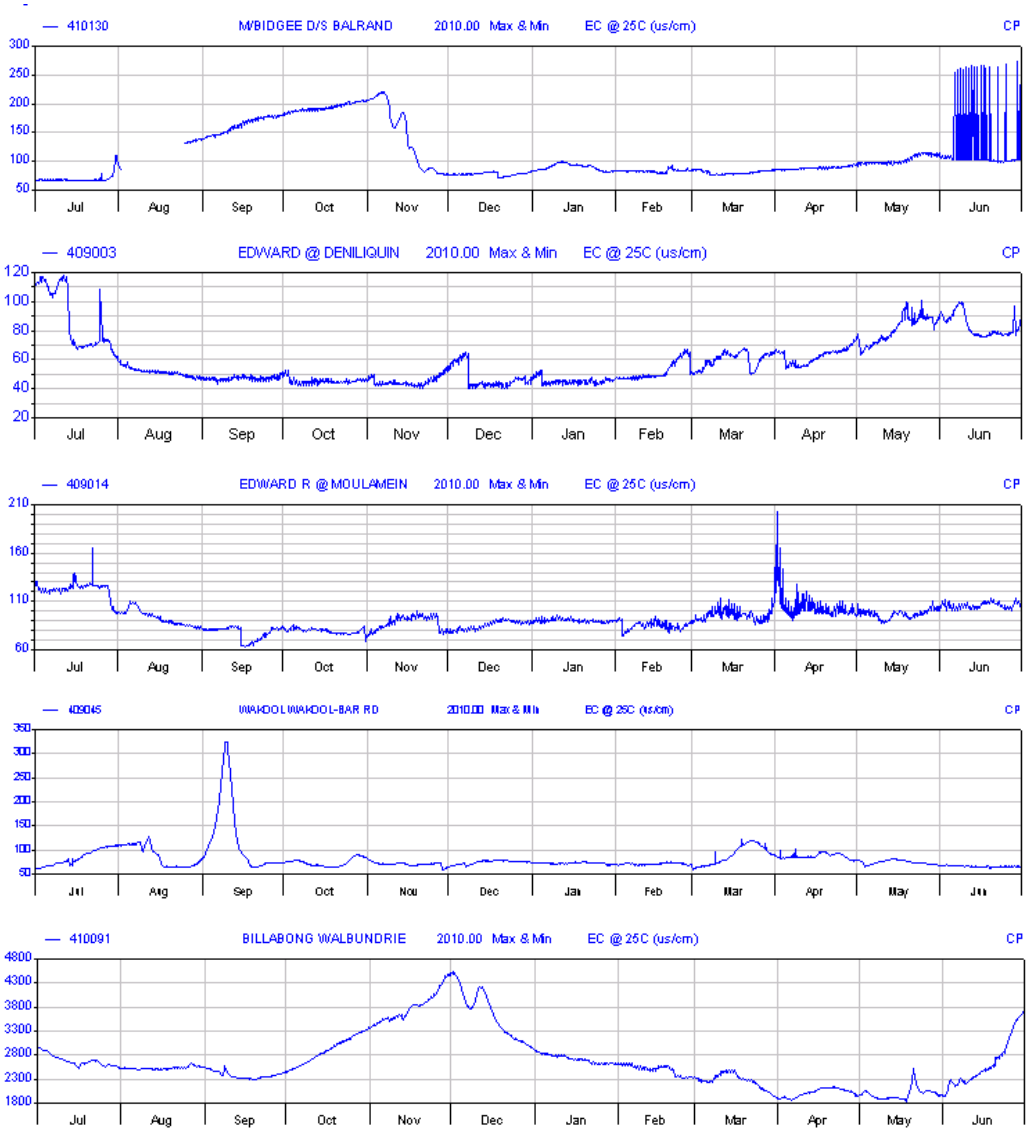
Salinity levels within rivers are an indicator of water quality and therefore river health. Salinity levels can be ascertained by measuring the electrical conductivity of water. A measure of the ability of water to conduct an electric current between electrodes relates to the nature and amount of salts present in the water and increases with concentration. The measurement is usually expressed in microsiemens per centimetre (µS/cm).

Figure 12 shows the results of monitoring electrical conductivity at various locations within the region's rivers for 2005/06. Some observations of the results include:

- Salinity levels generally increase with distance downstream in the catchment. This can be demonstrated in the Murray River by comparing measurements of EC levels at Howlong followed by Corowa, Yarrawonga, Tocumwal, Barmah, Torrumbarry and Wakool Junction.
- The tributaries of the Murray generally have higher salinity levels.
- The Billabong Creek has salinity levels many times higher than other rivers in the region. The EC reading at Walbundrie almost doubles from September to December, peaking at nearly 4500.
- There is no real pattern across the region as to the peaks and troughs of EC levels throughout the year.

Figure 12: Salinity levels in the regions rivers





(Source: Waterinfo 2005)

Stormwater discharge

Only Berrigan Shire advised of any changes to stormwater discharges stating that two new reservoirs were constructed at Tocumwal to collect and store stormwater for recycling and reuse at golf course. No new point discharges to waterways.

Wetlands

There is no new information relating to wetlands.

Groundwater quality

Figure 2 and 3 shows the levels of groundwater salinity within the Murray Irrigation that extends from Moulamein to Berrigan. The results are sourced from MIL's monitoring program. The maps shows that salinity levels in groundwater are higher around the Moulamein and Wakool area and lower in the east around Finley and Berrigan.

Only Wentworth LGA advised of a permit for new ground water bore in 2006/07.

4.4 BIODIVERSITY

There are two quite different fundamental needs that have to be met before it can be ensured that biodiversity is being conserved both for its intrinsic value and for its benefits to humans (including aesthetic and cultural benefits as well as material benefits such as improved agricultural productivity).

The first is philosophical. There must be a concept of stewardship, such that, as humans, we accept a fundamental responsibility to protect biodiversity, and to leave it to the next generation in at least as healthy a condition as it was left to us. An associated requirement is to apply the 'precautionary principle' - that it is better to err on the side of caution than otherwise, as a species or community once gone can never be recovered.

The second requirement is more pragmatic and is a need to know exactly what constitutes the current biodiversity situation, so that changes can be recognised, and corrections made as necessary. This is obviously easier said than done, but at the very least the existence and status of species and communities of concern in region need to be known. Initially such species and communities will be those specified in 'threatened species' legislation, but the process of such listing is very much ongoing, and a concerned management authority must also take account of other species and communities of local concern.

Native flora & fauna

Changes in patterns of the number of species of living organisms and their relative abundance in a given area can occur naturally – either seasonally or after significant events such as fire or storms. However, a significant loss of native species from an area is generally a clear indicator of major ecosystem disturbance such as habitat loss or predation/competition from introduced species.

It can be difficult to identify all species in an area, and even more difficult to monitor their populations. A significant decline in the abundance and condition of a particular species can be indicative of general trends for native species in the area in general.

No Councils within the study area reported any changes to biodiversity in their region during 2006/07.

NSW Environmental Trust Grants 2006

There were no Environmental Trust Grants given in the Murray region in 2006.

New listings under the Threatened Species Conservation Act 2006/07

The following final and preliminary listings apply to species known to habitat parts of the Murray region.

Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes bioregions - proposed endangered ecological community

The NSW Scientific Committee, established by the Threatened Species Conservation Act, has made a Preliminary Determination to support a proposal to list Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and NSW South Western Slopes bioregions as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule

1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- That the endangered ecological community is located within the Riverina, Murray-Darling Depression and NSW South Western Slopes bioregions.
- Sandhill Pine Woodland has been recorded in the far south-western portion of the NSW South Western Slopes bioregion near Urana, extending through the Riverina bioregion, from Urana – Narranderra district in the east, into the southern part of the Murray-Darling Depression bioregion, as far west as the South Australian border. It is currently known from the Balranald, Berrigan, Carrathool, Central Darling, Conargo, Corowa, Deniliquin, Hay, Murray, Narranderra, Urana, Wakool and Wentworth Local Government Areas, but may occur elsewhere in the Riverina, Murray-Darling Depression and NSW South Western Slopes bioregions.
- Throughout its distribution, the community occurs in relatively small patches, typically on red-brown sandy loams. In the Riverina and NSW South Western Slopes bioregions, these soils are associated with the beds of prior streams or source-bordering dunes adjacent to streams and lake beds, which are restricted and distinctive landforms on the extensive riverine plain. Further west, in the Murray-Darling Depression Bioregion, the community occurs on lunettes associated with dry lake beds, and as patches within a mosaic of vegetation types on extensive sandplains.
- The dominant community species is *Callitris glaucophylla*, that typically occupies red-brown loamy sands with alkaline sub-soils and the alluvial plaing of the Murray River and its tributaries, and on parts of the sand plain in south-western NSW.
- In the Riverina bioregion and far south-western portion of the NSW South Western Slopes bioregion, the community is typically associated with prior streams and aeolian source-bordering dunes, which are scattered within an extensive alluvial clay plain dominated by chenopod shrublands.
- In the Murray-Darling Depression bioregion, the community occurs as scattered patches on sandhills and lunettes within an extensive aeolian sandplain dominated by woodlands of mallee eucalypts or belah. Sandhill Pine Woodland typically comprises of an open tree canopy with a sometimes sparse, but highly variable ground layer dominated by grasses and herbs, sometimes with scattered shrubs and/or small trees. The structure and species composition of the community varies depending on disturbance history and temporal variability in rainfall.
- Sandhill Pine Woodland has undergone a large reduction in its geographic distribution as a consequence of clearing for cropping and pasture improvement (Grant 1989, Smith and Smith 1990, Scott 1992, Porteners 1993, Benson *et al.* 2006 cited in DECC 2007b). This has occurred within a time span appropriate to the life cycle of the dominant species of the community, with much of the clearing taking place between 1880 and 1910 (Grant 1989 cited in DECC 2007b). Some clearing for cereals and irrigated agriculture has occurred later in the twentieth century. A recent synthesis of available map data indicates that the disruption of

this community has been reduced by 40 - 75 % (Mackenzie and Keith 2007a cited in DECC 2007b). Fragmentation of the remaining stands is likely to have resulted in a large reduction in the ecological function of the community due to the small population sizes of many constituent species, enhanced risks from environmental stochasticity, disruption to pollination and dispersal of fruits or seeds, and likely reductions in the genetic diversity of isolated populations (Young *et al.* 1996, Young & Clarke 2000). The geographic distribution of the community continues to decline as a consequence of small-scale clearing (Sluiter *et al.* 1997 cited in DECC 2007b).

Allocasuarina luehmannii Woodland in the Riverina and Murray-Darling Depression bioregions - proposed endangered ecological community

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Preliminary Determination to support a proposal to list *Allocasuarina luehmannii* Woodland in the Riverina and Murray-Darling Depression bioregions as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- *Allocasuarina luehmannii* Woodland has undergone a large reduction in its geographic distribution as a consequence of clearing for cropping and pasture improvement (Smith and Smith 1990, Sluiter *et al.* 1997, Benson *et al.* 2006 cited in DECC 2007). This has largely occurred within the past 170 years, a time span appropriate to the life cycle of the dominant species of the community. In many cases, remnants are confined to roadsides or other small fragments (Sluiter *et al.* 1997), while some stands of the community have been reduced to a few isolated trees (Scott 1992 cited in DECC 2007). Fragmentation of the remaining stands is likely to have resulted in a large reduction in the ecological function of the community due to the small population sizes of many constituent species, enhanced risks from environmental stochasticity, disruption to pollination and dispersal of fruits or seeds, and likely reductions in the genetic diversity of isolated populations (Young *et al.* 1996, Young & Clarke 2000 cited in DECC 2007). The geographic distribution of the community continues to decline as a consequence of small-scale clearing (Sluiter *et al.* 1997 cited in DECC 2007).
- Many of the remaining stands of *Allocasuarina luehmannii* Woodland are degraded by overgrazing, which has resulted in simplification of community structure, changes in species composition, invasion of weeds and soil erosion. Overgrazing by domestic livestock and feral herbivores, including rabbits and goats, has resulted in a scarcity of woody understorey plants and a lack of regeneration of palatable trees and shrubs. Consequently, senescent trees are not replaced with new individuals and there is a prolonged trend of stand degeneration. Overgrazing also reduces structural complexity, plant species diversity and habitat suitability for vertebrate fauna of the community. The sandy-textured soils of *Allocasuarina luehmannii* Woodland are sensitive to erosion as a result of trampling by hooved animals and burrowing by rabbits. These impacts are exacerbated under drought conditions. Collectively, these processes have

resulted in a large reduction in the ecological function of the community (Sluiter *et al.* 1997, Benson *et al*. 2006 cited in DECC 2007b).

- *Allocasuarina luehmannii* Woodland in the Riverina and Murray-Darling Depression bioregions is the name given to the ecological community dominated by Buloke (*Allocasuarina luehmannii*), sometimes with co-occurring tree species, that typically occupies patches of red-brown loamy sands with alkaline sub-soils on the alluvial plain of the Murray River and its tributaries in south-western NSW. *Allocasuarina luehmannii* Woodland is characterised by the assemblage of species listed in paragraph 2 and typically comprises an open tree canopy with a sparse and highly variable ground layer dominated by grasses and herbs, sometimes with scattered shrubs and/or small trees. The structure and species composition of the community varies depending on disturbance history and temporal variability in rainfall.
- *Allocasuarina luehmannii* Woodland has been recorded in the southern part of Riverina bioregion from near Urana and Mulwala in the east to the Barham district, and may extend as far west as Euston in the southern part of the Murray-Darling Depression bioregion. The community occurs in small patches within this range and is currently estimated to cover less than 500-1500 ha (Benson *et al.* 2006 cited in DECC 2007b). It is currently known from the Balranald, Berrigan, Conargo, Corowa, Deniliquin, Murray and Wakool Local Government Areas, but may occur elsewhere in the Riverina and Murray-Darling Depression bioregions.

Pterostylis despectans - proposed critically endangered species listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Preliminary Determination to support a proposal to list the terrestrial orchid *Pterostylis despectans* (Nicholls) M.A.Clem. & D.L.Jones as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1A of the Act. Listing of critically endangered species is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- In New South Wales the species is known only from a single population discovered in 2005 near Moama, in the Riverina Bioregion (Thackway & Cresswell 1995 cited in DECC 2007b). The site is within the Murray Local Government Area. Several surveys of Riverina grassland and regional Travelling Stock Reserves, including McDougall *et al*. (1993 cited in DECC 2007b), Benson *et al.* (1997 cited in DECC 2007b), Webster (1999 cited in DECC 2007b), and McNellie *et al*. (2005 cited in DECC 2007b), did not record *P. despectans* and it seems likely that the species is extremely rare in New South Wales.
- Grazing, fire and other management regimes for conservation of *P. despectans* have not been determined. The species may be particularly endangered by current or changed future management of stock access and grazing, especially if a stock-watering point were to be added to the site. Some grazing may be beneficial for the native vegetation of the site and total stock exclusion may be detrimental, in part because of annual exotic grasses and *Romulea* spp. which are encroaching from a road drain and an easement on the site (K. McDougall *in litt*. Cited in DECC 2007b). McDougall (pers. comm. 2007 cited in DECC 2007b) states that as of September 2005 the *Romulea* was strongly associated with areas

of disturbed soil in, or adjacent to, the drain and the easement, and suggests that while cockatoo digging of *Romulea* bulbs may be contributing to the spread of that weed by soil disturbance, a higher risk of a major spread of *Romulea* (and other weeds) lies in a coincidence of a rain event with a major visitation by cattle, leading to intensive soil disturbance and subsequent weed spread.

Prasophyllum sp. 'Moama' - proposed endangered species listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Preliminary Determination to support a proposal to list the terrestrial orchid *Prasophyllum sp. 'Moama' (D.L. Jones 19276)* as an ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of endangered species is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- *Prasophyllum sp. 'Moama' (D.L. Jones 19276)* is known in NSW only from one locality, discovered in 2005, near Moama. The site is in the Murray Local Government Area, and the Riverina Bioregion of Thackway and Cresswell (1995). Several previous surveys of Riverina grassland and regional Travelling Stock Reserves in New South Wales (including McDougall *et al*. 1993, Benson *et al*. 1997, Webster 1999, and McNellie *et al.* 2005) did not detect this species. The species is not endemic to New South Wales, occurring also in Victoria in small to moderate-sized populations within a radius of about 50 km from Echuca (Rouse 2002).
- Natural grassland communities in the Riverina area of NSW and Victoria have undergone significant declines since the advent of European settlement and stock-grazing. McDougall *et al*. (1993) report high levels of decline of this general vegetation type. However, past decline of the specific habitat in which this *Prasophyllum* occurs in New South Wales cannot be confidently inferred as yet. It has been suggested (Benson *et al*. 1997:13, apropos a region to the north of the Moama site) that post-settlement declines of natural grassland communities may have been less severe on the NSW side of the border. Nevertheless, the assignment of the Moama grass/forb community to a distinct vegetation type (McDougall *et al*. 1993, DIPNR 2004, McNellie *et al*. 2005), that is rare and restricted in NSW, but shared with at least one occurrence of the same *Prasophyllum* species in Victoria (Terrick Terrick – K. McDougall pers. comm. May 2007), suggests that the Moama occurrence may be best regarded as a naturally isolated occurrence within NSW. This interpretation may be supported by the co-occurrence of *Prasophyllum sp. 'Moama' (D.L. Jones 19276)* and another rare orchid, *Pterostylis despectans*, at both the Moama site and at Terrick Terrick (Vic.), in both cases within habitat assignable to 'Community R1.1' of McDougall *et al*. (1993).

Crinia sloanei - proposed vulnerable species listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Preliminary Determination to support a proposal to list Sloane's Froglet *Crinia sloanei* Littlejohn 1958 as a VULNERABLE SPECIES in Part 1 of Schedule 2 of the Act. Listing of vulnerable species is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- *C. sloanei* has been recorded from widely scattered sites in the floodplains of the Murray-Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales (see Thackway and Cresswell 1995). It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.
- The specific threats to *C. sloanei* are not well understood. Chytridiomycosis, an infectious disease caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis*, has not been recorded in *C. sloanei* or any other *Crinia* species in eastern Australia, but is known to infect four other *Crinia* species from the same phylogenetic group as *C. sloanei* in Western Australia (Read *et al.* 2001, DEH 2006). Other threats include degradation of habitat quality through clearing and changes in flooding regimes, predation and climate change.

Eucalyptus leucoxylon subsp. pruinosa - vulnerable species listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list *Eucalyptus leucoxylon* F. Muell. subsp. *pruinosa* (F. Muell. Ex. Miq.) Boland, Yellow Gum as a VULNERABLE SPECIES in Part 1 of Schedule 2 of the Act. Listing of vulnerable species is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- *Eucalyptus leucoxylon* subsp. *pruinosa* is a tree species which, in New South Wales, occurs at the bases of sandy rises and on loamy clay flats on the floodplains of the Murray River and its tributaries in the Riverina Bioregion (Thackway and Creswell 1995).
- In New South Wales, *Eucalyptus leucoxylon* subsp. *pruinosa* is currently known from several localities along the Murray River valley, including a concentration of six stands to the west of Moulamein, and small scattered occurrences between Barham and Euston. A disjunct occurrence of the species reported from near Boorowa on the central western slopes has been investigated and refuted. The number of records of *Eucalyptus leucoxylon* subsp. *pruinosa* are relatively few for NSW, despite a number of systematic vegetation surveys being carried out across its range (Porteners 1993; Sluiter *et al*. 1997; Horner *et al*. 2002; McNellie *et al*. 2005).
- Most remaining stands of *E. leucoxylon* subsp. *pruinosa* stands are threatened by a lack of regeneration due to grazing and soil compaction. Other threats operating at some of the stands include canopy dieback, small-scale clearing and weed invasion (Benson *et al.* 2006). These threats contribute to a continuing decline of the species.

Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions - endangered ecological community listing

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act.

The Scientific Committee (DECC 2007b) has found that:

- Inland Grey Box Woodland may be found in the local government areas of Albury, Berrigan, Bland, Blayney, Boorowa, Cabonne, Carrathool, Conargo, Coolamon, Cootamundra, Corowa, Cowra, Deniliquin, Dubbo, Forbes, Gilgandra, Greater Hume, Griffith, Gundagai, Gunnedah, Gwyder, Inverell, Jerilderie, Junee, Lachlan, Leeton, Liverpool Plains, Lockhart, Mid-western Regional, Murray, Murrumbidgee, Narrabri, Narrandera, Narromine, Parkes, Temora, Upper Lachlan, Urana, Wagga Wagga, Wakool, Warrumbungle, Weddin, Wellington and Young. Inland Grey Box Woodland may occur elsewhere in the nominated bioregions. Bioregions are defined in Thackway and Creswell (1995).
- Grassy box woodlands of NSW were rapidly targeted for agriculture development and extensively cleared or degraded (Benson 1991) so that by 1948 few remnants existed and those were often degraded by grazing (Beadle 1948). Inland Grey Box Woodland has been greatly reduced in area, highly fragmented and greatly disturbed by clearing, cropping, grazing, introduction of exotic species and addition of fertiliser.

New Species Recovery Plans 2006/07

The following Species Recovery Plans which are applicable to this report, were approved during the reporting period.

- *Recovery Plan for the Large Forest Owls* adopted October 2006.

Vegetation clearing

Clearing vegetation is one of the major pressures on terrestrial ecosystems – both native ecosystems and agricultural lands. For this reason it is a key indicator in SoE reporting. In December 2005, the responsibility for the regulation of vegetation clearing in rural areas was transferred from local government to the Catchments Management Authorities. Councils still control vegetation in urban areas, mainly through the use of Tree Preservation Orders.

Councils participating in this SoE report advise as follows in regards to vegetation clearing activities (see Table 12).

Table 12: Vegetation clearing activities for each LGA

LGA	Tree Preservation Order	Applications for vegetation clearing	Approvals for vegetation clearing	Roadside Management Plan	Permit required for firewood collection
Balranald	Yes Tree removal in the urban area is dependent on assessment of hazard or nuisance practice, and to replace removed trees with more appropriate trees or shrubs. Tree removal in the rural area must comply with the Native Vegetation Act and adopted CMA practices. Replacement plantings to compensate for tree removal required.	3	3 approvals total area cleared was less than 5 hectares	No	No
Berrigan	No No tree preservation order in village or urban zone. Native Vegetation Act administered by MCMB for rural zones.	-	-	Yes Central Murray Roadside Vegetation Survey & Management Guidelines BSC Vegetation Management Plan Linear Reserves Project	Yes

LGA	Tree Preservation Order	Applications for vegetation clearing	Approvals for vegetation clearing	Roadside Management Plan	Permit required for firewood collection
Conargo	Yes – Shire has DCP for the protection of trees within the lands known as Sandhill country being the sand dune formations indicated on the LEP maps. Replacement trees for tree removal required.	Nil	Nil	Yes – Conargo Shire Council Roadside Vegetation Management Plan	No
Corowa	Yes Replacement trees for tree removal required in rural areas only.	Nil	Clearing now controlled through Murray Catchment Management Authority	Yes	Yes
Deniliquin	Yes – only rural land within riparian corridor and on Council land i.e. street trees, nil rural land clearing approved by Council and nil street trees removed. Replacement trees for tree removal required.	Nil	Nil	Yes- Plan in conjunction and funded by the MCA.	No

LGA	Tree Preservation Order	Applications for vegetation clearing	Approvals for vegetation clearing	Roadside Management Plan	Permit required for firewood collection
Greater Hume	No	Nil	Nil	Yes – Council has three road side vegetation management plans for roads considered to have significant vegetation. Agreements for management of these roadsides are in place in conjunction within the Murray CMA.	Yes
Jerilderie	Yes – Only in a limited area, not required in the village zone area. Replacement plantings for tree removal required.	Nil	Nil	Yes	Yes
Murray	No Replacement plantings for tree removal required.	Nil	Nil Permits issued by DWE or CMA	Yes – The Murray Shire Vegetation Management Plan 2000	No
Wakool	Approval required for tree removal in sand hill areas	Nil	Nil	A roadside vegetation Management Plan was developed in 2000.	Nil
Wentworth	Yes - 1 DA received to remove a total of five willow trees. Replacement plantings for tree removal not required.	18	3 54 hectares	No	No

(Information sourced from relevant Councils)

Weeds

Noxious weed control on roads and reserves is an important component of most Council's weed management plans. Under the arrangements, Councils and RLPB's can apply for Operational Grants to assist in the treatment of specific weeds on roads and other land. Priority is given to implementing agreed State and regional weed management plans.

For 2007/08 the NSW Government has provided $100,000 to assist local control authorities in implementing new weed incursion control. Weed control coordination for 2007/08 (DPI 2007) are listed in Table 13.

Table 13: Weed control coordination for 2007/08

LGA	$
Balranald Shire Council	$0
Berrigan Shire Council	$0
Conargo Shire Council	$0
Corowa Shire Council	$43,000
Deniliquin Shire Council	$0
Greater Hume Shire Council	$67,000
Jerilderie Shire Council	$17,100
Murray Shire Council	$0
Wakool Shire Council	$51,000
Wentworth Shire Council	$0

(Source: DPI 2007)

During 2007/08 a total of $283,000 has been provided to the Eastern and Western Riverina for new and continuing group projects. These projects and budget allocations are listed in Table 14.

Table 14: New and continuing group projects budget allocations for 2007/08

Group	$
Eastern and Western Rare and Isolated St Johns Wort 2006-2011	61,000
Eastern and Western Riverina Alligator Weed Wah Wah Irrigation District 2006-2011	16,000
Eastern and Western Riverina Hardhead Thistles 2004-2009	2,000
Eastern and Western Riverina Silverleaf Nightshade 2004-2009	57,000
Eastern and Western Riverina Prairie Ground Cherry 2006-2011	13,000
Eastern and Western Riverina Serrated Tussock 2006-2011	5,000
Eastern and Western Riverina Chilean Needlegrass 2006-2011	7,000
Eastern and Western Riverina Coolatai Grass 2005-2010	19,000
Eastern and Western Riverina Lower Murray Darling Regional Weed Strategy 2005-2010	48,000
Eastern and Western Riverina Noxious Weeds Project Officer 2007-2010	35,000
Eastern and Western Riverina Black Willow in Murray and Murrumbidgee Catchments 2007-2012	20,000
Total	283,000

(Source: DPI 2007)

Council's commitment to weed control during the 2006/07 period is listed in Table 15.

Table 15: Council's commitment to weed control during 2006/07

LGA	Commitment to Weed Control	Means of Weed Control including biological weed control	Other Weed Control Activities
Balranald	Yes	Council operates 1 staff member on Shire weed eradication and farmer education, advice, policy and practice in accordance with the adopted Regional Weed Strategy	On farm weed inspections One Council staff member committed to weed control. Regular patrols of Shire roads
Berrigan	Yes	Undertaken by Central Murray County Council Council spraying of roadside verges to maintain visibility of guide posts.	
Conargo	Yes	Council engages Central Murray County Council. Regular patrols for noxious weed identification. Weed mapping	
Corowa	Yes	Noxious weed policy currently on draft subject to Council approval. Ongoing commitment to NSW DPI in relation to Weed Control co-ordination within its area.	Regular inspections and spraying programs by Council targeting noxious weeds along road reserves and Council land. Inspection carried out for noxious weeds along the Murray River floodplain between Corowa and Mulwala.
Deniliquin	Yes	Undertaken by Central Murray County Council	In some circumstances, undertaken by Council on a needs basis.
Greater Hume	Yes	Noxious Weeds Policy – November 2006 Class 4 Weeds Management Plan – November 2006 Commitment to Eastern Riverina Noxious Weeds advisory group Commitment to Riverina Noxious Weeds Management Plans	Routine mapping of weed infestations. Biological control of St Johns Wort, Patterson's Curse and Horehound. Routine weed spraying across the Shire including local roads and other Council controlled areas. Inspection of portion of the Murray River, Mountain Creek and associated areas.
Jerilderie	Yes	Noxious weed policy Agreement with CMA for riparian areas District Weed Control co-ordination - grants and plans Weed Mapping	Weed spraying programs of Spinny burrgrass, Bathurst Burr, African Boxthorn, Silverheat Nightshade, Khaki weed, Horehound & St Johns Wort. Weed mapping Monitoring of waterways including drainage channels.

LGA	Commitment to Weed Control	Means of Weed Control including biological weed control	Other Weed Control Activities
Murray	Yes	Undertaken by Central Murray County Council	Weed spraying program undertaken to control weeds on Council owned land.
Wakool	Yes	Class 4 Noxious Weeds Management Plan developed in 2006 to minimise the negative impact of Class 4 noxious weeds on the economy, community and environment of NSW. Application for weed control co-ordination assistance grant for 06/07 totalling $48,413 including private property inspections (on-ground and aerial), training, publicity and other co-ordination and planning. Biological weed control	Weed spray of roadside shoulders Weed mapping Waterway inspections Survey of Edwards River for Saggitaria Survey of Shire for Parthenium weed Participation in schools program "Weed Warriors"
Wentworth	Yes	Committed to Lower Murray Darling Weed strategy implementation Council inspection policy Council weed spraying policy	Established 2 biological control sites Spray program targets high priority weeds GPS Mapping data base

(Information sourced from relevant Councils)

Pest animals

Prior to 2005/06 locust plagues were not reported in the study region by Councils (see Table 16). Mouse plagues are not uncommon throughout the area but the incidences of these are affected, to a very great degree, by climatic conditions. The ongoing drought conditions have witnessed animals such as kangaroos coming closer to areas of human habitation in search of food. Feral animals including foxes and rabbits remain of most concern to the Councils (see Table 16).

Table 16: Council's commitment to locust and pest animal control during 2006/07

LGA	Incidence of Locust Outbreak 2006/07	Action taken	Further information concerning pests 2006/07
Balranald	0	-	-
Berrigan	0	-	Feral animals
Conargo	0	Council work in conjunction with Murray RLPB for control programmes within the Shire.	Feral animal pests including foxes and cats, rabbits and hares.
Corowa	0	-	-
Deniliquin	0	-	-

LGA	Incidence of Locust Outbreak 2006/07	Action taken	Further information concerning pests 2006/07
Greater Hume Shire	0	Council accepts responsibility for locust control when required.	Feral rabbits and foxes are of concern to the Shire and are targeted by the Council in conjunction with Hume RLPB.
Jerilderie	0	-	-
Murray	0	-	-
Wakool	0		Feral foxes and pigs
Wentworth	0	-	-

(Information sourced from relevant Councils)

Dogs & cats

It is critical for the environmental health of a regional area for effective control of dogs and cats as a means of curbing the rate of increase of feral animals. Wild dogs and cats are major predators of native fauna as well as posing significant problems for farming livestock. Effective control of dogs and cats ensures that missing companion animals can be reunited with their owners whilst Council revenue from pet registration fees can help mitigate some of the costs incurred by Council. Council's commitment to dog and cat control is listed in Table 17.

Table 17: Council's commitment to dog and cat control during 2006/07

LGA	Dogs Seized	Cats Seized	Further information
Balranald	25	0	One part time animal ranger operating in Balranald and Euston.
Berrigan	109	7	One full time Ranger/Local laws officer to enforce companion animals legislation
Conargo	6	0	Council acts on complaints in relation to dog control issues.
Corowa	-	-	Council indicated a commitment to dog and cat control during 06/07
Deniliquin	144	15	-
Greater Hume Shire	134	37	
Jerilderie	18	0	-
Murray	37	5	-
Wakool	28	43	Feral cats caught using traps and destroyed.
Wentworth	172	0	Introduction of a dog control officer for impounding of animals.

(Information sourced from relevant Councils)

Bushfire

Current fire regimes, including the incidence of bushfires, in relation to ecosystem requirements are of concern to SoE reporting because they indicate the pressure on native ecosystems of human activities in the environment. Bushfire incidences and changes to Councils bushfire prone land during the 2006/07 reporting period can be found in Table 18.

Table 18: Bushfire incidences and changes to bushfire prone land during 2006/07

LGA	Changes to Bushfire Prone Categories	Incidence of Bushfires	Bushfire Section 66 Notices
Balranald	No	0	-
Berrigan	No	68*	-
Conargo	No	2	-
Corowa	No	0	-
Deniliquin	No	0	-
Greater Hume Shire	No	-	-
Jerilderie	No	-	-
Murray	Yes	0	-
Wakool	No	44*	-
Wentworth	No	4	-

(Information sourced from relevant Councils) * incidents include bushfires and motor vehicle accidents

4.5 HUMAN SETTLEMENT

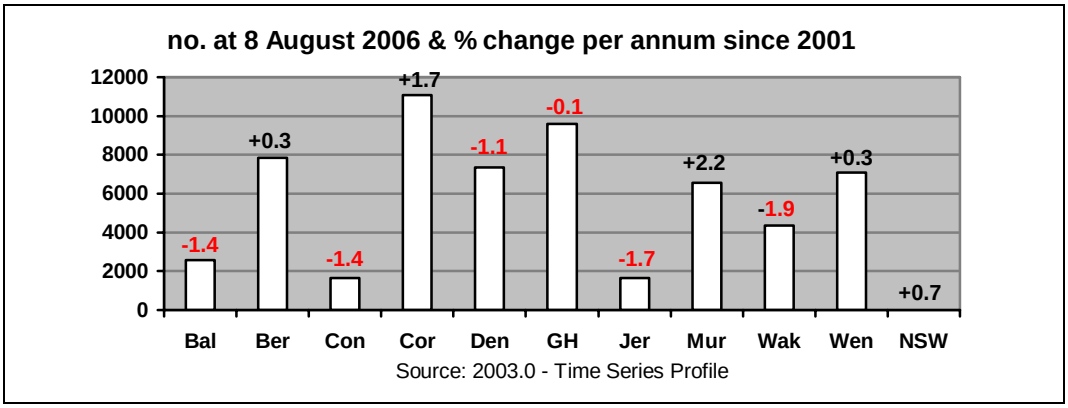
The composition of a population (i.e. its characteristics) underpins the changes of the pressure of the human population on the environment. There is a direct impact on the level of resources required to provide the range of services and infrastructure required to maintain a given quality of life in areas such as health, housing, education, employment, transport, resource use and management and construction. An understanding of this and of the dependency ratio in the population means that, as the composition characteristics of a population change, environmental, economic and social pressures can be minimised.

Demographics

Figures have recently been released for the last Census conducted on August 8th, 2006. However, time series figures are only available for the LGAs as 'enumerated population' – that is based on where people were located on Census Night.

Figure 13 shows the 'enumerated' population (location on Census night) for each LGA and provides a percentage change from the previous Census in 2001, given as a percentage per annum.

Figure 13: Enumerated Population at 2006 Census



The two fastest growing LGAs are Murray and Corowa Shires. Berrigan, Wentworth and Greater Hume all remained fairly steady. While four smallest LGA's in the region, Balranald, Conargo, Jerilderie and Wakool, as well as Deniliquin all declined by about 1-2% per annum since 2001.

Corowa has continued to increase and is the most populous LGA of those participating in this SoE.

The population of each LGA in relation to its area is given in Table 19. Clearly, Deniliquin has the greatest density with a large population and small area based around the township. Of the larger 'rural' LGAs, Berrigan and Corowa have the highest densities, while Balranald, Conargo, Wentworth and Jerilderie all have densities below 1 person / km^2.

Table 19: Population of each LGA at 2006 Census in relation to its area

LGA	Population	Area (sq km)	Density (persons/km^2)
Balranald	2,570	22,700	0.1
Berrigan	7,830	2,067	3.8
Conargo	1,655	8,751	0.2
Corowa	11,088	2,324	4.8
Deniliquin	7,348	130	56.5
Greater Hume	9,588	5,746	1.7
Jerilderie	1,640	3,375	0.5
Murray	6,554	4,345	1.5
Wakool	4,339	7,520	0.6
Wentworth	7,079	26,269	0.3

(ABS Census)

Socio-economic status

Table 20 details the unemployment rates and median incomes for each of the LGAs from Census statistics. Apart from Wentworth, all the LGAs were below the national unemployment average of 5.3 %. However all the LGA's median incomes are below the national weekly average of $466. Only Balranald LGA increased unemployment between to the two Census periods.

Table 20: Unemployment Rate at 2006 and 2001 Census and Median Income in 2006 for each LGA

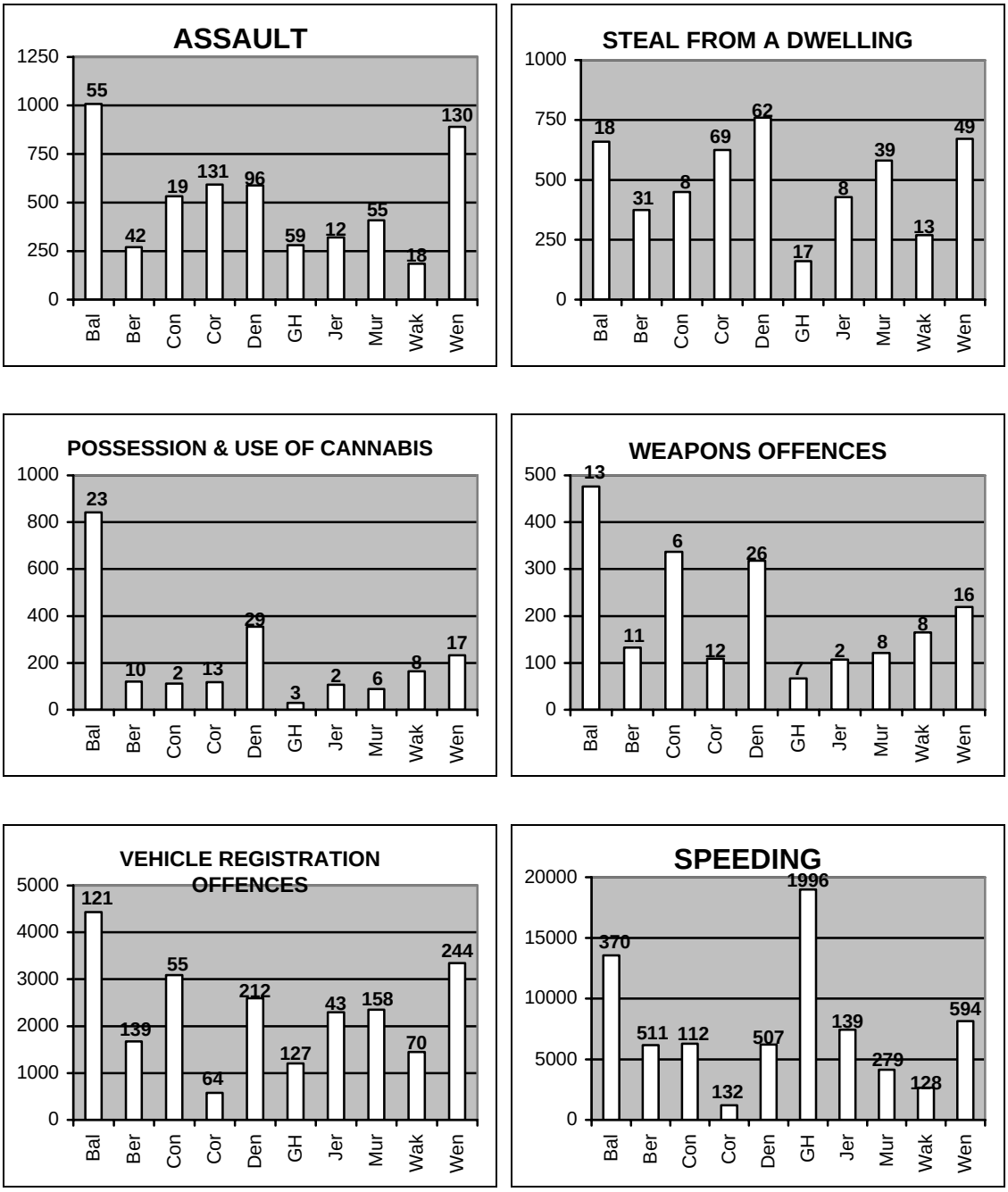
LGA	Unemployment 2006 (%)	Unemployment 2001 (%)	Median Income (2006) ($/week)
Balranald	4.7	3.8	396
Berrigan	4.2	4.3	387
Conargo	1.5	2.0	427
Corowa	4.8	-	389
Deniliquin	5.1	6.5	404
Greater Hume	3.7	-	410
Jerilderie	3.3	3.5	419
Murray	4.8	5.2	393
Wakool	3.5	4.1	372
Wentworth	5.3	5.3	385

(ABS Census)

A selection of crime statistics for participating LGA's produced by the NSW Bureau of Crime Statistics and Research is shown in Figure 14. Caution needs to be exercised in interpreting these statistics because of the low base from which they stem in many circumstances. Likewise direct comparisons on the number of incidents between LGA's should not be undertaken because of the differences in the size of respective populations. However, by expressing the number of incidents per 100,000 of the population allows for some comparison to be made.

Figure 14: Recorded crime statistics 2006

rate per 100,000 population & number of incidents



(Source: Bureau of Crime Statistics & Research, New South Wales)

Effluent treatment & disposal

Monitoring results for performance of sewerage treatment works are available for Berrigan, Corowa, Deniliquin, Greater Hume, Jerilderie and Wentworth. This monitoring is undertaken by the Department of Energy, Utilities and Sustainability

(DEUS). The most recent results are from 2005/06 and reveal that Berrigan and Corowa achieved less than 100% compliance with the 90 percentile requirement of the DEC licence for Biochemical Oxygen Demand (BOD), although Corowa did improve slightly from the previous year. The other Councils achieved the 100% compliance, which is an improvement for Deniliquin from the previous period.

For Suspended Solids (SS), Wentworth was the only Council to again achieve the DEC licence requirement (90 percentile). Corowa improved from previous years, while Deniliquin, Greater Hume and Berrigan decreased slightly. Jerilderie remained stable.

In relation to changes to sewerage treatment plants; Corowa advises that plans have been made for a new sewerage treatment plant at Mulwala with construction to commence in August 2008. Wakool Shire Council advised that they completed construction of Murray Downs new sewerage treatment plant ($121,000 final payment, of $.1.2 million). Berrigan also advised that approximately $30,000 was spent on 'screen extractors' at the Finley sewerage treatment works.

Balranald, Conargo, Deniliquin, Jerilderie and Wentworth did not change or invest money in alterations or development to sewerage treatment plants over the last reporting period.

Waste to landfill

The amount of urban waste generated and disposed of (either legally or illegally dumped) indicates the pressure of towns and the associated waste on the environment through potential contamination of soils and groundwater's and the physical area of land used for waste disposal. It is one indicator of the sustainability of towns. Management and Council control of waste landfill sites during this reporting period can be found in Table 21.

Table 21: Management and control of waste landfill sites during 2006/07

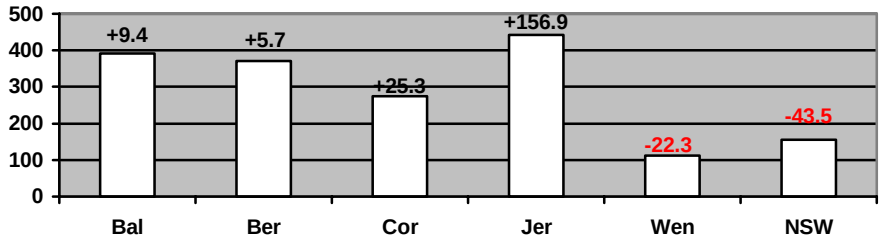
LGA	Waste to landfill	Change from last report	Location of landfill sites	Location of private or other landfill sites
Balranald	1,000 tonnes	-	Balranald and Euston	-
Berrigan	3756 tonnes (2188 – Berrigan) (1568 – Tocumwal)	↓	Berrigan	Tocumwal – rubble, green waste and recyclables only and Finley recycling centre
Conargo	Not recorded		Pretty Pine, Conargo, Blighty, Wanganella and Booroorban	-
Corowa	2,500 tonnes	↓	Corowa and Howlong.	Kerbside domestic waste disposed of at Albury City Council landfill.
Deniliquin	6682 tonnes	↓	North Deniliquin (5km NW of town)	-

LGA	Waste to landfill	Change from last report	Location of landfill sites	Location of private or other landfill sites
Greater Hume	2,000 tonnes to Council landfill	↓	Brocklesby, Culcairn, Henty, Holbrook, Mullengandra, Walla Walla and Woomargama.	Transfer stations at Burrumbuttock, Gerogery and Jindera
Jerilderie	720	↑	Jerilderie Town Landfill and Jerilderie Common Landfill	
Murray	6,000 tonnes	↑	10km north of Moama (50ha in size)	
Wakool	500 tonnes		Moulamein, Goodnight, Koraleigh and Wakool. Barham Transfer Station	Kerbside collection goes to private landfill; Patho Landfills Victoria (approx 950 tonnes of kerbside collection)
Wentworth	3,778 tonnes	↑	Pooncarie (31 tonnes), Ellerslie (21 tonnes), Pomona (446 tonnes), Buronga (3280 tonnes).	Wentworth and Dareton waste transfer stations

(Information sourced from relevant Councils)

The latest publication for the Department of Local Government Comparative Data was in January 2007 for 2004/05 data. Figure 15 compares domestic waste by LGA between 2003/04 and 2004/05. Figures were not available for a large number of Shires. Jerilderie had the largest increase of 156.9%, while Corowa, Berrigan and Balranald increased by smaller amounts. Wentworth was the only LGA to decrease their volume of waste. Wentworth is producing much less than the other Shire's volume of waste per capita. Balranald, Berrigan, Corowa and Jerilderie are all well above the state average of waste per capita.

Figure 15: Domestic waste 2004/05 kg per capita & % change from previous year



Source: Dept. of Local Government Comparative Date 2004/05

Materials recycling

Recycling is the process by which used products area sent to a factory where they are reprocessed to produce the same product or a different one. Examples include recycling glass from old bottles and jars to make new glass products, and the recycling

of paper into newspaper and other paper products. Another form of recycling relates to organic matter such as foodstuffs or garden wastes like leaves or grass clippings which, when composted, make useful soil additives.

The level of recycling is of concern to SoE reporting because it is a response towards minimising the amount of waste requiring disposal into landfill each year, and thus reducing the impact of human settlements on the natural environment. The existence of markets for recycled materials, and their rates of uptake, indicates the viability of recycling as a self-sustaining industry into the future. Management and control of Council's recycling program during 2006/07 can be found in Table 22.

Table 22: Waste recycling during 2006/07

LGA	Recycling Program	Volume Recycled	Change from last report	Nature of Program
Balranald	Yes	250 tonnes	↑	Waste deposited at Balranald and Euston landfill sorted into Metals, Green waste, Oils, Batteries, Timber and concrete rubble, Chemical containers (note rubber/tyres is 99% recycled by retailers)
Berrigan	Yes	789 tonnes	↓	Fortnightly kerbside collection by Cleanaway in a joint contract with Moira Shire (Victoria) from about 2,400 premises across four towns every fortnight.
Conargo	No	-		-
Corowa	Yes	977 tonnes	↑	Fortnightly kerbside collection of recycling provided to all residences in urban area
Deniliquin	Yes	11.6 tonnes	↓	Voluntary recycling at landfill for paper, steel, aluminium, cardboard, oil, batteries and glass.
Greater Hume	Yes	500 tonnes	↓	3,000 households and commercial premises provided with fortnightly kerbside collection of recyclables. Some recycling provided at all 10 waste facilities.
Jerilderie	No	-		-
Murray	Yes	5700 tonnes	↑	Services available in Moama, Mathoura, Cummerjunga and a rural service collecting from 2,600 homes.
Wakool	Yes	274 tonnes (47 tonnes via skips)	↓	All towns and villages (except Mallan and Goodnight) have kerbside pickup. Servicing about 1,100. Collection from recycling skips at landfills and Burraboi and Mallan. Most of the Shire's residents can access recycling facilities.

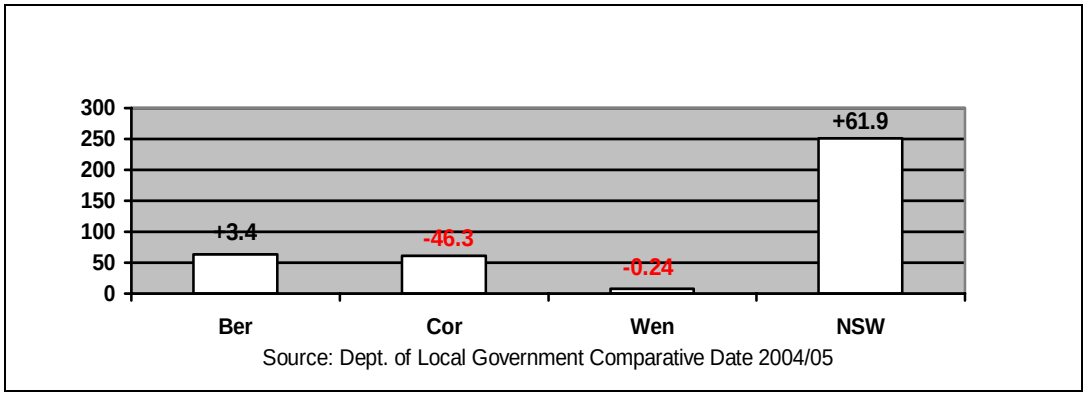
LGA	Recycling Program	Volume Recycled	Change from last report	Nature of Program
Wentworth	No	-		-

(Information sourced from relevant Councils)

Seven of the 10 Councils have in place some form of regular recycling program or activity. This is a positive and encouraging impact for the environment within these locales.

Only three LGAs have recycling information available in the Department of Local Government Comparative Data. This figure demonstrates how the region is well below the state average (see Figure 16).

Figure 16: Recyclables 2004/05 kg per capita & % change from previous year

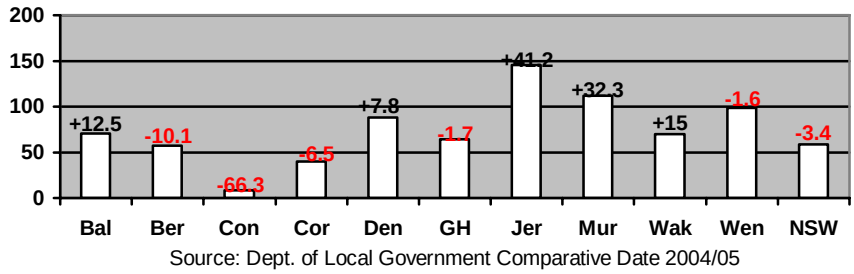


Source: Dept. of Local Government Comparative Date 2004/05

Recreation

Figure 17 compares the annual expenditure on recreation across the study region for the financial year 2004/05. It is interesting to note how closely the LGAs follow the state average but with only two of the LGAs are below the state average. Conargo fell further below the average with a 66% reduction. Jerilderie and Murray Shires had the biggest increases.

Figure 17: Recreation 2004/05 $ per capita & % change from previous year

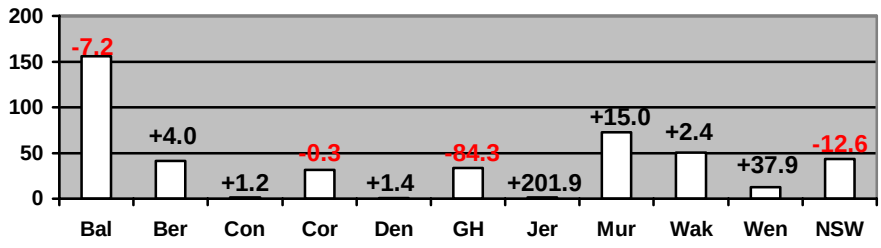


Source: Dept. of Local Government Comparative Date 2004/05

Community services

Figure 18 reveals the impost on LGA budgets to provide community services which are in particular demand in rural or isolated regions. As an average the state of NSW provided $44.00 per capita on community services throughout 2004/05 which was a reduction of 12.6%. Three LGAs within the study area exceeded the state average. These were Balranald, Murray and Wakool. Murray and Wakool are only marginally ahead of the state average however Balranald provided more than three times this figure with per capita expenditure in excess of $150.00 per capita. Greater Hume had the greatest reduction of 84%. Only three LGAs witnessed a reduction in spending on community services and this expenditure is anticipated to continue to increase with the increasing demands of an ageing Australian population.

Figure 18: Community services 2004/05 $ per capita & % change from previous year

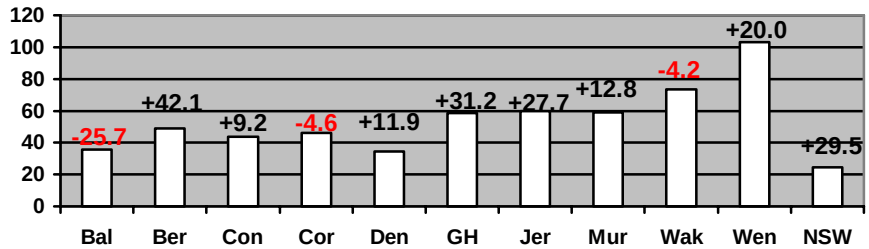


Source: Dept. of Local Government Comparative Date 2004/05

Environment & health

Figure 19 compares the expenditure on environmental management and health by LGA for 2004/05 with the financial year 2003/04. It is of note that each LGA spends significantly more on environmental management and health than the state average of about $25 per capita. Wentworth is the LGA with the highest expenditure within the region and had a increase in expenditure of 20.0%. It is of significant note that only three LGAs had a reduction.

Figure 19: Environmental management and health 2004/05 $ per capita & % change from previous year



Source: Dept. of Local Government Comparative Date 2004/05

Noise

Noise pollution can be defined as unwanted noise and does not need to be determined by decibel level alone. Noise can be an unpleasant nuisance and the degree to which this has an impact on the population is an indicator of the pressure on individual's quality of life in this SoE annual update.

In 2006/07 there was a number of noise complaints were made across the region. The information in the table below demonstrates that noise is generally not an environmental issue in the region and is restricted to a few isolated instances.

Table 23: Noise complaints during 2006/07

LGA	Maintenance of Complaint Register	Number of complaints received	Nature of complaint
Balranald	Yes	2	Noise from household dogs and other animals investigated
Berrigan	Yes	3	Motorbikes x2 Powertools
Conargo	No	0	
Corowa	Yes	4	-
Deniliquin	Yes	4	Motorcycle noise
Greater Hume	Yes	9	Truck parking x4 Water pump Powertools and idling cars Loud music x3
Jerilderie	No	-	
Murray	Yes	5	Dogs barking Powertools Vehicles
Wakool	Yes	-	Barking Dogs
Wentworth	Yes	1	Coolroom

(Information sourced from relevant Councils)

Heritage listings

There is a growing awareness among Australians of heritage places and objects and the importance of preserving them.

The number and condition of heritage listing indicates the community's response to identifying and preserving heritage, as well as the value seen in heritage in maintaining a sense of place in a region – an important factor in our quality of life.

Identification of new places is an on-going process. Places and objects that are no longer listed should be identified individually, and the reason for de-listing provided, e.g. through decay or change of use that can involve demolition or inappropriate renovation. Heritage listings during 2006/07 is listed in Table 24.

Table 24: Heritage listings during 2006/07

LGA	Number of New Heritage Listings	Details of Listing
Balranald	No new listings	
Berrigan	No new listings	
Conargo	No new listings	
Corowa	No new listings	
Deniliquin	No new listings	
Greater Hume	No new listings	
Jerilderie	No new listings	
Murray	No new listings	Council is reviewing Heritage items in the Shire for possible inclusion in the Draft LEP
Wakool	1	The former Moulamein courthouse located at the junction of the Billabong Creek and the Edwards River. The courthouse was opened to the public in October 1899 and fulfils the NSW Assessment Criteria for Cultural Significance. It was nominated for inclusion in the NSW State Register at the beginning of 2006. – Still awaiting a decision.
Wentworth	No new listings	

(Information sourced from relevant Councils)

Aboriginal sites

All LGA's within the study area are aware of the importance of identifying and preserving places and objects of Aboriginal heritage. Most council's advised that no new Aboriginal objects or places were identified within their LGA during 2006/07.

However, Greater Hume advised that there may have been some Aboriginal artefacts identified during the construction of the Hume Highway but details have not been conveyed to Council.

Also an Aboriginal 'place of significance' was identified and gazetted adjacent to the Murrumbidgee River on the Southern edge of Balranald Urban Area.

5. CONCLUSION

All Council's participating in this supplementary report appear to continue to take small steps towards a more positive contribution to the environment. Council's continue to become more aware of their responsibilities to the environment as a result of new environmental legislation as well as a general increase in awareness on environmental issues across the community as a whole. It is important that Council's continue to minimise the impact of their activities on the environment.

At the conclusion of the Principal SoE Report three years ago, a number of recommendations were made to assist Council's in addressing their responsibilities to the environment. The recommendations are not binding on any Council and are intended as a guide or stimulus for consideration of local government environmentally related projects and activities.

It is worth reiterating these recommendations for the benefit of this third supplementary report.

- Maintain a file on SoE reporting for the purposes of collecting environmental information as it becomes available. This will make the task of data collection easier for Council staff and allow for consideration of environmental matters that otherwise might be missed. The use of GPS and mapping systems could be particularly useful in this regard.
- Support government initiatives for improved land management practices that reduce the rate of land degradation.
- Seek funding and support from all possible sources to implement environmental improvements.
- Take the opportunity in the LEP review process to strengthen controls where appropriate for the protection of the environment and in particular the Murray River.
- Prepare Potentially Contaminated Lands Registers.
- Investigate opportunities to change Council work practices that reduce motor vehicle usage (eg. improvements in technology).
- Prepare long term (say 20 years) strategic plans across the whole of the LGA that includes aims and objectives for achieving net gain for the environment.
- Monitor major developments within their LGA for compliance, particularly those that have the potential to detrimentally impact on the environment.
- Seek environmental enhancements through conditions of consent on development applications (e.g. re-vegetation).
- Ensure that urban infrastructure such as potable water supply, sewer and stormwater drainage continues to be constructed and upgraded as resources permit.
- Encourage water conservation and recycling measures in new development as well as energy efficient design.

- Take a stronger stance on illegal activities such as vegetation clearing and firewood collection.
- Ensure staff are fully briefed and understanding of changes to environmental legislation and other regulations relating to the environment.
- Continue to initiate measures that reduce waste to landfill and increase waste recycling.
- Endeavor to be responsive to complaints on environmental matters (eg. odour and noise).
- Undertake reviews of heritage listings.

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Section 55 Protection of the Environment Operations Act 1997

Environment Protection Licence

Licence - 3727

Department of **Environment & Climate Change** NSW

Licence Details	
Number:	3727
Anniversary Date:	01-July
Review Due Date:	01-Nov-2010

Licensee

GREATER HUME SHIRE COUNCIL
PO BOX 99
HOLBROOK NSW 2644

Licence Type

Premises

Premises

CULCAIRN SEWAGE TREATMENT WORKS AND EFFLUENT REUSE AREA
Cemetery Road
CULCAIRN NSW 2660

Non Scheduled Activity

Sewage Treatment Systems

Fee Based Activity	**Scale**
Sewage treatment - processing by small plants (< 10000 ML per year)	> 20 - 100 ML discharged

Region

South - Albury
4th Floor, Albury City Council Chambers, 553 Kiewa Street
ALBURY NSW 2640
Phone: 02 6022 0600
Fax: 02 6022 0610

PO Box 544 ALBURY
NSW 2640

Environment Protection Licence

Licence - 3727

Department of Environment & Climate Change NSW

Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act); and
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).

The EPA publication "A Guide to Licensing" contains information about how to calculate your licence fees.

The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

GREATER HUME SHIRE COUNCIL
PO BOX 99
HOLBROOK NSW 2644

subject to the conditions which follow.

1 Administrative conditions

A1 What the licence authorises and regulates

A1.1 This licence regulates water pollution resulting from the activity/ies specified below carried out at the premises specified in A2.

Sewage Treatment Systems

A1.2 Not applicable.

A1.3 Not applicable.

A2 Premises to which this licence applies

A2.1 The licence applies to the following premises:

Premises Details
CULCAIRN SEWAGE TREATMENT WORKS AND EFFLUENT REUSE AREA
Cemetery Road
CULCAIRN
NSW
2660
LOTS 1, 2, 3 & 4 DP250901 AND LOTS 1 & 2 DP864231

A2.2 The premises also includes the reticulation system owned and operated by the licensee that is associated with the sewage treatment plant(s) identified in condition A2.1.

A2.3 The premises also includes the utilisation area located at Lots 2&5 DP250901, Lot 4 DP250901, Lots 4-6 Section 34, DP9695; Lots 1-14 Section 27, DP7151; Lot 1 DP571235 & Lot 1 DP587128, Lots 36 & 82 DP753757 submitted with the EIS dated 22/07/2008.

A3 Other activities

A3.1 Not applicable.

A4 Information supplied to the EPA

A4.1 Works and activities must be carried out in accordance with the proposal contained in the licence application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:

(a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
(b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

A5 Objectives of this licence

A5.1 The objectives of this licence are to:

(a) prevent as far as practicable sewage overflows and sewage treatment plant bypasses;
(b) require proper and efficient management of the system to minimise harm to the environment and public health; and
(c) require practical measures to be taken to protect the environment and public health from sewage overflows and sewage treatment plant effluent.

A5.2 This licence is to be construed in a manner that will promote the objectives referred to in A5.1.

2 Discharges to air and water and applications to land

P1 Location of monitoring/discharge points and areas

P1.1 Not applicable.

P1.2 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

P1.3 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

Water and land

EPA identification no.	Type of monitoring point	Type of discharge point	Description of location
2	Total volume monitoring	Total volume monitoring	The STP supply pumpstation in Gordon Street Culcairn
3	Effluent quality monitoring	Effluent quality monitoring	Sampling point prior to discharge from effluent pond, labelled "ADP001 Monitoring Point", shown on drawing titled 'Culcairn Sewage Treatment Works' submitted with Licence Information Form dated 24/05/2000
4	Culcairn Sportsground effluent reuse area	Culcairn Sportsground effluent reuse area	Lot 36 and 82 DP753757
5	Sewerage Treatment Works and effluent reuse area, Cemetery Road Culcairn	Sewerage Treatment Works and effluent reuse area, Cemetery Road Culcairn	Lots 2 & 5 DP250901, Lot 4 DP250901
6	Billabong High School, oval and garden irrigation	Billabong High School, oval and garden irrigation	Lots 4-6 DP9695, Lots 1-14 DP7151, Lot 1 DP571235 and Lot 1 DP587128

3 Limit conditions

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

L1.2 The licensee may only discharge untreated or partially treated sewage from the sewage treatment plant and/or the reticulation system subject to the conditions of this licence, including O1 and O2.

L2 Load limits

L2.1 Not applicable.

L2.2 Not applicable.

L3 Concentration limits

L3.1 For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.

L3.2 Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.

L3.3 To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.

Water and Land

POINT 3

Pollutant	Units of Measure	50 percentile concentration limit	90 percentile concentration limit	3DGM concentration limit	100 percentile Concentration Limit
Oil and Grease	milligrams per litre				10
BOD	milligrams per litre				20
Total suspended solids	milligrams per litre				30
TN	milligrams per litre				20
TP	milligrams per litre				10

L4 Volume and mass limits

L4.1 For each discharge point or utilisation area specified below (by a point number), the volume/mass of:

(a) liquids discharged to water; or;

(b) solids or liquids applied to the area;

must not exceed the volume/mass limit specified for that discharge point or area.

Point	Unit of measure	Volume/Mass Limit
2	kilolitres per day	300

L5 Waste

L5.1 The licensee must not cause, permit or allow any waste generated outside the premises to be received at the premises for storage, treatment, processing, reprocessing or disposal or any waste generated at the premises to be disposed of at the premises, except as expressly permitted by the licence.

L5.2 This condition only applies to the storage, treatment, processing, reprocessing or disposal of waste at the premises if those activities require an environment protection licence.

L5.3 The licensee may receive and/or transfer sewage and Group C waste generated outside the premises for treatment, processing or reprocessing at the premises. The licensee must take reasonable steps to ensure that sewage received at the premises has been lawfully discharged in accordance with a trade waste agreement or customer contract (as applicable) in force between the licensee and the generator of the waste. The licensee must treat, process or reprocess the sewage and Group C waste in accordance with this licence prior to discharge from the premises.

L5.4 The licensee may receive, store, treat, process or reprocess and/or transfer at the premises sewage products generated or stored outside the premises by the licensee's other sewage treatment systems. Sewage products must be received, treated, processed or reprocessed in accordance with this licence.

L6 Noise Limits

L6.1 Not applicable.

L7 Frequency limits

L7.1 Not applicable.

L8 Potentially offensive odour

L8.1 No condition in this licence identifies a potentially offensive odour for the purposes of section 129 of the Protection of the Environment Operations Act 1997.

Note: Section 129 of the Protection of the Environment Operations Act 1997 provides that the licensee must not cause or permit the emission of any offensive odour from the premises but provides a defence if the emission is identified in the relevant environment protection licence as a potentially offensive odour and the odour was emitted in accordance with the conditions of a licence directed at minimising odour.

4 Operating conditions

O1 Activities must be carried out in a competent manner

O1.1 Licensed activities must be carried out in a competent manner.

This includes:
(a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
(b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

Note: The requirements of O1.1 apply to the whole of the premises, including the reticulation system.

O2 Maintenance of plant and equipment

O2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:
(a) must be maintained in a proper and efficient condition; and
(b) must be operated in a proper and efficient manner.

Note: The requirements of O2.1 apply to the whole of the premises, including the reticulation system.

O3 Appropriate treatment processes

O3.1 Sewage or effluent must not be discharged from Point(s) 3 unless it has been treated in accordance with the requirements of the table below.

Required treatment process	Flow range
Intermittent extended aeration processing	All sewage inflow less than 17 L/s

The flows noted in the table above are the inflows to the premises' sewage treatment plant(s).

O4 Prohibition on acceptance of pesticides

O4.1 The licensee must not consent to the receipt of organochlorine pesticides (including dieldrin, heptachlor and chlordane) into the sewage treatment system after October 2003.

O5 Biosolids management

O5.1 Biosolids at the premises must be stored, treated, processed, classified, transported and disposed in accordance with the Biosolids Guidelines, or as otherwise approved in writing by the EPA.

Note: This condition does not apply to the reuse or disposal of biosolids by the licensee at locations other than the premises.

O6 Effluent application to land

O6.1 Effluent liquid waste pipelines and fittings must be clearly identified. Standard watertaps, hoses and valves must not be fitted to the pipelines of the effluent system. The effluent system must not be connected to other pipelines. Lockable valves or removable handles must be used where there is public access to the effluent.

O6.2 Public access to any effluent utilisation area must be denied during effluent application and until the effluent application area has dried.

O6.3 Adequate notices, warning the public not to drink or otherwise use the treated effluent, must be erected on the site. These notices must be legible English and in any other languages as may be necessary, and must indicate at least that the water in use is "Reclaimed Water - Unfit for Drinking".

O6.4 The quantity of effluent applied to the utilisation area(s) must not exceed the capacity of the utilisation area(s) to effectively utilise the effluent.

For the purpose of this condition, “effectively utilise” includes the ability of the soil to absorb the nutrient, salt and hydraulic loads and the applied organic material without causing harm to the environment.

O6.5 Effluent application to the utilisation area(s) must not occur in a manner that causes surface run-off from the utilisation area(s).

O6.6 Spray from effluent application to the utilisation area(s) must not drift beyond the boundary of the utilisation area(s) to which it has been applied.

O7 New sewage pumping stations

O7.1 Dry weather overflows resulting in pollution of waters from any sewage pumping station(s) installed within the sewage treatment system after 1 January 2004 are not permitted.

O8 Extensions to the reticulation system

O8.1 The licensee must ensure that any extensions to the reticulation system after 1 January 2004 are planned, designed, constructed and installed to prevent as far as practicable overflows from the premises.

Note: “The premises” includes both the new and the previously existing parts of the sewage treatment system.

5 Monitoring and recording conditions

M1 Monitoring records

M1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.

M1.2 All records required to be kept by this licence must be:
(a) in a legible form, or in a form that can readily be reduced to a legible form;
(b) kept for at least 4 years after the monitoring or event to which they relate took place; and
(c) produced in a legible form to any authorised officer of the EPA who asks to see them.

M1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
(a) the date(s) on which the sample was taken;
(b) the time(s) at which the sample was collected;
(c) the point at which the sample was taken; and
(d) the name of the person who collected the sample.

M2 Requirement to monitor concentration of pollutants discharged

M2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

Water and Land

POINT 3

Pollutant	Units of measure	Frequency	Sampling Method
Biochemical oxygen demand	milligrams per litre	Quarterly	Grab sample
Conductivity	microsiemens per centimetre	Quarterly	Grab sample
Faecal Coliforms	colony forming units per 100 millilitres	Quarterly	Grab sample
Nitrogen (total)	milligrams per litre	Quarterly	Grab sample
Phosphorus (total)	milligrams per litre	Quarterly	Grab sample
Total suspended solids	milligrams per litre	Quarterly	Grab sample
pH	pH	Quarterly	Grab sample

POINTS 4,5,6

Pollutant	Units of measure	Frequency	Sampling Method
Conductivity	deciSiemens per metre	Yearly	Composite sample prepared from area profile samples
Nitrogen (total)	milligrams per kilogram	Yearly	Composite sample prepared from area profile samples
Phosphorus (total)	milligrams per kilogram	Yearly	Composite sample prepared from area profile samples
Sodium Adsorption Ratio	sodium adsorption ratio	Yearly	Composite sample prepared from area profile samples

M2.2 The monitoring at point(s) 3 required by condition M2.1 is conducted to determine compliance with limits specified for discharge to point(s) 1 respectively.

M3 Testing methods - concentration limits

M3.1 Not applicable.

M3.2 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

M4 Recording of pollution complaints

M4.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

M4.2 The record must include details of the following:
(a) the date and time of the complaint;

(b) the method by which the complaint was made;
(c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
(d) the nature of the complaint;
(e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
(f) if no action was taken by the licensee, the reasons why no action was taken.

M4.3 The record of a complaint must be kept for at least 4 years after the complaint was made.

M4.4 The record must be produced to any authorised officer of the EPA who asks to see them.

M5 Telephone complaints line

M5.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the licence.

M5.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.

M5.3 Conditions M5.1 and M5.2 do not apply until 3 months after:
(a) the date of the issue of this licence or
(b) if this licence is a replacement licence within the meaning of the Protection of the Environment Operations (Savings and Transitional) Regulation 1998, the date on which a copy of the licence was served on the licensee under clause 10 of that regulation.

M5.4 For the purpose of condition M5.1, operating hours are defined as twenty-four hours a day, seven days a week.

M5.5 The public notification referred to in condition M5.2 must include specific reference to the fact that the complaints line may be used by the community for the reporting of overflows.

M6 Requirement to monitor volume or mass

M6.1 For each discharge point or utilisation area specified below, the licensee must monitor:

(a) the volume of liquids discharged to water or applied to the area;
(b) the mass of solids applied to the area;
(c) the mass of pollutants emitted to the air;

at the frequency and using the method and units of measure, specified below.

POINT 2

Frequency	Unit Of Measure	Sampling Method
Continuous during discharge	kilolitres per day	Flow meter and continuous logger

M6.2 The monitoring at point(s) 2 is conducted to determine compliance with the limits specified for discharge to point(s) 1 respectively.

M6.3 Equipment used to monitor the volume must provide data that is within 5 percent of the actual volume over the likely full range of flow required to be measured by the equipment.

M6.4 In the event that the licensee cannot comply with a volume monitoring method as required by this licence solely due to the failure or malfunction of essential monitoring equipment, volume may be estimated using another agreed method approved in writing by the EPA. This provision only applies for the duration of the failure or malfunction. The licensee is to rectify the failure or malfunction as soon as practicable.

M6.5 The licensee must:

(a) submit in writing to the EPA a proposal for a method of volume estimation; or

(b) use a method of volume estimation already approved in writing by the EPA,

to be used in the event that essential monitoring equipment referred to in the previous condition has failed or malfunctioned.

M7 Requirement to record sewage treatment plant bypasses

M7.1 The licensee must record the following details in respect of each bypass of any of the appropriate treatment processes required by condition O3 which may be reasonably expected to adversely affect the quality of the final discharge:

(a) the EPA point identification number through which the bypass discharged;
(b) the date, estimated start time and estimated duration of the bypass;
(c) the estimated volume of the bypass;
(d) the level of treatment of the sewage at the STP prior to discharge;
(e) the probable cause of the bypass;
(f) any actions taken to stop the bypass happening; and
(g) any actions taken to prevent the bypass happening again.

M7.2 In addition to the details listed in the previous condition, the licensee must also record classification as a wet or dry weather bypass in respect of each bypass referred to in the previous condition. A dry weather bypass is a bypass that occurs when the flow rate of sewage at the inflow volume monitoring point of the STP does not exceed 10 L/s and a wet weather bypass occurs when this flow is equalled or exceeded at any time during the bypass event.

M8 Biosolids monitoring

M8.1 Biosolids at the premises must be recorded, monitored and classified in accordance with the Biosolids Guidelines, to the extent that those Guidelines are applicable, or as otherwise approved in writing by the EPA.

Note: This condition does not apply to the reuse or disposal of biosolids by the licensee at locations other than the premises.

M8.2 If biosolids are removed from the premises, the licensee must record the

(a) date;
(b) estimated weight of biosolids;
(c) identity of the person removing biosolids.

M9 Requirement to record overflows

M9.1 From 31 October 2003 the licensee must record the following details in relation to each observed or reported overflow from the reticulation system and from the sewage treatment plant:

(a) the location of the overflow;
(b) the date, estimated start time and estimated duration of the overflow;
(c) the estimated volume of the overflow;
(d) a description of the receiving environment of the overflow;
(e) classification as a dry or wet weather overflow;
(f) the probable cause of the overflow;
(g) any actions taken to stop the overflow happening;
(h) any actions taken to clean up the overflow; and
(i) any actions taken to prevent the overflow happening again.

M10 Environmental monitoring

M10.1 Not applicable.

6 Reporting conditions

R1 Annual return documents

What documents must an Annual Return contain?

R1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:
(a) a Statement of Compliance; and
(b) a Monitoring and Complaints Summary.
A copy of the form in which the Annual Return must be supplied to the EPA accompanies this licence. Before the end of each reporting period, the EPA will provide to the licensee a copy of the form that must be completed and returned to the EPA.

Period covered by Annual Return

R1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.

Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the Annual Return until after the end of the reporting period.

R1.3 Where this licence is transferred from the licensee to a new licensee:
(a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
(b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

R1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
(a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
(b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.

Deadline for Annual Return

R1.5 The Annual Return for the reporting period must be supplied to the EPA by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').

Notification where actual load can not be calculated

R1.6 Not applicable.

Licensee must retain copy of Annual Return

R1.7 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.

Certifying of Statement of Compliance and signing of Monitoring and Complaints Summary

R1.8 Within the Annual Return, the Statement of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
(a) the licence holder; or
(b) by a person approved in writing by the EPA to sign on behalf of the licence holder.

R1.9 A person who has been given written approval to certify a certificate of compliance under a licence issued under the Pollution Control Act 1970 is taken to be approved for the purpose of this condition until the date of first review of this licence.

R2 Notification of environmental harm

Note: The licensee or its employees must notify the EPA of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

R2.1 Notifications must be made by telephoning the EPA's Pollution Line service on 131 555.

R2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

R3 Written report

R3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:
(a) where this licence applies to premises, an event has occurred at the premises; or
(b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

R3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

R3.3 The request may require a report which includes any or all of the following information:
(a) the cause, time and duration of the event;
(b) the type, volume and concentration of every pollutant discharged as a result of the event;
(c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
(d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
(e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
(f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
(g) any other relevant matters.

R3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

R4 Notification of bypass or overflow incidents

R4.1 Where either:

(a) sewage or partially treated sewage is discharged from the premises as a result of a bypass of the sewage treatment plant, or:
(b) an observed or reported overflow has occurred from the reticulation system, and overflow or bypass may pose a risk to public health, the licensee is to promptly give appropriate notification to any parties that are likely to be affected, including:
    (i) the potentially affected community;
    (ii) the Department of Health;
    (iii) any other government organisation or water utility provider whose administrative role, operations or service provision is likely to be affected or impacted by the overflow or bypass.

R4.2 When the licensee notifies the Department of Health or Safe Food NSW Shellfish Quality Assurance Program of a bypass or overflow incident, the licensee must also notify the EPA by telephoning its Pollution Line service on 131 555. Notifications are to be given as soon as practicable after the licensee or one of the licensee's employees or agents becomes aware of the incident, and must include all relevant information including the information required under condition M9.1 or M7.1.

R5 Annual System Performance Report

R5.1 The licensee must supply to the EPA an Annual System Performance Report not later than 60 days after the end of each reporting period.

R5.2 The report is to supplement the Annual Return and must include but need not be limited to:

(a) the 50 percentile, 90 percentile, 100 percentile and 3DGM values calculated from the monitoring data required by this licence for the reporting period for each pollutant which has corresponding concentration limits specified in this licence;
(b) the total amounts of biosolids, as classified in the Biosolids Guideline, disposed of on-site, off-site and to landfill during the reporting period;
(c) a diagram showing the major process elements, discharge points and monitoring points at the premises' sewage treatment plant(s),where there has been any significant change since the previous reporting period or this information has not been provided previously to the EPA;
(d) the number of dry and wet weather bypasses recorded over the reporting period (recorded in accordance with condition M7);
(e) a breakdown of the total number of complaints received by the licensee during the reporting period in relation to the premises into categories of "odours – sewage treatment plant", "odours – reticulation system", "water pollution – sewage treatment plant", "water pollution – reticulation system" and any other category indicated by the complaints;
(f) a summary of observed, reported or recorded wet weather overflows and observed, reported or recorded dry weather overflows and sewage treatment plant bypasses. These data are to be for the current reporting period and for the four previous twelve-month periods, for which data has been collected. Any significant actions taken to address bypasses or overflows are to be noted;
(g) the amount of rainfall measured at a rain gauge at the STP, or at the rain gauge closest to the centre of the catchment of the sewage treatment system, for each month of the reporting period; and
(h) a brief progress report on the implementation over the reporting period of actions specified in PRP100.

R5.3 The Annual System Performance Report must be presented in a format approved in writing by the EPA.

R5.4 The requirements of R5.2 (d), (e), (f) and (g) apply to the part of the reporting period beginning three months after the date the licence is varied to include this condition.

General conditions

G1 Copy of licence kept at the premises

G1.1 A copy of this licence must be kept at the premises to which the licence applies.

G1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

G1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

Note: For the purposes of this condition, "the premises" refers to each Sewage Treatment Plant(s) described in condition A2.1.

G2 Signage

G2.1 The location of EPA point number(s) 1,2 and 3 must be clearly marked by signs that indicate the point identification number used in this licence and be located as close as practical to the point.

G3 Contact number for incidents and responsible employees

G3.1 The licensee must operate 24-hour telephone contact lines for the purpose of enabling the EPA to directly contact one or more representatives of the licensee who can:
(a) respond at all times to incidents relating to the premises; and
(b) contact the licensee's senior employees or agents authorised at all times to:
(i) speak on behalf of the licensee; and
(ii) provide any information or document required under this licence.

G3.2 The licensee is to inform the EPA in writing of the appointment of any subsequent contact persons, or changes to the person's contact details as soon as practicable and in any event within fourteen days of the appointment or change.

G4 Clean-up

G4.1 In the event of an overflow or bypass that harms or is likely to harm the environment, the licensee must use all practicable measures to minimise the impact of the overflow or bypass on the environment and public health. These measures are to be implemented as soon as practical after the licensee or one of the licensee's employees or agents becomes aware of the overflow or bypass.

Pollution studies and reduction programs

PRP100 Sewer Overflow Investigations Report

100.1 The objective of this PRP is to identify overflows from the sewage reticulation system that pose a significant risk of harm to the environment or public health, and to identify management priorities and actions required to reduce this risk.

100.2 The licensee must prepare a Sewer Overflow Investigations Report for the premises' reticulation system. The report must include but need not be limited to:

(a) identification of the location of all designed overflow points and other frequent overflow points within the reticulation system and an assessment of the likelihood of overflows from these points;
(b) assessment of the significance of impacts on the environment and public health resulting from these overflows;
(c) evaluation and ranking of the resultant risk to the environment and public health from these overflows; and
(d) identification of management priorities and actions to reduce the risk of harm to the environment and public health.

100.3 With regard to the identification of actions to reduce the risk of harm to the environment and public health, as required by condition 100.2(d), the licensee must consider the effects of any actions that improve the performance of the reticulation system with respect to the performance of the sewage treatment plant, for example with respect to the frequency and volume of bypasses or overflows from the sewage treatment plant, to ensure that the actions minimise the potential environmental and public health impact of discharges from the whole of the premises.

100.4 The report must also include the identification of any sewage pumping stations within the premises that are not capable of meeting a condition prohibiting dry weather overflows, including reasons why any sewage pumping station is not capable of meeting such a condition and whether it should be upgraded.

100.5 This report is to be submitted to the EPA in writing by 30 June 2007.

Notes:

(1) If this requirement is included on a number of sewage treatment system licences held by the licensee, a single report may be submitted to the EPA provided that it meets the requirements relating to all of the licences.
(2) The requirement to prepare this report does not affect the requirement to comply with any other condition of this licence.

(3) It is the EPA's intention to include, at some point in the future, a licence condition prohibiting dry weather overflows from those sewage pumping stations that have been identified as being capable of meeting such a condition. This would be consistent with the requirement for proper and efficient maintenance and operation of the system.
(4) Progress reports on the implementation over the reporting period of actions specified in PRP100 are required in the Annual System Performance Report under condition R5 of this licence.

Special conditions

E1.1 Not applicable.

Dictionary

General Dictionary

In this licence, unless the contrary is indicated, the terms below have the following meanings:

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 1998
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 1998
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 1998
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*

	the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 1998.
flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder described at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 1998
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997

premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 months. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.
TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste code	Means the waste codes listed in Appendix 5 of the EPA document A Guide to Licensing Part B
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non-putrescible), special waste or hazardous waste

Special Dictionary

ug/L	Means micrograms per litre.
access chamber	a structure constructed to provide physical access to sewer pipes. Also known as a manhole.
approved	Means approved in writing by the EPA. The EPA's approval may be given unconditionally, or subject to conditions.
Biosolids	Has the same meaning as in Schedule 1, Part 3 of the *Protection of the Environment Operations Act 1997.*
Biosolids Guidelines	Means the "Environmental Guidelines: Use and disposal of biosolids products" published by the EPA in October 1997, or any subsequently updated guidelines which replace this publication.
bypass	Means circumstances where sewage has been received at the sewage treatment plant but is discharged from the plant without it being treated, processed or reprocessed by means of any or all of the designed treatment processes of the plant. A new bypass event is defined as a bypass that commences at least 24 hours after the end of the previous bypass.

cfu	Means colony forming units
condition	Means a condition of this licence.
designed overflow structure	Means a designed structure (excluding access chambers) in the reticulation system which operates as a relief to allow sewage to discharge at a planned location or a sewage pumping station, but does not include a bypass from a sewage treatment plant.
designed overflow	Means an overflow from a designed overflow structure.
dry weather bypass	Means a bypass that occurs when the flow rate of sewage at the inflow point of the STP does not exceed the flow rate specified in M7.2.
dry weather overflow	Means an overflow that is not a wet weather overflow.
dry weather sewage treatment plant discharge	Means a discharge of sewage or effluent from the STP that occurs when the flow rate of sewage at the inflow point of the STP does not exceed the flow rate specified in M7.2
effluent	Means sewage that has received all of the designed treatment processes at the sewage treatment plant.
fc	Means faecal coliforms expressed in colony forming units per 100mL.
Group C waste	Has the same meaning as in Part 3 of Schedule 1 of the *Protection of the Environment Operations Act 1997*.
ISO	Means International Standards Organisation.
kL	Means kilolitre.
L/s	Means litres per second.
metal-A	Means the following metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc.
mL	Means millilitres.
ML	Means megalitres.
offensive odour	Has the same meaning as in the *Protection of the Environment Operations Act 1997*.
overflow	Is a discharge of untreated or partially treated sewage from the sewage treatment system.
reticulation system	Means that part of the sewage treatment system owned and operated by the licensee which collects and transports sewage to the sewage treatment plant and includes all sewer pipes (whether greater or less than 300mm diameter), sewer rising mains, access chambers, vent shafts, designed overflow structures, sewage ejection units and sewage pumping stations, but does not include the sewage treatment plant.
sewage	Means untreated liquid waste received in the reticulation system.
sewage ejection unit	Is a pump intended to control the transport of sewage from premises normally occupied by no more than 10 persons, or of an average daily flow of sewage not exceeding 2,000 litres through the sewer pipes, where steep hills and other variations in the land topography can prevent or limit the gravity flow of sewage to the sewage treatment plant.
sewage products	Means any by-product of the treatment processes and includes biosolids, raw sludge, liquid sludge, thickened sludge, digested sludge, screenings and grit.
sewage pumping station (SPS)	Is a structure which controls the transport of sewage through the sewer pipes, where steep hills and other variations in the land topography can prevent or limit the gravity flow of sewage to the sewage treatment plant, but does not include a sewage ejection unit.

sewage treatment plant (STP)	Is a facility at which sewage is stored and treated following delivery from the reticulation system prior to discharge, and includes discharge structures and STP bypass points.
sewage treatment system	Means the reticulation system and the sewage treatment plant used for the transport, treatment and discharge of effluent and sewage.
Trade waste agreements	Means agreements reached between the licensee and industrial and commercial customers to restrict the amount of toxic and other potentially harmful substances discharged to the reticulation system.
TRC	Means total residual chlorine.
waters	Has the same meaning as in the *Protection of the Environment Operations Act 1997*.
wet weather bypass	Means a bypass that occurs when the flow rate of sewage at the inflow point of the STP equals or exceeds the rate specified in condition M7.2.
wet weather overflow	A wet weather overflow is an overflow where the probable cause is rainfall.

Ms Nadia Kanhoush

Environment Protection Authority

(By Delegation)

Date of this edition - 01-Oct-2008

End Notes

1	Licence varied by notice 1017179, issued on 27-Nov-2002, which came into effect on 22-Dec-2002.
2	Licence varied by notice 1028799, issued on 18-Aug-2003, which came into effect on 12-Sep-2003.
3	EPA Condition ID S40934 amended 13-08-04
4	Licence varied by notice 1041233, issued on 07-Oct-2004, which came into effect on 01-Nov-2004.
5	Licence transferred through application 143367, approved on 07-Apr-2005, which came into effect on 26-May-2004.

End Notes

6	Licence fee period changed by notice 1063412 on 27-Jul-2006.
7	Licence varied by notice 1060531, issued on 31-Jul-2006, which came into effect on 31-Jul-2006.
8	Licence fee period changed by notice 1063678 on 01-Aug-2006.
9	Licence varied by notice 1079189, issued on 16-Oct-2007, which came into effect on 16-Oct-2007.
10	Licence varied by notice 1083914, issued on 01-Oct-2008, which came into effect on 01-Oct-2008.

Table 6.1 Example definitions of consequence

Score	Descriptor	Example Definition	
		Human Health	Environment
5	Catastrophic	Severe illness or death affecting a large population	Severe, permanent environmental impact
4	Major	Severe illness or death affecting a small population	Severe, long-term environmental impact
3	Moderate	Short term, low level illness, affecting a large population	Localised, medium-term environmental impact
2	Minor	Short-term, low level illness affecting a small population	Localised, short-term environmental impact
1	Insignificant	No detectable human health illness	No detectable environmental impact

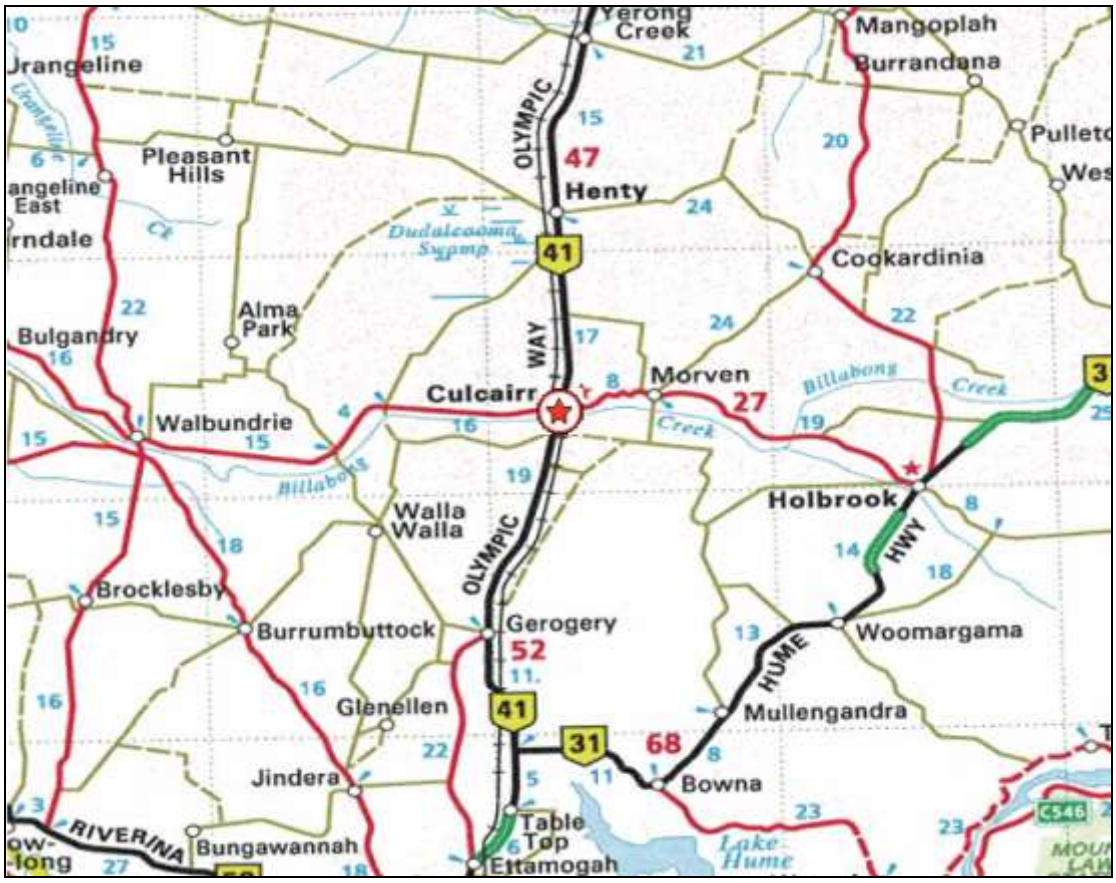
Table 6.2 Example definitions of likelihood

Score	Descriptor	Example Definition
E	Almost certain	Event is expected to occur often (several times per year)
D	Likely	Event will probably occur often (once every 1 to 3 years)
C	Possible	Event might occur (once every 3 to 10 years)
B	Unlikely	Event could occur (once every 20 years)
A	Rare	Event will occur only in rare circumstances (once every 100 years)

Table 6.3 Risk ratings

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost certain	Low	Medium	High	Very High	Very High
	Likely	Low	Medium	High	Very High	Very High
	Possible	Low	Medium	Medium	High	Very High
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

Figure 1: Regional Location Map



N
W E
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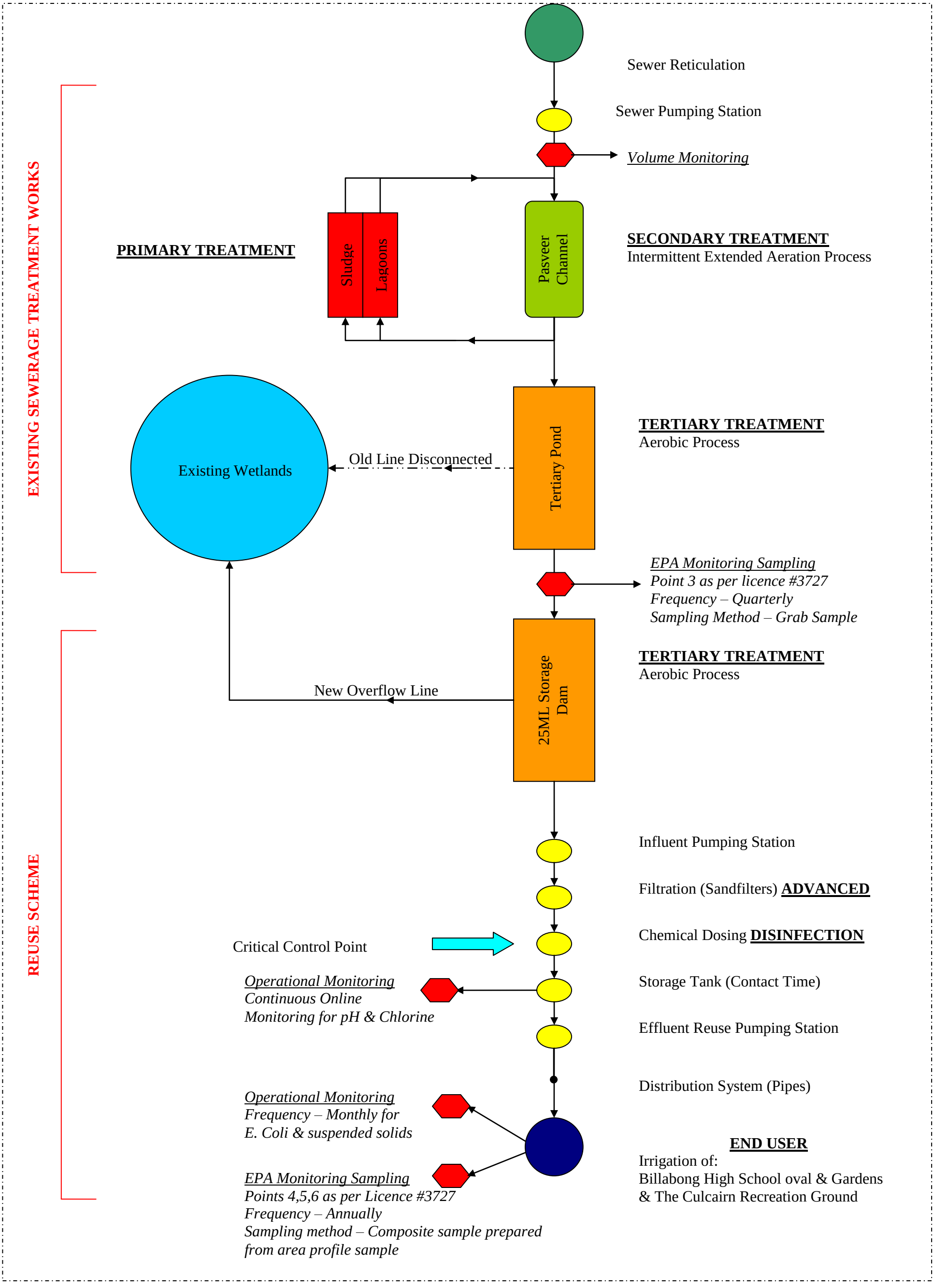
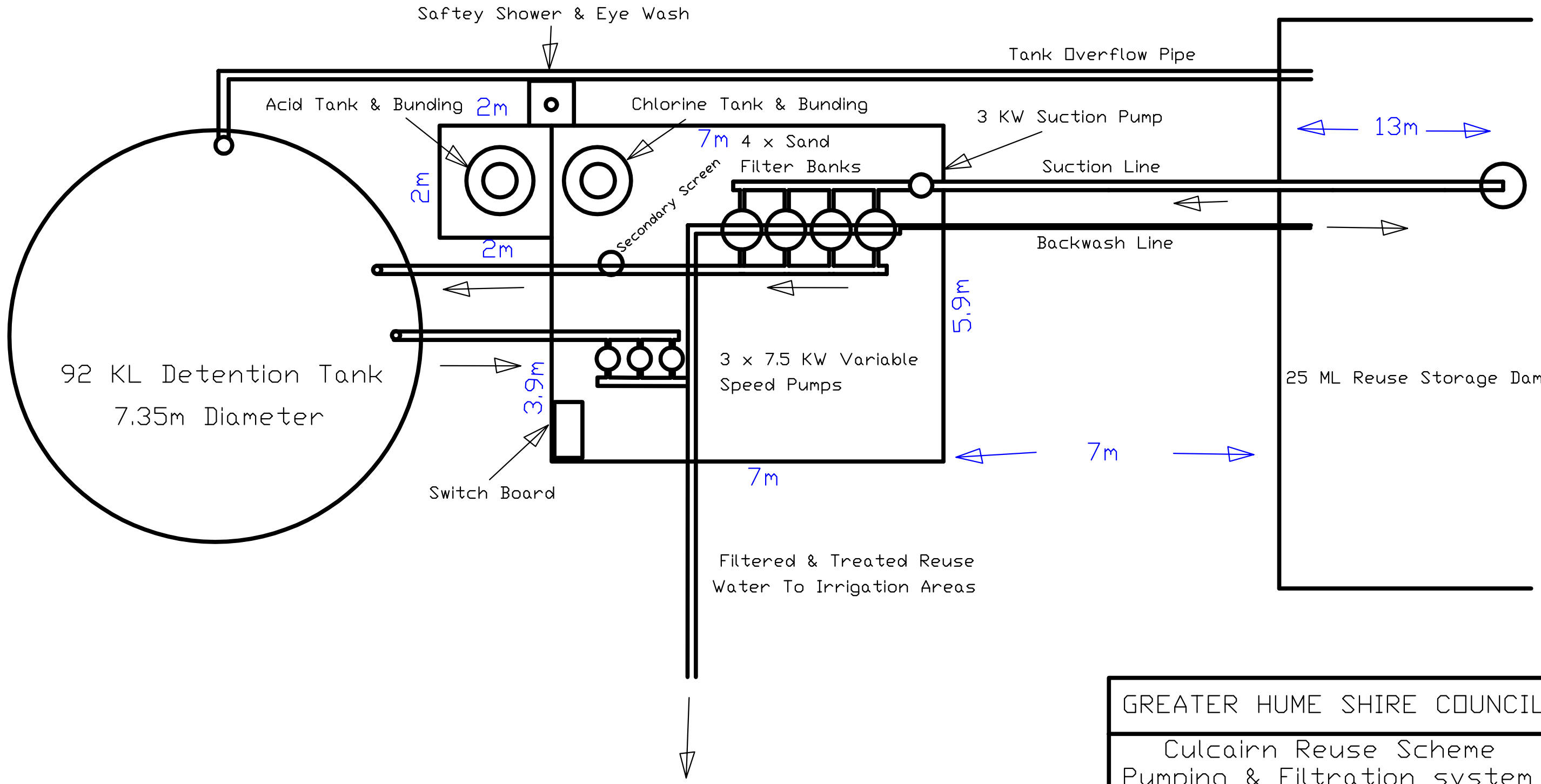
GREATER HUME SHIRE COUNCIL

Culcairn Community Water Reuse Scheme Proposed Site Plan Revised Plan 2 1st June 2008 Year 2008

Not To Scale

CULCAIRN SEWERAGE TREATMENT WORKS
REUSE SCHEME FLOWCHART





Plant Monitoring System
PH and Chlorine Analyser
Data Logger 24/7 stored Info of Total Flow
L/sec,PH measurement Chlorine Measurement,Start & Stop times

GREATER HUME SHIRE COUNCIL		
Culcairn Reuse Scheme Pumping & Filtration system		
Not To Scale	Drawn By T Plunkett	
Proposed Plan	June 08	Plan 1A

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INDUSTRIAL • AGRICULTURAL • DOMESTIC • SANITATION • CHEMICALS

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Email: headoffice@milestonechemicals.com.au
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Telephone: (03) 9459 9833
Facsimile: (03) 9457 5518

Material Safety Data Sheet

Issue date: December 2005 / Expiry Date: December 2010

SODIUM HYPOCHLORITE

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: SODIUM HYPOCHLORITE
Synonym:

Use: Sodium Hypochlorite kills germs, mould, sanitises, whitens, brightens, removes stains, and is widely used in water treatment within the Laundry, Household, Commercial premises and the Dairy Industry

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Emergency Advice All Hours:

Chief Chemist	**Tel: (03) 9459 9833**	**Monday 8:00 a.m. - Friday 6:00 p.m.**
Poisons Information Centre	**Phone Australia: 13 1126**	**24 hours**

2. HAZARDS IDENTIFICATION

HAZARDOUS ACCORDING TO EU CRITERIA
Hazard Category: Corrosive (C)
Hazard Classification: HAZARDOUS SUBSTANCE, DANGEROUS GOOD

RISK PHRASES

R31	Contact with acids liberates toxic gas.
R34	Causes burns.

SAFETY PHRASES

S1/2	Keep locked up and out of reach of children.
S28	After contact with skin, wash immediately with plenty of water.
S45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)
S50	Do not mix with acids.

Poison Schedule: S5 [Aust]
This material is a Scheduled **S5** Poison and must be stored, handled and used according to the appropriate regulations..

Warning Statement:
WARNING - Vapour may be harmful
Corrosive Liquid
Product will irritate the eyes, nose, throat and skin.
May give off dangerous gas if mixed with other products

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SODIUM HYPOCHLORITE

3. COMPOSITION / INFORMATION ON INGREDIENTS

SUBSTANCE NAME	Proportion	CAS Number
SODIUM HYPOCHLORITE	10 to 30%	7681-52-9
WATER AND OTHER NON-HAZARDOUS SUBSTANCES	Greater than 60%	Mixture
This product contains:	Available Chlorine 12.5%	

All other ingredients not hazardous according to EU Criteria.

4. FIRST AID MEASURES

Swallowed:
If swallowed, DO NOT induce vomiting. If victim is conscious give water to drink. Immediately transport to hospital or doctor.
Eye:
If material is splashed into eyes, flush with plenty of water for at least 15 minutes, ensuring eye lids are held open. Immediately transport to hospital or doctor.
Skin:
If material is splashed onto the skin, remove any contaminated clothing and wash skin thoroughly with water and soap. Immediately transport to hospital or doctor.
Inhaled:
Remove victim to fresh air. Do not use mouth-to-mouth method if victim inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult.
First Aid Facilities:
Eye wash fountain, safety shower and normal wash room facilities.
Advice to Doctor:
Treat symptomatically.
In case of poisoning, contact Poisons Information Centre
In Australia call Tel: 131126
In New Zealand Tel: 034747000

5. FIRE-FIGHTING MEASURES

Fire/Explosion Hazard
CAUTION: Use of water spray when fighting fire may be inefficient.
EXTINGUISHING MEDIA: Use dry chemical, carbon dioxide, foam or water fog.
SPECIAL FIRE FIGHTING PROCEDURES: Self-contained breathing apparatus (SCBA) required for fire-fighting personnel. If possible to do so safely, shut off fuel to fire. Use water spray to spray to cool fire-exposed surfaces and to protect personnel.
UNUSUAL FIRE AND EXPLOSION HAZARDS: If tanks, drums or containers of this material are heated, they may rupture and project corrosive materials over a wide area.
HAZCHEM CODE: 2X [Aust]
FLAMMABILITY
Heat or damage to containers may release corrosive or toxic fumes.

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SODIUM HYPOCHLORITE

6. ACCIDENTAL RELEASE MEASURES

EMERGENCY ACTION:
Keep unnecessary people away; Isolate hazard area and deny entry. Stay upwind; Keep out of low areas. Do not walk or touch spilt material unless wearing personal protection as outlined under MSDS.
SPILL OR LEAK PROCEDURE:
Shut off ignition sources, no flares, smoking or flames in hazard area. Stop leak if you can do it without risk. Water spray may reduce vapour.
SMALL SPILLS:
Take up with sand, dirt or vermiculite. DO NOT use sawdust. Use non-sparking tools. Place into labelled drum(s) for later disposal.
LARGE SPILLS:
Notify Emergency Services (Police or Fire Brigade). Tell them exact location, nature, hazards, quantities, type of vehicle and any other information that would be helpful. Contain spill. Remove all ignition sources and safely stop flow of spill. Bund area. Trained personnel should wear Personal Protective equipment as highlighted in this MSDS. Blanket the spill with foam or use water fog to disperse vapour clouds. Consult an expert regarding disposal of this product.

7. HANDLING AND STORAGE

Avoid prolonged breathing of vapors and skin or eye contact. Store in a cool place and out of direct sunlight. Store away from sources of heat or ignition. Store away from oxidizing agents and strong acids. Keep containers tightly closed, when not using the product. Store in original packages as approved by manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards
No exposure standards have been assigned by [NOHSC] for this product or any of the components:
SODIUM HYPOCHLORITE
No exposure standards have been assigned by the National Occupational Health & Safety Commission (NOHSC)

WATER AND OTHER NON-HAZARDOUS SUBSTANCES
No Exposure details available

Engineering Controls
Corrosive liquid. Maintain adequate ventilation at all times. In most circumstances natural ventilation systems are adequate unless the material is heated, reacted or otherwise changed in some type of chemical reaction, then the use of a local exhaust ventilation system is recommended.

Personal Protection Equipment
This product is hazardous and poisonous and will bleach clothing and skin. The following protective clothing should be worn when handling product directly.
NOTE ----- When diluted at a rate of one part product to two parts water or greater, the resulting mixture is no longer considered to be hazardous.

CLOTHING: Neoprene or nitrile apron
GLOVES: Neoprene or nitrile.
EYES: Chemical goggles or faceshield to protect eyes.

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8. EXPOSURE CONTROLS / PERSONAL PROTECTION continued…

RESPIRATORY PROTECTION: Avoid breathing of vapours. Select and use respirators in accordance with AS/NZS 1715/1716. The use of a P1 respirator with replaceable filters is recommended. Filter capacity and respirator type depends on exposure levels and type of contaminant. If entering spaces where the airborne concentration of a contaminant is unknown then the use of a Self-contained breathing apparatus (SCBA) with positive pressure air supply complying with AS/NZS 1715 / 1716, or any other acceptable International Standard is recommended.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Yellow dense clear liquid
Boiling Point Melting Point:	>100ºC
Vapour Pressure:	Not Available
Specific Gravity:	1.19
Flash Point:	None
Flammability Limits:	Non Flammable
Solubility in Water:	All proportions

Other Properties

pH (1% solution) :	12.0 - 13.0
Odour :	Strong Chlorine

10. STABILITY AND REACTIVITY

STABILITY:
Stable under normal conditions of use.
HAZARDOUS DECOMPOSITION PRODUCTS:
Emits choking and corrosive fumes when heated to decomposition.
HAZARDOUS POLYMERIZATION:
Will not occur.
INCOMPATIBILITIES:
Strong alkalis and oxidizing agents.
CONDITIONS TO AVOID:
Incompatibles.

11. TOXICOLOGICAL INFORMATION

No adverse health effects are expected, if the product is handled in accordance with this Material Safety Data Sheet and the product label. Symptoms and effects that may arise if the product is mishandled and overexposure occurs are:

ACUTE HEALTH EFFECTS:
Swallowed:
Will cause burns to the mouth, mucous membranes, throat, oesophagus and stomach. If sufficient quantities are ingested (swallowed) death may occur.
Eye:
Will cause burns to the eyes with effects including: Pain, tearing, conjunctivitis and if duration of exposure is long enough, blindness will occur.
Skin:
Will cause burns to the skin, with effects including; Redness, blistering, localised pain and dermatitis.

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11. TOXICOLOGICAL INFORMATION continued…

Inhaled:
Toxic if inhaled.
Will cause severe irritation to the nose, throat and respiratory system with effects including: Dizziness, headache, coughing, loss of co-ordination, chest pains, respiratory paralysis and or failure.
Chronic:
Prolonged or repeated skin contact will lead to necrosis (death) of the skin.
Prolonged or repeated exposure or deliberately concentrating and inhaling the vapour(s) may result in lung function incapacity or death.
Toxicological Data:
There is no other toxicological information available for this product.

12. ECOLOGICAL INFORMATION

Ecotoxity:
In large concentrations, this product is detrimental to the aquatic environment.
Mobility:
Readily dilutes with water.
Persistence / Degradability:
Readily Biodegradable.
Chemical Fate Information:
This substance may cause long term adverse effects in the aquatic environment.

13. DISPOSAL CONSIDERATIONS

Refer to appropriate authority in your State. Dispose of material through a licensed waste contractor. Normally suitable for disposal by approved waste disposal agent.

14. TRANSPORT INFORMATION

Road Transport
UN Number: 1791
Proper Shipping Name: HYPOCHLORITE SOLUTION
Dangerous Goods Class: 8
Packing Group: III
Label: Corrosive (**C**)

Air Transport
UN Number: 1791
Proper Shipping Name: HYPOCHLORITE SOLUTION
Dangerous Goods Class: 8
Packing Group: III
Label: Corrosive (**C**)

Sea Transport
UN Number: 1791
Proper Shipping Name: HYPOCHLORITE SOLUTION
Dangerous Goods Class: 8
Packing Group: III
Label: Corrosive (**C**)

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Issue date: December 2005 / Expiry Date: December 2010

SODIUM HYPOCHLORITE

15. REGULATORY INFORMATION

Poison Schedule: S5 [Aust]
Inventory Status:

Inventory	*Status*
Australia (AICS)	All materials are listed.

16. OTHER INFORMATION

Date of Preparation:
Issue date: 15/12/2005
Supersedes: 28/04/05
Reasons for Update:
Poison Schedule change

Key Legend Information:
NOHSC - National Occupational Health & Safety Commission {Formerly Worksafe}[Aust]
SUSDP - Standard for the Uniform Scheduling of Drugs and Poisons [Aust]
TWA - Time Weighted Average [Int]
STEL - Short Term Exposure Limit [Int]
AICS - Australian Inventory of Chemical Substances
EPA - Environmental Protection Agency [Int]
NIOSH - National Institute for Occupational Safety and Health [US]
AS/NZS 1715 - Selection, use and maintenance of respiratory protective devices. [Aust/NZ]
AS/NZS 1716 - Respiratory protective devices. [Aust/NZ]
IATA - International Aviation Transport Authority [Int]
ICAO - International Civil Aviation Organization [Int]
IMO - International Maritime Organisation. [Int]
IMDG - International Maritime Dangerous Goods [Int]
United Nations Recommendations for the Transport of Dangerous Goods and Globally Harmonized System for the classification and labelling of Chemicals. [Int]
EU - European Union

[Aust/NZ] = Australian New Zealand
[Int] = International
[US] = United States of America

Removal of the heading of *Poison Schedule [Aust]*, in section 3 and 15 of this Material Safety Data Sheet (MSDS) makes this a valid health and safety document in other international jurisdictions/countries. For full compliance please contact your Federal, State or Local regulators for further information.

Disclaimer
This MSDS summarises our best knowledge of the health and safety hazard information available on the product and the measures to be used to handle and use the product safely. Each user should read this MSDS and consider the information in connection with the way the product is intended to be handled or used.

Principal References:
Information supplied by manufacturer, reference sources including the public domain.

END OF MSDS

Material Data Safety Sheet (MSDS): HYDROCHLORIC ACID

Note: This information sheet has been re-formatted for better clarity by the Department of Earth Sciences.
Some of the data such as information on shipping and weapons treaties were intentionally left out. If you
want to look at the complete MSDS, you can either check one of the hardcopy versions in the Department,
contact the manufacturer, or check one of the various Web-based databases such as those compiled by BU's Office of Environmental Health & Safety (www.bu.edu/ehs/msds/index.htm).

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1. Product Identification

MSDS Name: **Hydrochloric Acid**, Reagent ACS

Chlorohydric acid, hydrogen chloride, muriatic acid, spirits of salt.
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

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2. Composition/Information on Ingredients

CAS#	Chemical Name	%	EINECS#
7647-01-0	Hydrochloric acid, reagent ACS	37%	231-595-7

7732-18-5	Water	Balance	231-791-2

Hazard Symbols: C
Risk Phrases: 34 37

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3. Hazards Identification

Emergency Overview

EMERGENCY OVERVIEW
Appearance: Clear, colorless to faintly yellow.
Danger! Corrosive. Sensitizer. Causes eye and skin burns. May cause severe respiratory and digestive tract irritation with possible
burns.
Target Organs: None.

Potential Health Effects

Eye:
May cause irreversible eye injury. Vapor or mist may cause irritation and severe burns. Contact with liquid is corrosive to the eyes and causes severe burns. May cause painful sensitization to light. May cause conjunctivitis.

Skin:
May be absorbed through the skin in harmful amounts. Contact with liquid is corrosive and causes severe burns and ulceration. May cause photosensitization in certain individuals.

Ingestion:
May cause circulatory system failure. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death. May cause
corrosion and permanent tissue destruction of the esophagus and digestive tract.

Inhalation:
Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May cause pulmonary edema and severe respiratory disturbances.

Chronic:
Prolonged or repeated skin contact may cause dermatitis. Repeated exposure may cause erosion of teeth. May cause conjunctivitis and photosensitization.

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4. First Aid Measures

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid
immediately. Do NOT allow victim to rub or keep eyes closed.
Skin:
Get medical aid. Rinse area with large amounts of water for at least 15 minutes. Remove contaminated clothing and shoes.
Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately.
Inhalation:
Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician:
Treat symptomatically and supportively.

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5. Fire Fighting Measures

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full
protective gear. Not flammable, but reacts with most metals to form flammable hydrogen gas. Use water spray to keep fire-exposed containers cool.
Extinguishing Media:
Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.

Autoignition Temperature: Not available.
Flash Point: Not available.
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

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6. Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:
Large spills may be neutralized with dilute alkaline solutions of soda ash, or lime. Absorb spill using an absorbent, non-combustible
material such as earth, sand, or vermiculite.

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7. Handling and Storage

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Do not get on skin
or in eyes. Do not ingest or inhale.

Storage:
Keep away from heat and flame. Do not store in direct sunlight. Store in a cool, dry, well-ventilated area away from incompatible substances.

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8. Exposure Controls/Personal Protection

Engineering Controls:
Use adequate general or local exhaust ventilation to keep airborne
concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name ACGIH NIOSH OSHA - Final PELs
Hydrochloric acid, reagent ACS C 5 ppm; C 7.5 mg/m3 50 ppm IDLH C 5 ppm; C 7 mg/m3

OSHA Vacated PELs:
Hydrochloric acid, reagent ACS:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face
protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to prevent skin exposure.
Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

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9. Physical and Chemical Properties (Hydrochloric Acid)

	Clear, colorless to faintly yellow

Appearance:	liquid
Odor:	Strong, pungent
Solubility:	823g/L water at 32F
Density:	1.16-1.19
pH:	1.1 (0.1N sol)
% Volatiles by volume @ 21C (70F):	Not available
Boiling Point:	230 deg F
Melting Point:	-101 deg F
Vapor Density (Air=1):	1.257
Vapor Pressure:	160 mm Hg
Evaporation Rate (Butyl acetate =1):	2.0

Molecular Formula: HCl
Molecular Weight: 36.46

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10. Stability and Reactivity

Chemical Stability:
Stable under normal temperatures and pressures.

Conditions to Avoid:
Incompatible materials, light.

Incompatibilities with Other Materials:
Acetate, acetic anhydride, alcohols + hydrogen cyanide, 2-aminoethanol, ammonium hydroxide, calcium carbide, calcium phosphide, cesium acetylene carbide, cesium carbide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethyleneimine, fluorine, lithium silicide, magnesium boride, mercuric sulfate, oleum, perchloric acid, potassium permanganate, b-propiolactone, propylene oxide, rubidum acetylene carbide, rubidum carbide, silver perchlorate + carbon tetrachloride, sodium, sodium hydroxide, sulfuric acid, uranium phosphide, vinyl acetate. Substance polymerizes on contact with aldehydes or epoxides.

Hazardous Decomposition Products:
Hydrogen chloride, chlorine, carbon monoxide, carbon dioxide, hydrogen gas.

Hazardous Polymerization: May occur.

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11. Toxicological Information

RTECS#:
CAS# 7647-01-0: MW4025000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7647-01-0: Inhalation, mouse: LC50 =1108 ppm/1H; Inhalation, rat: LC50 =3124 ppm/1H; Oral, rabbit: LD50 = 900 mg/kg.
CAS# 7732-18-5: Oral, rat: LD50 = >90 mL/kg.

Carcinogenicity:
Hydrochloric acid, reagent ACS -
IARC: Group 3 carcinogen
Epidemiology:
No information available.
Teratogenicity:
Embryo or Fetus: Stunted fetus, ihl-rat TCLo=450 mg/m3/1H Specific Developmental Abnormalities: homeostasis, ihl-rat TCLo=450 mg/m3/1H.
Reproductive Effects:
No information available.
Neurotoxicity:
No information available.
Mutagenicity:
No information available.
Other Studies:
None.

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12. Ecological Information

Ecotoxicity:
Trout LC100=10 mg/L/24H Shrimp LC50=100-330 ppm Starfish LC50=100-330mg/L/48H Shore crab LC50=240 mg/L/48H Chronic plant toxicity=100 ppm

Environmental Fate:
Substance will neutralize soil carbonate-based components.

Physical/Chemical:
No information available.

Other:
None.

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13. Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: None listed.
RCRA D-Series Chronic Toxicity Reference Levels: None listed.
RCRA F-Series: None listed.
RCRA P-Series: None listed.
RCRA U-Series: None listed

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16. Other Information

MSDS Creation Date: 11/09/1995 Revision #4 Date: 4/28/1998

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

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APPENDIX G:

Specialist Soil and Agronomy Report

Culcairn sporting Ovals / Grounds

SOIL PROPERTIES AND AGRONOMY OF BILLABONG HIGH SCHOOL AND CULCAIRN RECREATION (FOOTBALL)

03 July 2008

Culcairn Sporting Ovals / Grounds

SOIL PROPERTIES AND AGRONOMY OF BILLABONG HIGH SCHOOL AND CULCAIRN RECREATION (FOOTBALL)

Prepared by:

Dennis E Toohey

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ALBURY NSW 2640

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E-mail: tooheyde@bigpond.net.au

03 July 2008

Disclaimer

Dennis E Toohey makes no representations or warranties as to the accuracy or completeness of the Report, Culcairn Sporting Ovals / Grounds and disclaims all liability for all claims, expenses, losses, damages and costs any third party may incur as a result of them relying on the accuracy or completeness of the Report.

SOIL PROPERTIES AND AGRONOMY OF BILLABONG HIGH SCHOOL AND CULCAIRN RECREATION (FOOTBALL)

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ABBREVIATIONS / UNITS

Megalitre (ML)	1 000 000 litres ($1x10^6$ litres or 1 000 cubic metres ($1x10^3$ m^3)
STP	Sewage Treatment Plant

Note
All prices quoted in report unless otherwise stated are GST Exclusive.

SUMMARY

This is a report into the agricultural / agronomy issues on using tertiary treated effluent water from the Culcairn Sewage Treatment Plant (STP) at the Billabong High School and the Culcairn Recreation (Football) sites.

The assessments have been undertaken in accordance with the *Guidelines for the Use of Reclaimed Water from Municipal Sewage Treatment Plants*, (DEC, 2004).

The findings from the proposed investigations into the soils and agronomy of the ovals and grounds will contribute to the Environmental Impact Statement in these areas:

- The design of a set of best practice irrigation and soil and turf management guidelines.
- The overall assessment of impacts and benefits of applying effluent water.

FINDINGS

From an irrigation perspective the STP waters are categorised as medium to high salinity where a medium rating is 270 to 780 EC and high from 780 to 2 300 EC. Such waters may be used on a long-term basis where leaching of salts within the surface soil occurs through low salinity water and / or rainfall. In well drained soils, like those of this project, salts are more easily leached down deep in the soil profile, beyond the roots of plants.

The waters from the STP are sodic. Unlike salinity, in which the salt in the irrigation water has a direct and predictable impact on the soil, potential sodicity problems from irrigating with sodic water are difficult to predict.

The pH of the soils is within the ideal range. The aim is to keep the pH at above 5.5 in the top 10 cm of soil. The soils are not saline.

The soil at both sites is sodic, i.e. they have a sodium content of more than 6 as a percentage of the Exchangeable Sodium Percentage. Billabong High School has an ESP of 9% and Culcairn Recreation, 10.5%.

The prospect of the sodic STP water being applied to the already sodic soils requires sustained management so as to prevent a worsening of soil structural problems and in turn poor performance of the grasses that constitute the turf.

The solution is to raise the calcium levels in the soil to counteract the deleterious impacts from using a sodic irrigation water. Gypsum is the recommended ameliorant. A trial application and the laying down of test strips in the first year of implementation of the proposal are strongly recommended

In terms of the common plant species for the ovals and grounds of kikuyu (*Pennisetum clandestinum*), paspalum (*Paspalum dilatatum*), couch grass (*Cyndon dactylon*) and trefoil (*Medicago* spp.), they have a moderate degree of tolerance to salinity. The salinity of the STP water at its present level of 0.815 dS/m (815 EC) could rise to 1.2 dS/m with no reduction effect on their growth where there is good internal soil drainage, gypsum is applied and the plants are provided with adequate nutrients.

The management plan for the soils and water is underpinned by their being an integrated soil-moisture-sensor-controlled irrigation system for each of the two areas.

Using soil-moisture-sensor-controlled irrigation systems enables automatic implementation of irrigation schedules that match supply of water to meet the turf's requirements, even when changes in weather occur. Soil moisture sensor controlled irrigation systems enable flexible

watering schedules to be implemented without the need for daily monitoring or seasonal adjustments by personnel. Such systems retail from $1 200.00 and have an annual operating cost of between $200 and $600. These tools to be effective need to be installed correctly with the operator receiving training and support from the supplier / manufacturer.

RECOMMENDATIONS

Arising from the investigations are eight recommendations grouped into three themes.

1. Recommendations to protect the quality of the surface waters surrounding the reuse areas:

   1.1. Install soil-moisture-sensor-controlled irrigation systems at the Billabong High School and the Culcairn Recreation oval.

   1.2. Institute operator training and maintenance support contracts to underpin the successful operation of the soil-moisture-sensor-controlled irrigation systems.

   1.3. Operators of the irrigation systems undertake visual checks of sprinkler operation four times a year and repair/replace sprinkler heads found to be faulty.

2. Recommendations for achieving the sustainable use of the soils for applying reuse water:

   2.1. Establish gypsum test strip sites at both the Billabong High School and Culcairn Recreation to provide guidance on correcting effluent water induced plant growth imbalances that arise within the soil.

   Note. These strips are planned to provide through visual observations guidance on both the quantity and frequency of application of gypsum to counteract the sodium in the effluent water.

   2.2. In the first year, apply gypsum at 250 kg/ha on all areas not associated with the test strips.

   Note. The cost of treating one hectare at a rate of one tonne of gypsum per hectare is around $140.00 based on prices ruling in November 2007.

   2.3. Sample and test quarterly, i.e. four times a year, the ‘treated’ water within the Culcairn STP storage dam.

   Note. The cost to Council is an additional two samplings and testing in the spring and summer to the present autumn and winter analyses.

   2.4 Analyse samples of soil from different depths (0 - 10 cm, 10 - 30 cm) for salinity, sodicity and for plant nutrients. Note..

   Notes. Omit from the sampling program the gypsum test strip areas.

   As the water is of medium to high salinity it is of critical importance to establish an on-going monitor of the soil’s salt content and through the salt balance methodology, the extent of leaching from the winter rains.

   Test once every five (5) years at the same time so that results can be compared to each other with confidence. To address whether there is a risk of a build up of cadmium in the soil arising from applications of phosphatic fertilizers and / or gypsum, test for changes in the presence of this element at the fifth and tenth year after commencing the application of the reuse water and then review.

The cost per five-yearly interval is $172.00 per sample. Assuming 6 samples and analysis charges as per 2007 baseline study, the projected cost is $1 032.00 or an annualised charge of $206.40.

3. Recommendation for sustaining healthy ovals and grounds:

   3.1. Establish an integrated system for recording observations as well as treatments - fertilizers, ameliorants and pesticides (herbicides and insecticides) - so as to provide a permanent maintenance and monitoring record.

FOREWORD

GUIDE TO REPORT

This is the report of investigations into the soil and water issues for using reuse water on the Billabong High School and the Culcairn Recreation (Football) ovals and grounds.

Section One provides the background to and the methodologies applied for undertaking the provision of a soils and water management plan for the ovals and grounds.

Section Two discussions focus upon the two major water quality issues - salinity and sodicity. Assessments of these two issues had regard for the quality of the source water; the projected quality from the proposed enhancements to the Culcairn STP and findings from research and water quality guidelines.

Section Three presents discussion on the analysis of soil samples collected and analysed for the specific purpose of assessing the soils from the two sites as to their suitability for irrigation with reuse quality water.

Section Four presents a plan of managing the areas subjected to the application of reuse water from the perspectives of managing identified risks. A managed approach has been applied to protecting the surrounding surface waters, local groundwater quality and plant health through achieving a sustainable use of reuse water.

Section Five is the annexes of supporting information.

ACKNOWLEDGEMENTS

Sincere thanks to Ms Nuala Jewett, Engineering Support Officer and Tom Plunkett, Water & Sewer Co-ordinator from the Greater Hume Shire Council for the provision of water quality data and general assistance throughout the project. To Mick Powell, Principal and to Stewart Lowe, Farm Assistant, Billabong High School for their support and encouragement during one very hot day when sampling of the soils.

1 STUDY BACKGROUND, OBJECTIVES AND METHODOLOGY

1.1 Background

Greater Hume Shire Council has commissioned investigations into the use of treated sewage effluent water for the purposes of irrigating specific parcels of land, namely the ovals and grounds of the Billabong High School and the Culcairn Recreation (Football) within the town of Culcairn.

An environmental impact statement is being prepared to assess the proposed use of tertiary treated effluent water from the Culcairn Sewage Treatment Plant (STP) that has undergone additional treatments of filtration, disinfection and control over pH. These additional treatments are planned to enhance the suitability of the effluent and bring it into conformity with NSW Department of Environment and Conservation (DEC) licensing requirements.

Council has engaged SJE Consulting Engineers of Albury (**Principal Consultant**) to prepare the Environmental Impact Statement. Dennis E Toohey was engaged as a **Sub-Consultant** by the Principal Consultant to report upon the agricultural / agronomy issues of applying effluent water that accord with the *Guidelines for the Use of Reclaimed Water from Municipal Sewage Treatment Plants*, (DEC, 2004) and National Guidelines for Water Recycling: Managing Health and Environmental Risks, (NRMMC, 2006).

This report has been prepared to address the agricultural / agronomy aspects of the EIS.

1.2 Objectives

Two separate areas amounting to a little over four hectares have been identified for the use of treated effluent water from the Culcairn Sewage Treatment Plant (STP). These areas - Billabong High School and Culcairn Recreation Ground (Football) - and their size are as per Table 1.1 and Figure 1.1.

Table 1.1: Project area

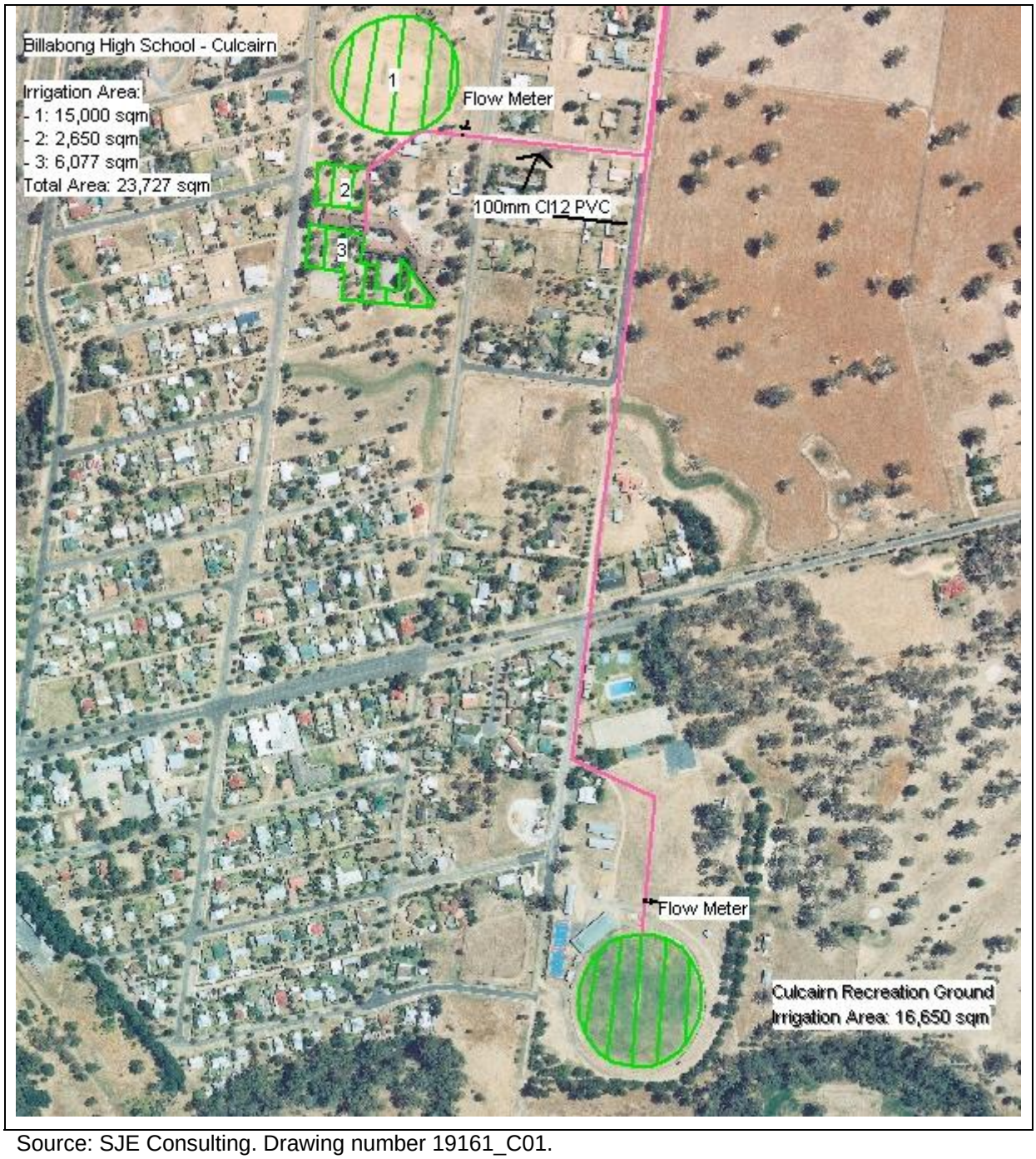
Location	**Estimated area** (square metres)
Billabong High School	
Oval No. 1	15 000
Oval No 2	2 650
Oval No 3	6 077
Sub Total	23 727
Culcairn Recreation Ground (Football)	16 650
Sub Total	16 650
Total	**40 377**

Source: SJE Consulting. Drawing number 19161_C01.

To objectives of the soil properties and agronomy project investigations of the Billabong High School and the Culcairn Recreation (Football) within the town of Culcairn are:

- Assess the suitability of the ovals and grounds for application of effluent water and the necessity for any treatment prior to commencement of their use.
- Develop a best practice soil and grass monitoring program for the ovals and grounds and a financial budget using to-day's prices.
- Present information from investigations into the soils and agronomy as contributions to the design of a set of best practice irrigation guidelines within an appendix to the EIS.

Figure 1.1: Sporting ovals and grounds proposed for reuse water



Source: SJE Consulting. Drawing number 19161_C01.

1.3 Methodology

The critical stages of the methodology deployed within the project were:

1. **A focus upon the soils**. Establishing a soil testing regime that accorded with the requirements of the Guidelines, (DEC, 2004).
2. **Researching quality of reuse water**. The results from the Henty STP plant were used as a surrogate as it has in place identical additional treatments to that proposed for the Culcairn STP. Comparisons were undertaken between the data from Henty with equivalent from Culcairn.
3. **A sustainability irrigation framework**. Interpreting from analytical data on the sampled soils and of the surrogate water source the capacity of the soils to absorb the major nutrients dissolved in the reuse water.
4. **Producing a management plan**. Develop a plan of management for the ovals and grounds.

1.3.1 Soil sampling

The NSW Department of Primary Industries recommendations as appearing in the Guidelines (DEC, 2004) were applied in designing the soil sampling plan as per Table 1.2.

Table 1.2: Soil sampling plan proposal

Oval	Location	Surface sampling		Sub-soil sampling	
		Cores x depth (No)	Samples (No)	Cores x interval (No)	Samples (No)
Billabong High School	No. 1	30 [0-10 cm]	1	2 [4 intervals]	4
	No 2	5 [0-10 cm]	1	1 [4 intervals]	4
	No 3	12 [0-10 cm]	1	1 [4 intervals]	4
Culcairn Recreation		30 [0-10 cm]	1	2 [4 intervals]	4
Samples for analysis			4		16

Drought and water restrictions in combination, severely limited the implementation of the sampling plan. Sub-soil sampling at the Billabong High School extended to only 20 cm. Samples to the sought after 70 cm were achieved at the Culcairn Recreation oval as parts had been recently watered prior to sampling on 19 November 2007.

Level 4 water restrictions (no outside watering) were in place in Culcairn for much of the preceding months. In addition, September and October rainfall registrations for Culcairn were 32% and 30.5% of long term average for respective months, (Pers. Comm. Janet Wilkins, District Agronomist, DPI, Albury, monthly crop reports).

A motorised hand-held 50 mm soil auger was used for taking the soil samples. See Photograph 1.1. Sampling occurred on 19 November with samples delivered to Riverina Laboratories, Albury on 20 November 2007. Laboratory was requested to provide analyses in order to establish their suitability for irrigation. The analyses sought are presented in Table 1.3.

Photograph 1.1: Motorised soil sampler

Table 1.3: Tests performed on the soils

Test	Surface sampled soils	Sub-soil samples
pH ($CaCl_2$)	✓	✓
EC (dS/cm)	✓	✓
P (mg/kg)	✓	✓
N, Total (%)	✓	✓
Exchangeable cations (Calcium, Magnesium, Potassium, Sodium and Aluminium) (mg/kg) and CEC	✓	✓
Organic matter, Total (%)	✓	
Bulk density (gm/cm^3)	✓	✓
Texture	✓	
Clay dispersion (g/100 gm or %)	✓	
Phosphorus sorption capacity (mg/kg)	✓	

1.3.2 Reuse water quality

Reports of recent year's analyses of Culcairn town water supply and the Culcairn STP were sourced from the Greater Hume Shire Council. Comparisons between Culcairn were undertaken with Henty and Albury City Council to provide some regional perspectives.

1.3.3 Sustainability of irrigation

One of the major concerns with water used for irrigation is decreased crop yields and land degradation - expressed at the extreme as bare patches - arising from an excess of salts being present in the water and in soils. Salinity is the term used when referring to soluble salts in the soil or in the water. This and many other terms are defined in Annex 5.7.

The assessment of the suitability of reuse water has regard for the other factors, namely, salt tolerance of the plants, characteristics of the soil under irrigation and the annual loading of major plant nutrients - nitrogen and phosphorus. Climate, soil management and water management practices impact upon the expression of these factors.

Assessment of these factors involves interpreting the inter-relations between the water and the soil that comes from experiences, observations and research. The state departments of primary industries provide guidelines for interpreting water and soil analyses. These guidelines were accessed during the project with a listing appearing in the Bibliography. (Annex 5.6).

1.3.4 Management plan

The management plan will be framed so as to address the objectives of the Guidelines (DEC, 2004) plus other relevant issues that emerged throughout the project.

The findings from the soils and agronomy investigations will be incorporated into the chapters and annexes of the document prepared by the **Principal Consultant**.

2 QUALITY OF REUSE WATER

Global research into the quality of irrigation water has identified two leading parameters that can be deleterious to the sustainable use of soils for irrigation:

- Salinity. Regular use of saline irrigation water will cause soil salinity.
- Sodicity. High sodicity of irrigation water can lead to degradation of soil structure, which is characterised by water infiltration problems. Irrigation water is classified as sodic when above a sodium absorption ratio of 3.

The analysis of the waters has focused upon these two parameters with a brief coverage of three other possible risks: Boron, Cadmium and Chlorine.

Assessment of the water quality matters had regard for:

- The quality of the source of water for Culcairn – water from deep bores.
- The quality of water from the present Culcairn STP and from the Henty STP which has undergone modifications of an identical nature to those planned for Culcairn. In this respect the Henty STP data were used as a surrogate for project planning purposes.
- Research findings, guidelines and reports that are within the public domain and with a focus upon the quality issues experienced in the Southern Murray-Darling Basin and then interpreted in the context of the proposed watering of ovals and grounds at Culcairn.

2.1 Interpreting the water quality

From an irrigation perspective the STP waters are categorised as medium to high salinity where a medium rating is 270 to 780 EC and high from 780 to 2 300 EC. (Annex Table 2). Such waters may be used on a long-term basis where leaching of salts within the surface soil occurs through low salinity water and / or rainfall. In well drained soils (see glossary, Annex 5.7), like those of this project, salts are more easily leached down deep in the soil profile, beyond the roots of plants.

The waters from the STP are sodic. (SAR, column, Annex Table 1). Unlike salinity, in which the salt in the irrigation water has a direct and predictable impact on the soil, potential sodicity problems from irrigating with sodic water are difficult to predict. Of note is the level of calcium and magnesium in the saturated soil water.

The best available source for interpreting the potential risks from irrigating with poor quality water is the Food and Agriculture Organisation (FAO) of the United Nations Organisation. The combined interactions between saline and sodic waters are presented in Table 2.1. At an EC of 815 EC and an SAR of 18 the table reveals there is a high risk of developing potential problems. (Select line with SAR of 12 -20 and look across to find the best match of water quality which is < 1.3 [less than]). Gill, (2005a) urges caution in applying these FAO guidelines as some of the assumptions behind them may not be relevant to irrigation in the southern Murray-Darling Basin.

Table 2.1: FAO guidelines for interpretation of water quality for irrigation

Potential problem associated with water quality	Units	Risk of developing potential problem		
		None	Medium	High
Salinity				
EC of water (EC_w)	dS/m	0.7	0.7 - 3.0	>3.0
Total dissolved solids	mg/L	<450	450 - 2 000	>2 000
Sodicity and salinity				
SAR = 0-3 and EC_w	dS/m	>0.7	0.7 - 0.2	<0.2
SAR = 3-6 and EC_w	dS/m	>1.2	1.2 - 0.3	<0.3
SAR = 6-12 and EC_w	dS/m	>1.9	1.9 - 0.5	<0.65
SAR = 12 -20 and EC_w	dS/m	>2.9	2.9 - 1.3	<1.3
SAR = 20 - 40 and EC_w	dS/m	>5.0	5.0 - 2.9	<2.9

Source: H. S. Gill, NSW Agriculture as published in IREC Farmers' Newsletter, No. 169, Autumn 2005.

In Annex 5.3 the **soil** calcium to magnesium ratio for the soil test results are presented for the Billabong High School and for the Culcairn oval. A quite favourable ratio exists at the High School but it is very close to the desired figure of 2.0 at the latter. The solution is to raise the calcium levels in the soil to counteract the deleterious impacts from using sodic irrigation water. Gypsum is the recommended ameliorant.

In terms of the common plant species for the ovals and grounds of kikuyu, paspalum, couch grass and trefoil, an irrigation water salinity of 1.2 dS/m would have no reduction effect on their growth where there is good internal soil drainage, gypsum is applied and the plants are provided with adequate nutrients. These species have a degree of tolerance to salinity with couch grass having the highest level where waters of up to 4.6 dS/m may be used without resulting in a reduction in yield. Corresponding figures for the other species are: paspalum 2.6, kikuyu and trefoil 2.0 dS/m.

3 SOILS OF THE OVALS AND GROUNDS

There is considerable interest by communities and agencies in using in a safe manner STP water as a substitute for potable water. The droughts of the decade to-date and of climate change are major influencing factors in bringing about this change.

While agencies and local councils encourage the safe, sustainable use of effluent, it is recognised that a case-by-case approach is required. Adoption of the EIS methodology ensures that all the issues and risks are fully addressed with strategies proposed for their addressing.

The NSW Government through the Department of Environment and Conservation has framed seven environmental performance objectives to apply to the use of effluent by irrigation. See listing below. The findings from investigations into the suitability of the soils proposed for receiving effluent water are fundamental to the conduct of the EIS.

3.1 Billabong High School soils

The test results do not show any major changes between surface samples, i.e. 0 - 10 cm and those of the sub-soil, i.e. 0 - 20 cm, thus commentary focuses upon the surface soils. (Annex Table 3). The texture of the surface soils was assessed in the laboratory as sandy loam. There were no signs of layering within the soil profile.

Acidity

The pH of the soils is within the ideal range of 5 to 7. The aim is to keep the pH at above 5.5 in the top 10 cm of soil.

Major elements

Nitrogen. The average reading is 0.18 mg/L. Readings of less than 0.1 are rated as low; with 0.1 to 0.2 given a medium rating, (Abbott, 1989). The slightly lower readings at the 0 - 20 cm depth of 0.12 mg/L are an expression of lower levels of organic matter, which is a normal feature.

Phosphorus. The phosphorus level in all samples, (average of 247mg/L) is very high, possibly arising from past liberal applications of phosphatic fertilizers or manures.

Secondary elements

Sodium percentage, at 9.7% of the sum of exchangeable cations, i.e. calcium + magnesium + potassium + aluminium + sodium, is nearly twice the desirable figure of ‘less than 5%, (Brown and Smith, 1998). Three of the four samples collected from the 0 to 10 cm depth had an Exchangeable Sodium Percent (ESP) at or exceeding 8 with fourth having an ESP of 6. The two deeper samples (0 to 20 cm) had an ESP of 10.

These high ESP readings are partly a natural phenomenon and partly attributable to the source of Culcairn’s water being from bores where the level of sodium is 64 mg/L (median value, 2001 to 2007) and with a salinity content of 367 EC (median value, 2005 to 2007), (Water test results supplied by Greater Hume Shire Council).

Calcium levels vary across the three sites at the 0 - 10 cm depth. In Area #1, they average 54% of the sum of exchangeable cations, which is less than the lowest point of the desirable

range of 65 - 80%. For Area #2 and #3, the calcium level is 65% thus at the lower end of the desirable range.

Magnesium and aluminium are within the desirable ranges for % cations.

Calcium to magnesium ratio at 4, i.e. 2 parts calcium to 1 part magnesium, is twice the desired minimum. If there are high levels of magnesium it has a similar effect upon the soil to that of sodium in causing dispersion. This is not the situation at the High School.

Salinity

The electrical conductivity of the soil water solution averages 0.4 dS/m or 400 EC across all soil depths. This quite low level of salinity has no reduction affects upon the growth of the plants. Such background salinity levels are encouraging in that no special measures are required beyond that of routine monitoring.

Other

Organic matter at 2.0% is at the target levels. Again this is encouraging and should be maintained through the application of a soundly-based watering and fertilizing regime.

Exchangeable Sodium Percentage at an average of 9%, (0 to 10 cm) is more than the desired maximum of 6%. At this level the soil has a probability of displaying signs of dispersion. Dispersive soil problems can be addressed through the periodic application of gypsum in conjunction with soil testing.

3.2 Culcairn Recreation Oval

COMMENTS

The test results do not show any major changes between surface samples, i.e. 0 - 10 cm and those of the sub-soil, i.e. 0 - 20 cm, thus commentary focuses upon the surface soils. (Annex Table 4). The texture of the surface soils was assessed in the laboratory as sandy loam. There were no signs of layering within the soil profile.

Acidity

The pH of the soils - both surface and subsoil is within the ideal range of 5 to 7. The aim is to keep the pH at above 5.5 in the top 10 cm of soil.

Major elements

Nitrogen. The average reading is 0.18 mg/L. Readings of less than 0.1 are rated as low; with 0.1 to 0.2 given a medium rating, (Abbott, 1989). The slightly lower readings at the 0 - 20 cm depth and lower of 0.16 to 0.0 mg/L, are an expression of lower levels of organic matter, which is a normal feature.

Phosphorus. The phosphorus level in all samples is very high, (range of 88 to 240 mg/L) possible arising from past liberal applications of phosphatic fertilizers or manures. The lower readings at depth also high but reflect the normal scene of highest levels being present in the upper 10 cm. Phosphorus is not very mobile in the soil.

Secondary elements

Sodium percentage, at 13.5% of the sum of exchangeable cations, i.e. calcium + magnesium + potassium + aluminium + sodium, is 2.7 times higher than the desirable figure of ‘less than 5%, (Brown and Smith, 1998). ESP readings increased with depth. At the 0 to 10 cm, 10.5 average; 0 to 20 cm 13; 20 to 40 cm 19; and 10 to 70 cm the ESP was 23.

These high ESP readings are partly a natural phenomenon and partly attributable to the source of Culcairn’s water being from bores where the level of sodium is 64 mg/L (median

value, 2001 to 2007) and with a salinity content of 367 EC (median value, 2005 to 2007), (Water test results supplied by Greater Hume Shire Council).

Calcium levels are consistent at 55% of the sum of exchangeable cations, which is less than lower point of the desirable range of 65 - 80%.

Magnesium levels at 20% are higher than the desirable range of 10 - 15% and may induce potassium deficiency. However, as the level of potassium is at the high end of the range (1 to 5% of the sum of exchangeable cations) this is an unlikely event.

Aluminium is well below the maximum desirable figure of less than 5% with a reading of 0.3%.

Calcium to magnesium ratio at 2.7:1 is on the desired minimum, i.e. 2 parts calcium to 1 part magnesium. Compared to the Billabong High School areas, the Culcairn oval has comparable levels of calcium but it is the higher magnesium level, (345 mg/L compared to High School of 220 mg/L) at the latter which result in a less favourable ratio.

Salinity

The electrical conductivity of the soil water solution averages 0.54 dS/m or 540 EC for the 0 to 10 cm soil samples with slightly lower readings at depth. These readings reflect a soil containing a low level of dissolved salts (salinity), which if maintained will not be a causal factor limiting the growth of the plants. Such background salinity levels are encouraging in that no special measures are required beyond that of routine monitoring.

Other

Organic matter at 1.8% is just outside the target level of 2.0%. Again this is encouraging and should be maintained through the application of a soundly-based watering and fertilizing regime.

Exchangeable Sodium Percentage at an average of 10.5%, (0 to 10 cm) is nearly twice that of the desired maximum of 6%. At this level the soil has a probability of displaying signs of dispersion. Dispersive soil problems can be addressed through the periodic application of gypsum in conjunction with soil testing.

3.3 Nitrogen and phosphorus sustainability

Reclaimed waters from STPs contain valuable plant nutrients. Their content requires assessment for these reasons:

- Avoidance of over applying nutrients that may lead to adverse impacts upon the soil, e.g. soil acidification and ‘externalities’, e.g. contamination of underground water supplies.
- Accounting for the dissolved nutrients in the irrigation water as well as of those of artificial fertilizers or organic manures.

Sustainable application rates of reclaimed waters are governed by the ability of the grasses to utilise the nutrients in the STP water or for the soils to immobilise them. This in turn depends on the soil type and growth rates of the grasses.

Worked examples of sustainable nitrogen and phosphorus loadings are presented below.

3.3.1 Nitrogen loading

The behaviour of nitrogen in plant-soil systems is complex where both inputs and outputs of the element have to be accounted for. The calculation of sustainable nitrogen loading is based upon:

- The concentration of nitrogen in the STP water.
- The rate of uptake of nitrogen by the plants and if the mown grass is removed, its nitrogen content.
- The amount of any of losses of nitrogen to the atmosphere and to the soil organic pool.

For this project, a simple approach was taken by comparing the amount of nitrogen applied in the water to the amount used by the grasses that constitute the turf for the ovals and grounds. From Annex Table 5 , there is an estimated 14 kg of nitrogen applied annually based on 909 mm reuse water being applied. This equates to an application of 30 kg/ha of Urea (46% nitrogen) or a 'saving' upon the annual nitrogen fertilizer purchases of 14 kg/ha (200 kg/ha nitrogen is a typical fertilizer regime for well-maintained sporting ovals).

A rate of 14 kg/ha/year of nitrogen sourced from the STP water applied as irrigations, being seven percent of the typical nitrogenous fertilizer regime for ovals, is assessed as being sustainable. Sustainability is also achieved should the nitrogen content be 5.3 mg/L (median value from Annex Table 2) where 48 kg N/ha/year is supplied to the soil when 909 mm of reuse water is applied.

3.3.2 Phosphorous loading

Phosphorus is primarily utilised by growing plants but the soils also have a capacity to adsorb (or sorb) phosphorus to clay particles, thereby immobilising it. The sorption capacity of soils differs widely as evidenced from analysis of samples taken from the Billabong High School and the Culcairn Recreation oval. For the High School, the average sorption was 190 mg/kg compared to the Culcairn oval of 95 mg/kg. (Annex Table 6 and Annex Table 7) The reasons for such differences have not been explored but in part are related to the initial phosphorus contents: High School 247 mg/kg (average, 0 - 10 cm) compared to 200 mg/kg at the Culcairn oval.

The calculation of sustainable phosphorus loading is based upon:

- The concentration of phosphorus in the STP water.
- The rate of uptake of phosphorus by the plants.
- The level of phosphorus sorption in the soil before leaching of phosphorus occurs.
- The expected life of the project.

The Guidelines, (DEC, 2004) provide a worked example for calculating phosphorus sustainability. This approach was adopted for the project with sustainability calculations undertaken for the Billabong High School and for the Culcairn oval. See Annex Table 6 and Annex Table 7, respectively. In these calculations the determining factor for establishing sustainability is the number of years of life which is the measure used in setting up load-based licence conditions by environmental agencies.

Both sites have very acceptable sustainable life timeframes: the High School site has a calculated 50 year life for absorbing phosphorus whereas for the Culcairn oval it is 20 years

under an identical methodology. Again the differences are attributed to the soils absorptive properties and their initial phosphorus levels.

One measure for achieving a comparable sustainability life at the Culcairn oval to the High School is to remove, at the time of mowing, some of the mown grass. Should it be assessed as desirable to achieve this 50-year goal, then by removing 7.3 t/ha of mown grass (dry matter equivalent [1]) from the total annual production of say 15 t/ha (dry matter), the sustainable phosphorus life of the Culcairn oval achieves 50 years.

[1] The phosphorus content of a tonne of grass pasture assumed to be 2.9 kg/ha.

4 MANAGEMENT PLAN

The NSW Government through the Department of Environment and Conservation has established environmental performance objectives on the use of effluent by irrigation. These objectives have in turn become the framework for preparing a management plan on the soils and water issues that arise from the use of Culcairn STP treated water.

4.1 Environmental performance objectives

The environmental performance objectives publicised as, Environmental Guidelines: Use of effluent by irrigation, (DEC, 2004) have been adopted for the project. The relevant guidelines for the soils and water matters are:

Protection of surface waters. Effluent irrigation systems should be located, designed, constructed and operated so that surface waters do not become contaminated by any flow from irrigation areas, including effluent, rainfall runoff, contaminated sub-surface flows or contaminated groundwater.

Protection of groundwater: Effluent irrigation areas and systems should be located, designed, constructed and operated so that the current or future beneficial uses of groundwater do not diminish as a result of contamination by the effluent or runoff from the irrigation scheme or changing water tables.

Protection of lands. An effluent irrigation system should be ecologically sustainable. In particular, it should maintain or improve the capacity of the land to grow plants, and should result in no deterioration of land quality through soil structure degradation, salinisation, waterlogging, chemical contamination or soil erosion.

Protection of plant and animal health. Design and management of effluent irrigation systems should not compromise the health and productivity of plants, domestic animals, wildlife and the aquatic ecosystem. Risk management procedures should avoid or manage the impacts of pathogenic micro-organisms, biologically active chemicals, nutrients and oxygen depleting substances.

Resource use. Potential resources in effluent, such as water, plant nutrients and organic matter, should be identified, and agronomic systems developed and implemented for their effective use.

The remainder of this Section contains the detailed responses to the above objectives.

4.2 Protection of surface waters

The best protection that may be offered to local surface waters is an irrigation system that can be readily adjusted to suit local circumstances and is easy to operate. Pressurised irrigation systems equipped with devices for measuring either changes in soil moisture or climate or both enable the operator to supply only what is required by the plants thereby avoiding impacts upon surrounding areas.

4.2.1 Risks identified

- Excess irrigation beyond soil fill point with water flowing off site.
- Irrigation continuing during rainfall and/or when soil is saturated thus allowing effluent to flow off site.
- Irrigation system isn't maintained.

4.2.2 Scheduling of irrigations

Scheduling matches plant needs and irrigation timing.

Matching the timing of irrigations to plant water demand will improve the performance of the turf species and in turn the appearance and the softness-hardness feel of the land, minimise accessions to the groundwater and reduce risks of runoff.

In Annex 5.5.3 a four-step methodology is presented of a simple scheduling system commencing with measuring the water within the soil containing the bulk of the plants roots. Whilst the methodology is low cost and simple to apply it requires daily attention and is not geared to automation. Scheduling involves responding to the prevailing climatic conditions. In Annex Table 11 an illustration is provided of scheduling when well above average rainfall is received in a month.

Using soil-moisture-sensor-controlled irrigation systems enables automatic implementation of irrigation schedules that match supply of water to meet the turf's requirements, even when changes in weather occur. Soil moisture sensor controlled irrigation systems enable flexible watering schedules to be implemented without the need for daily monitoring or seasonal adjustments by personnel.

There are a number of such integrated tools like EnviroSCAN® and EasyAg® that log the soil moisture through probes inserted in the soil. EasyAg is a mini-EnviroSCAN being designed for shallow-rooted plants. They retail from $1 200.00 and have an annual operating cost of between $200 and $600, (Charlesworth, 2005). These tools to be effective need to be installed correctly with the operator receiving training and support from the supplier / manufacturer.

4.2.3 Maintenance of irrigation system

The standard of the irrigation system and the manner in which it is operated are critical matters. For instance, where the output from a sprinkler head is substantially above that for which it was designed, over watering results that can lead to excesses of nutrients and resultant environment not conducive for plants to grow, i.e. appearance of dead areas.

Sprinklers may malfunction for a variety of reasons such as blockages, mechanism damaged whilst mowing or through malicious acts. Routine checks at least visually, are sought. Where visual observations reveal unevenness of application and there are no faults with the mechanisms then reporting of such discrepancies to be made to the system maintenance supervisor.

Recommendations

1. Install soil-moisture-sensor-controlled irrigation systems at the Billabong High School and the Culcairn Recreation oval.

2. Institute operator training and maintenance support contracts to underpin the successful operation of the soil-moisture-sensor-controlled irrigation systems.

3. Operators of the irrigation systems to undertake visual checks of sprinkler operation four times a year and repair/replace sprinkler heads found to be faulty.

4.3 Protection of groundwater

Groundwater is an important resource and needs to be managed so as to prevent its devaluation. It is an important commodity and is a vital component of both urban and rural industries and our economic and social framework. In the Culcairn community, groundwater provides the potable reticulated water system.

4.3.1 Risks identified

- Excessive fertiliser application in conjunction with over-watering resulting in contamination of groundwater.
- Salt and other chemicals getting into groundwater.

4.3.2 Groundwater degradation

Groundwater and surface water systems are closely integrated in the water cycle. Surface waters can flow naturally to groundwater carrying with them dissolved chemicals that were applied to growing plants as reuse water.

Whilst the quality of the reuse water is of a very high standard it has a high salt content as measured against criteria as to its suitability for irrigation.

No additional measures to those proposed elsewhere are necessary for addressing the risks. If these measures, notably those discussed and recommended in Section 4.2, are fully implemented they will protect the local shallow groundwater from degradation arising from the utilisation of reuse water on Culcairn's ovals and grounds.

4.4 Protection of lands

It is a sound management approach to have an on-going soils and irrigation system monitoring program to complement the routine watering and fertilizing of the ovals and grounds. The necessity for a soil and irrigation monitoring program may arise from one or all of the following:

- Provision of well-founded information on the use of treated effluent water to the Billabong High School and to the trustees / managers of the Culcairn Recreation oval (Football).
- Provision of early notification as to impending issues requiring intervention which can be budgeted for. Alternatively, operations continuing as per established practices.
- Fulfilling Council's internal risk management policies and those of the State Government.
- Fulfilling in a cost-effective way licence or other requirements placed by agencies upon Council.

Sporting ovals and grounds are perceived as fixed infrastructure on the landscape unlike crops of wheat or pasture on a farm where the farmer has considerable flexibility as to where they appear on the farm. Thus where a farmer can and does use the concept of rotating the uses of the land as a tool for managing the soils, managers of sporting oval have to act in ways that will provide early warning signs of impending issues.

For the study's ovals and grounds the driving force has been the inability to use potable water arising from restrictions imposed by the Council in response to directives from the NSW Government. Dissolved within the effluent water are essential nutrients for healthy plant growth. There are also substances that can harm the soil. Finally, it is possible to over water the soil and render it unsuitable for growing turf species. These risks are considered from an agricultural perspective in the following paragraphs.

4.4.1 Risks identified

- Changes to the soil structure that prevents proper drainage and aeration.
- Rise in soil salt levels.
- Too much water applied resulting in water logged soils.

4.4.2 Soil chemical sustainability

Assessments were undertaken in accordance with the Guidelines, (DEC, 2004) by calculating the capacity of the soils to absorb the nitrogen and phosphorus load in the effluent water.

An actively growing sward producing 15 000 kg dry matter is estimated to require 525 kg N/ha/year. From Annex Table 5 , the water supplies an estimated 14 kg of nitrogen based on 909 mm reuse water being applied. From these parameters the sustainable application of nitrogen is 35 kg/ha/year. The plants requirement for nitrogen well exceeds the nitrogen applied in the reuse water at the estimated annual rate of 909 mm per year. See Section 4.6 for further discussion on sustainability.

Both sites have very acceptable phosphorus sustainable life timeframes: the High School site has a calculated 50 year life for absorbing phosphorus whereas for the Culcairn oval it is 20 years. (See Section 3.3.2 for discussion on raising the sustainable life of the Culcairn site to 50 years).

The salt content of the reuse water is 0.815 dS/m or 815 EC, (from Annex Table 1). Waters of this salinity contain about 520 kg of salt per megalitre [2] (based upon 1 dS/m water containing about 640 kg of salt). Hence, around 520 kg of salt, primarily chloride, is applied per 100 mm of reuse water or 4 680 kg, if 909 mm applied per year. Monitoring of the soil's chloride content will enable the establishment of relationship between the amount of reuse water applied and the movements in soil salt levels.

Soil testing in the laboratory is the main way to determine the fertility or chemical properties of a soil. Testing costs are small compared with the savings that can be made by more efficient use of fertilisers and other soil amendments.

A complete soil test supplies over a dozen pieces of information, some of which are valid for a substantial length of time. Soil tests are also carried out to prevent the under or oversupply

[2] A megalitre of irrigation water would cover one hectare to a depth of 100 mm. One megalitre is one million litres which is equivalent to 1 000 cubic metres (m^3).

of nutrients, monitor changes in nutrient levels over time and help decide which areas to fertilise.

Assessments were undertaken of three supplementary analytes - boron, cadmium and residual chlorine. Only cadmium was identified as a risk that required monitoring through inclusion of this analyte in the early years of the soil testing regime.

4.4.3 Soil structure

High concentrations of sodium in irrigation water can result in the degradation of well-structured soils, i.e. a loss of structure. Where the Sodium Adsorption Ratio (SAR) value is 3 or higher this is **sodic water**. Culcairn's water supply source - bore - median SAR figures for 2006 and 2007 had a calculated SAR of 18. Such SAR values are not unexpected from deep groundwater bores in the Murray Valley of NSW, (Gill, 2005b) where median values of 6.7, SAR for the Calivil aquifer (bores extracting between 70 to 140 metres below the surface) and 9.3, SAR in Renmark aquifer (140 to 350 metres).

A **sodic soil** has an Exchangeable Sodium Percentage (ESP) of more than 6. This means that sodium comprises more than 6% of the total exchangeable cations in the soil. Both sites exceed this threshold level at the 0 to 10 cm depth:

- Billabong High School. ESP of 9%.
- Culcairn. ESP of 10.5%.

These soils are already classified as sodic and through the use of sodic water their sodicity level will worsen in the absence of amelioration. The preferred method of amelioration is the application of gypsum as detailed in the following paragraphs.

There is an inter-relationship between the EC of the irrigation water and that of SAR. A water of 1 000 EC units and an SAR of 4 will not produce unstable soil structure. However a water of 200 EC units at the same SAR is most likely to present soil structural problems.

Infiltration problems primarily occur in the upper centimetres of the soil. Hence, it is normally more effective to apply small, frequent doses of gypsum, left on the soil surface or mixed with the upper few centimetres of the topsoil than higher doses incorporated deeper in the soil profile.

Tests undertaken in the laboratory inform the soils are already dispersive. Clay dispersion % of 5 were recorded which is high [3].

It is possible to calculate the theoretical amount of gypsum required to reduce the sodicity from its present value to zero. This is usually of little value in practice, however, because the calculated rate is frequently very high (exceeding 10 t/ha), (Abbott and McKenzie, 1986).

The favoured method for establishing a soil's responsiveness to gypsum is to establish test strips. Here strips of say five metres by 20 metres of turf have gypsum applied at differing rates, usually in the autumn. Each strip represents one rate of gypsum. Typical rates are within the range of 200 kg/ha up to 1 000 kg/ha. Following the application of the gypsum within the strips all subsequent treatments such as watering and fertilizing are to be identical to that of the oval or ground. During the ensuing 12 months look within the strips for increased growth of the plants and changes in infiltration of water. These observations will help in deciding whether or not the soil is responsive to gypsum and if so what rate to use over the oval or grounds. Continued observations in subsequent years will suggest when to reapply.

[3] Clay dispersion percentages of 1 to 2% are rated low; 2 to 5%, as medium.

Gypsum from mines in western NSW and north west Victoria has a landed price of $60.00 per tonne at Wodonga. The cost for treating a hectare at a rate of one tonne is around $140.00 based upon the following assumptions:

Travel, Wodonga to Culcairn, round trip	$70.00
4 ha treated with gypsum @ 1 t/ha	$240.00
Spreading, $80.00 per hour by 3 hours	$240.00
Total	**$550.00** or $137.50 per hectare.

The standard of the irrigation system and the manner in which it is operated are critical matters. For instance, where the output from a sprinkler head is substantially above that for which it was designed, over watering results that can lead to excesses of nutrients and resultant environment not conducive for plants to grow, i.e. appearance of dead areas.

Sprinklers may malfunction for a variety of reasons such as blockages, mechanism damaged whilst mowing or through malicious acts. Routine checks at least visually, are sought. Where visual observations reveal unevenness of application and there are no faults with the mechanisms then such discrepancies to be reported to the system maintenance supervisor.

Recommendations

4. Establish gypsum test strip sites at both the Billabong High School and Culcairn Recreation to provide guidance on correcting effluent water induced plant growth imbalances that arise within the soil.

   These strips are planned to provide through visual observations guidance on both the quantity and frequency of application of gypsum to counteract the sodium in the effluent water.

5. In the first year, apply gypsum at 250 kg/ha on all areas not associated with the test strips.

6. Sample and test quarterly, i.e. four times a year, the ‘treated’ water within the Culcairn STP storage dam for these analytes:

   Conductivity, pH; Total phosphorus as P; Total nitrogen as N; Bicarbonate Alkalinity as HCO_3; Chloride as Cl; Calcium as Ca; Magnesium as Mg; Sodium as Na; Potassium as K and Sodium Adsorption Ratio.

   The cost to Council is an additional two samplings and testing in the spring and summer to the present autumn and winter analyses.

7. Analyse samples of soil from different depths (0 - 10 cm, 10 - 30 cm) for salinity, sodicity and for plant nutrients. Note. Omit from the sampling program the gypsum test strip areas. As the water is of medium to high salinity it is of critical importance to establish an on-going monitor of the soil’s salt content and through the salt balance methodology, the extent of leaching from the winter rains. Test once every five (5) years at the same time so that results can be compared to each other with confidence. The analytes to be tested are:

   Conductivity, pH; Total phosphorus as P; Total nitrogen as N; Exchangeable Sodium, Potassium, Calcium, Magnesium, Aluminium and Cadmium; Cation Exchange Capacity; and Exchangeable Sodium Percentage (ESP). After testing for Cadmium in the fifth and tenth year undertake a review as to a need for its continuation.

   The cost per five-yearly interval is $172.00 per sample. Assuming 6 samples and analysis charges as per 2007 baseline study, the projected cost is $1 032.00 or an annualised charge of $206.40.

4.5 Protection of plant health

The impositions of restrictions in towns on the use of water for outside garden purposes have been a major force propelling the proposal for reusing the Culcairn's STP water on nominated ovals and grounds. When implemented, it will address the major impediment, i.e. the lack of water for realising the value of these areas. However, plants as well as the soil, (see discussion in Section 4.4) can display signs of receiving too much water and in extreme circumstances the impacts of over watering may extend beyond the ovals and grounds. These risks are considered in the following paragraphs.

4.5.1 Risks identified

- The reuse water lowers the productivity of the turf grasses and legumes.
- Too much fertilizer applied that in some ways limits the capacity of the soils to sustain healthy growing plants.
- Weeds and their propagation off-site.

4.5.2 Turf maintenance

A common error with turf maintenance is over watering. This practice promotes excessive growth encouraging thatch build-up and fungal attack. Adoption of a watering schedule as presented in Section 4.2.2 that encourages deep as opposed to shallow root structure builds up the plants ability to tolerate the heated up top layer of soil.

Watering during the evening reduces evaporation losses but encourages fungal growth by keeping the turf damp. Program irrigations to occur approximately one hour before sunrise when wind is usually calm and water can be taken up through roots before evaporation begins.

In the summer months apply this general rule of thumb: irrigate once to twice a week for as long until the calculated soil refill point has been achieved [4]. This approach will encourage the plant root system to penetrate deeper into the soil allowing better resistance to the hotter days.

Observations of the growth of the turf (grass and legumes) within the ovals and grounds complement the soil monitoring program. For instance, the appearance of thin patches may indicate the turf is being mown too closely, trampled excessively or badly watered. Signs of replacement of kikuyu (*Pennisetum clandestinum*) with couch grass (*Cyndon dactylon*) may signify the soil has increased levels of salt as the latter species is more tolerant of salt in the soil. An integrated system is required for recording observations as well as treatments - fertilizers, ameliorants and pesticides (herbicides and insecticides) - so as to provide a permanent monitoring record.

[4] The refill point varies with most scheduling systems based upon keeping the soil moisture level above 50% of the available water. Refilling the profile before the 50% level is reached minimises plant stress. See also discussion in Annex 5.5.3.

Fertilizers whilst essential part of regular turf maintenance can also have detrimental effects. Too much fertilizer or fertilizers applied in the wrong quantity or conditions can cause the following problems:

- Create disease problems.
- Create a build up of thatch over a very short period of time.
- Scalding or burning of lawn.
- Encourage weed growth.

When fertilizing, adopt the following techniques:

- Apply the product evenly with a spreader.
- Apply quantities as directed by the manufacturer (see information on the bag).
- Fertilize regularly but lightly.
- Water following applying fertilizer.

Weeds pose a minor risk both within the watered area and surrounding areas. The water is not likely to contain suspended weed seeds as discharges into the STP are from residences. The watering regime is planned to achieve an actively growing spread of grasses and legumes throughout the year. An actively growing sward affords the best protection from unwanted plants establishing. Further, through regular mowing of the ovals and grounds and buffer areas most weeds will be inhibited from setting seed. For low spreading weeds like Khaki Weed (*Alternanthera pungens*) and Caltrops (*Tribulus terrestris*) chip out with a hoe when plant is flowering or if dense, apply a non-residual herbicide, e.g. Glyphosate (Roundup®). The proximity of gardens and vegetable or vine crops makes the use of 2, 4-D inadvisable.

High chloride levels in water may cause poor plant growth and death of sensitive plants, particularly if sprayed on leaves. Damage to plants is expressed on the foliage as leaf burn, bronzing and leaf drop. For example, signs of chloride affects on lucerne appear when the chloride concentration is between 350 - 750 mg/L, (Yiasoumi, 2005). Reuse water with chloride levels below 175 mg/L will not result in damage to plants.

Recommendation

8. Establish an integrated system for recording observations as well as treatments - fertilizers, ameliorants and pesticides (herbicides and insecticides) - so as to provide a permanent maintenance and monitoring record.

4.6 Resource use

The effluent water contains useful amounts of two major plant nutrients, namely nitrogen and phosphorus. Assessments were made as to the sustainable application of reuse water by measuring the ability of the plants to utilise the nutrients or for the soils to immobilise them. As was found in Section 4.4.2 this depends upon the soils.

A simplified nutrient balance was been constructed below to illustrate the accounting for the major plant nutrients in the water when devising a fertilizing program

At median Culcairn STP water qualities the respective plant nutrient resource findings are:

- Nitrogen. 14 kg N/ha/year is supplied to the soil when 909 mm of reuse water is applied or 1.5 kg N/ha/100 mm of reuse water. This small amount of nitrogen, i.e. 14 kg

when delivered in 909 mm of reuse water equates to 7% of the 200 kg/ha nitrogen a typical fertilizer regime for well-maintained sporting ovals.

- Phosphorus. 36 kg P/ha/yr is supplied to the soil when 909 mm of reuse water is applied or 4 k P/ha/100 mm of reuse water. At 36 kg/ha/yr of phosphorus this equates to 316 kg/ha of single superphosphate (11.4 %P) or 79% of the 45 kg phosphorus requirements for achieving an actively growing sward of species throughout the year.

These amounts of nitrogen and phosphorus sourced from the reuse water must be accounted for when working out the **net annual** application of nitrogenous and phosphatic fertilizers.

Assumptions[1]:

Nitrogen fertilizer. 46 % nitrogen as Urea @ $490.00/tonne. Total nitrogen applied per annum is 200 kg.

Phosphatic fertilizer. 11.5 % phosphorus as Single Super @ $215.00/tonne. Total phosphorus applied per annum is 45 kg.

Reuse water. 909 mm per hectare per annum.

Note 1. 2007 NSW Department of Primary Industries, Gross Margin budgets.

'Net' Nitrogen budget (kg/ha)

Total nitrogen	= fertilizer nitrogen + reuse water nitrogen
200 kg	= x kg + 14 kg
200 - 14	= 186 kg N
186 kg N	= 404 kg urea at a cost of $197.96 per hectare.

'Net' Phosphorus budget (kg/ha)

Total phosphorus	= fertilizer phosphorus + reuse water phosphorus
45 kg	= x kg + 36 kg
45 - 36 kg	= 9 kg P
9 kg P	= 78 kg single superphosphate at a cost of $16.77 per hectare.

5 ANNEXES

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ANNEX 5.1 PROJECT TIMETABLE

Greater Hume Shire Council Use of treated effluent on selected sporting ovals Study								
TIMETABLE 2007 2008								
	WEEK COMMENCING							
TASK	WK 1 12 - 16 Nov	WK 2 19 - 23 Nov	WK 3 26 - 30 Nov	WK 4 03 - 07 Dec	WK 5 10 - 14 Dec	WK 6 - 7 17 - 28 Dec	WK 8 - 11 01 - 25 Jan	WK 12 29 Jan - 01 Feb
Stage I **Management briefing** * Confirm project scope * Planning timeline * Collecting reports								
Stage II **Soil sampling and analysis** * Sample soils * Laboratory analysis								
Stage III **Sustainability of irrigation** * Matching of the water to the soils * Framing management actions								
Stage IV **Reporting on project** * Draft report								
Stage IV (Continued) * Review of draft								
Stage IV (Continued) * Revise and finalise report								
Reviews with Management Committee	**							

ANNEX 5.2 WATER TEST RESULTS

The analysis of the waters has focused upon two parameters:

- Salinity. Regular use of saline irrigation water will cause soil salinity.
- Sodicity. High sodicity of irrigation water can lead to degradation of soil structure, which is characterised by water infiltration problems. Irrigation water is classified as sodic when above 3.0, sodium absorption ratio.

Three other parameters were also considered, namely, Boron, Cadmium and Chlorine (as disinfection residual) with their risks assessed in the absence of local data against typical values from the literature.

Annex 5.2.1 Water quality of sewage treatment works

Water test results were supplied for the Culcairn, Henty and Albury City Sewage Treatment Plants and brought together to produce a representative collection of data for analysis. (Annex Table 1). For Culcairn, an additional purpose was to review the extent of variation of salinity where the median for June was 750 EC (Annex Table 2) compared to an all-tests median of 815 EC.

Annex Table 1: Water quality, sewage treatment plants

Location	pH	EC	Total P (mg/L)	Total N (mg/L)	SAR
Culcairn [1]	7.8	815	7.25	5.25	
Henty - raw [1]	7.8	675	9.0	5.1	
Henty - treated [2]	7.9	860	4.0	1.5	5.3
Albury City [3]	n.a.	517	n.a.	n.a.	
Notes					
1. Median values for tests, 2005 to 2007.					
2. Final treatment pond - Modified for reuse on recreation ovals. 22 Nov 2007					
3. Mean values for tests, 2004 to 2006. Anthony Foley, Albury City Council, 4 Dec. 2007.					
n.a. - not available					

Sources. Greater Hume Shire Council and Albury City Council.

The low STP, EC value for Albury is attributed to the much lower EC for the city's water source - the River Murray. Water source values for the centres are:

- Albury. 44 EC. Anthony Foley, Albury City Council, 4 December 2007.
- Culcairn. 367 EC.
- Henty. 256 EC. Leanne Hastings, Riverina Water, 30 November 2007.

The substantially lower phosphorus and nitrogen content of the Henty STP for November 2007 compared to that of its median values warrants some follow-up inquiries with the analytical firm by Council to see if there has been any change in testing procedures.

Annex Table 2: Water quality, Culcairn sewage treatment plants, 2005 to 2007

Year	Date	Test number	pH	EC	Total P (mg/L)	Total N (mg/L)
2005	17-Mar	3514	7.9	850	11.0	7.3
2005	23-Jun	8520	7.8	720	5.5	3.9
2005	8-Sep	13638	7.8	760	6.7	3.8
2005	9-Nov	17453	7.9	790	7.6	11
2006	9-May	8285	7.8	840	8.7	6.8
2006	28-Jun	11966	7.7	750	6.9	4.5
2007	26-Jun	14279	7.7	840	7.1	4.4
2007	27-Sep	23985	8.0	890	7.4	6
		Minimum	7.7	720.0	5.5	3.8
		Maximum	8.0	890.0	11.0	11.0
		Median	7.8	815.0	7.3	5.3

Source. Greater Hume Shire Council.

There are no Sodium Adsorption Ratio figures for the Culcairn STP which is a matter to be addressed within the reuse proposal. The Henty STP has an SAR of 5.3 for the final treatment pond. (Annex Table 1). The median SAR figure for Culcairn water source for 2006 and 2007 is 18. It is speculated that the Culcairn STP will have an SAR reading of at least 18.

There is a general relationship between the salt content of the irrigation water and what might be the salt content of the recipient soil. This relationship is expressed as follows:

ECe (dS/m) = 0.0015 x ECw (EC units), approximate.

Where ECe is the electrical conductivity of the saturated soil water and ECw is the electrical conductivity of the irrigation water.

From the median EC in Annex Table 2 the formula produces an approximate soil water salinity of 1.2 dS/m. A soil water salinity of 1.2 dS/m exceeds the salt tolerance of sensitive crops like, beans and peas (where the maximum value is 1.0 dS/m) and would have a substantial detrimental impact upon yields of subterranean clover (maximum value 1.5 dS/m).

Annex 5.2.2 Supplementary analytes

The available analyses of water produced within the Culcairn and Henty STPs do not extend to the provision of test results for boron, cadmium or residual chlorine. These constituents in irrigation water may pose potential risks through either accumulating in the soil and / or in presenting a hazard to plants via foliar application. These risks are discussed below.

Boron. Boron is a micronutrient applied in very small amounts to plants. Concentrations in Australian recycled waters average 0.3 mg/L, (NRMMC, 2006).

The plant species for the ovals and grounds are within two plant families: Family Poaceae is represented by kikuyu, paspalum and couch grass, with Family Fabaceae by trefoil. None of these species are listed in the principal reference, that of NRMMC (2006), thus extrapolations were undertaken. For the Family Poaceae, from the listed species, Kentucky Bluegrass (*Poa pratensis*) was selected as the indicator which is in the Moderately Tolerant group with a boron threshold of 2.0 to 4.0 mg/L. Similarly, for the Family Fabaceae, the selected indicator species was lucerne (alfalfa) (*Medicago sativa*), which is within the Tolerant group with a boron threshold of 4.0 to 6.0 mg/L.

With the highest reported boron level in recycled water of 0.8 mg/L and the high levels of tolerance of the species growing on the ovals there is considerable latitude before boron poses a risk, if ever.

Cadmium. Cadmium is a naturally occurring element. The chemical symbol for cadmium is Cd. In Australia, natural levels of cadmium in the soil are low by world standards ranging from les than 0.1 to 0.5 milligrams per kilogram (mg/kg) or about 0.1 to 0.7 kg cadmium per hectare in the top 10 centimetres of soil.

Elevated levels of cadmium in the soil may arise from applying one or more of the following:

- Phosphate fertilizers.
- By-product gypsum (phosphogypsum).
- Some sewage sludges (biosolids).
- Organic wastes and manures.

The Australian fertiliser industry has made significant reductions in the cadmium contents in fertilisers over the last 10 years. It now uses rock phosphate with lower cadmium concentrations for local manufacture.

The use of pasture grades of single superphosphate may elevate cadmium levels. These low phosphatic content fertilizers may contain up to 250 mg cadmium per kg phosphorus compared to concentrated phosphatic fertilizers like DAP and MAP with less than 100 mg cadmium per kg phosphorus.

Allied with the movement to source lower cadmium rock phosphate there has been a corresponding lessening of the risk of by-product gypsum posing a risk.

The pH of the soil and the salt content of the water influence the uptake by plants of cadmium. Soil pH of less than 5.5 (measured in water) or 4.8 (measured in calcium chloride) should be amended upwards to pH levels of between 6.2 - 6.7 (measured in water) and 5.5 - 6.0 (measured in calcium chloride), through the addition of lime.

With irrigation water salt content of greater than (>) 750 mg/L (1 170 EC) there is a high risk of increasing the concentration of cadmium in edible portions of vegetables, e.g. potato tubers and leafy vegetables, (Horticulture Australia, 2003).

The soils of the proposed area for receiving used water have a pH exceeding 6.0 (CaCl), thus if this is maintained there is no risk of elevated cadmium through soil pH levels. See Annex Table 3 and Annex Table 4.

The median salt content of the water (from Annex Table 2) is 815 EC which sends a warning signal that there may be a risk if the water was being used for growing potatoes or leafy vegetables. Where the use of the water is for non-food purposes such as irrigating turf there is no direct cross over between the quality of the water and the presence of cadmium.

Given there are no local data on cadmium and the need for regular applications of phosphatic fertilizers and gypsum it is highly desirable to establish some baseline data from which informed decisions may be taken as to whether this element poses a risk.

Chlorine, residual. Chlorination is currently the most widely used irrigation water disinfectant in Australia. One of chlorines biggest advantages is its ability to provide a stable residual that helps clean slimes out of the irrigation systems. If chlorine is to be effective in controlling the spread of pathogens, it is essential to accurately control both the free chlorine content and the pH. Chlorination is unsuitable if the pH of water is above 7.5.

It is not recommended that chlorination be done when the concentrations of dissolved iron or manganese in water are high. This is because chlorine acts to oxidise the iron to form precipitates that could cause clogging.

Culcairn WTP figures for iron and manganese from a test result of 5 October 2007 are as follows:

> Iron 0.01 mg/L
> Manganese less than 0.005 mg/L, (Pers. comm. Tom Plunkett, Water & Sewer Co-ordinator from the Greater Hume Shire Council).

When iron levels are 0.2 mg/L or lower there are no problems with the use of this water for irrigation. Maximum concentration of manganese for irrigation is 0.5 mg/L, (Yiasoumi, *et al*, 2005).

These low levels of iron and manganese do not pose a risk of causing blockages in the watering system. Thus it is safe to continue the use of chlorine as a disinfectant in the knowledge that any residual chlorine will not result in blockages.

ANNEX 5.3 SOIL TEST RESULTS

Annex Table 3: Billabong High School, soil analyses

Laboratory Number	**9796**	**9797**	**9798**	**9799**	**9800**	**9801**
Location	Area #1 - East	Area #1 - West	Area #1 - E + W	Area #2	Area #3	Area #3
Depth (cm)	0 - 10	0 - 10	0 - 20	0 - 10	0 - 10	0 - 20
TEST DESCRIPTION						
Acidity						
Ph (CaCl2)	6.3	6.3	6.0	6.1	6.3	6.1
Major elements						
Total N (%)	0.18	0.18	0.12	0.18	0.20	0.11
Total P (mg/kg)	232	347	224	210	200	112
Secondary elements						
Exch. Sodium (mg/kg)	158	178	205	171	144	123
Exch. Potassium (mg/kg)	410	393	443	197	311	263
Exch. Calcium (mg/kg)	899	947	930	1,177	1,333	675
Exch. Magnesium (mg/kg)	209	214	221	243	217	105
Exch. Aluminium (mg/kg)	7	4	6	7	6	8
Salinity						
E.C. (dS/m)	0.440	0.453	0.462	0.425	0.490	0.341
Calculations						
Cation Exchange (CEC) (me%)	8.0	8.3	8.5	9.2	9.9	5.5
Other						
Total Organic Matter (%)	2.0	2.5	-	2.1	2.1	-
Bulk Density (gm/cm^3)	1.23	1.15	1.15	1.21	1.33	1.36
Texture	Sandy loam	Sandy loam	-	Sandy loam	Sandy loam	-
Clay Dispersion (%)	5	5	-	4	5	-
P Sorption (mg/kg)	175	195	-	200	190	-

Source: Laboratory Report Number 07/4722 of 8 December 2007, Riverina Laboratories, Albury.

Annex Table 4: Culcairn Recreation Oval (Football), soil analysis

Laboratory Number	**9802**	**9803**	**9804**	**9805**	**9806**
Location	Oval - East	Oval - West	Oval - E + W	Oval - E + W	Oval - West
Depth (cm)	0 - 10	0 - 10	0 - 20	20 - 40	10 - 70
TEST DESCRIPTION					
Acidity					
Ph (CaCl2)	6.3	6.9	6.9	6.9	6.7
Major elements					
Total N (%)	0.18	0.18	0.16	0.08	0.06
Total P (mg/kg)	160	240	232	104	88
Salinity					
E.C. (dS/m)	0.550	0.540	0.545	0.395	0.459
Secondary elements					
Exch. Sodium (mg/kg)	219	240	274	308	432
Exch. Potassium (mg/kg)	213	197	196	164	163
Exch. Calcium (mg/kg)	963	930	848	601	667
Exch. Magnesium (mg/kg)	346	345	391	280	313
Exch. Aluminium (mg/kg)	7	3	4	3	3
Calculations					
Cation Exchange (CEC) (me%)	9.2	9.1	9.2	7.1	8.3
Other					
Total Organic Matter (%)	1.7	2.0	-	-	-
Bulk Density (gm/cm^3)	1.36	1.38	1.35	1.42	1.36
Texture	Sandy loam	Sandy loam	-	-	-
Clay Dispersion (%)	4	5	-	-	-
P Sorption (mg/kg)	95	95	-	-	-

Source: Laboratory Report Number 07/4722 of 8 December 2007, Riverina Laboratories, Albury.

ANNEX 5.4 NITROGEN AND PHOSPHOROUS SUSTAINABILITY

Annex Table 5: Nitrogen sustainability - Billabong High School / Culcairn Recreation

Assumptions: [1]						
N applied in STP water [2]			1.5	mg/L		
Plant uptake [3]						
Perennial pasture			15,000	kg Dry Matter per year/ha		
N content			3.5	%		
	Uptake		525	kg/ha/year		
Calculations:						
Total N in irrigation water			1.5	mg/L		
Amount applied [4]			9,100,000	L/year		
Amount N per year						
	1.5 mg/L x 9,100,000) ÷ 1,000,000					
	13.65	kg/ha/yr				
Sustainable application						
	Plant uptake ÷ N content of water (1- losses from N pool) [5]					
	525 kg/yr ÷ 15.0 kg N applied/yr					
	35.0	kg/ha/yr				
Notes						
1. Draft paper: Application rates for feedlot manure - a nutrient budget approach, (Young, 2005).						
2. Henty STP, 'treated' analysis of 22 November 2007.						
3. Perennial ryegrass, 20 t/ha/yr with 3.5%N, Table 4.2 (DEC,2004).						
4. Annex 5.5. 909 mm per year.						
5. No losses of N to the atmosphere.						

Annex Table 6: Phosphorous sustainability - Billabong High School

Assumptions: [1]						
Phosphorous sorption capacity [2]			190	mg/kg		
Phosphorous sorption capacity (critical) [3]				62.7	mg/kg	
Soil depth			1	metre		
Soil density [4]			1,230	kg/m^3		
Land area for irrigation [5]			2.37	ha		
Total P applied in water			4	mg/L		
Volume of water applied [6]			0.025	ML/day	9.1	ML/year
Calculations:						
Total P absorbed before leaching:						
	P sorption capacity (critical) x soil density x soil depth x area					
	(63 mg/kg x 1,230 kg/m^3 x 2.37 ha x 10,000) ÷ 1,000,000					
	1,827.8	kg				
Total P in STP water per year						
	(4 mg/L P in water x 9,100,000 L) ÷ 1,000,000					
	36.4	kg				
Total P removed by grasses per hectare per year [7]					0	kg
Site irrigation period						
	P absorbed kg ÷ (P in effluent kg - P removed kg)					
	1,827.8 kg P ÷ (36.4 kg P - 0 kg P)					
	50	**years**				
Notes						
1. Environmental guidelines: Use of effluent by irrigation, (DEC, 2004).						
2. Average of 0 -10 cm soil samples across Area's 1 to 3. Annex 5.3.						
3. One third of P sorption capacity used before some leaching of P occurs.						
4. Average of 0 -10 cm soil samples across Area's 1 to 3, Annex 5.3.						
5. Table 1.1.						
6. Annex 5.5. 909 mm per year.						
7. Mowed grass is retained and forms mulch.						

Annex Table 7: Phosphorous sustainability Culcairn Recreation oval

Assumptions: [1]						
Phosphorous sorption capacity [2]			95	mg/kg		
Phosphorous sorption capacity (critical) [3]				31.4	mg/kg	
Soil depth			1	metre		
Soil density [4]			1,370	kg/m^3		
Land area for irrigation [5]			1.67	ha		
Total P applied in water			4	mg/L		
Volume of water applied [6]			0.025	ML/day	9.1	ML/year
Calculations:						
Total P absorbed before leaching:						
	P sorption capacity (critical) x soil density x soil depth x area					
	(31.4 mg/kg x 1,360 kg/m^3 x 1.677 ha x 10,000) ÷ 1,000,000					
	717.3	kg				
Total P in STP water per year						
	(4 mg/L P in water x 9,100,000 L) ÷ 1,000,000					
	36.4	kg				
Total P removed by grasses per hectare per year [7]					0	kg
Site irrigation period						
	P absorbed kg ÷ (P in effluent kg - P removed kg)					
	20	**years**				
Notes						
1. Environmental guidelines: Use of effluent by irrigation, (DEC, 2004).						
2. Average of 0 -10 cm soil samples across Area's 1 to 3. Annex 5.3.						
3. One third of P sorption capacity used before some leaching of P occurs.						
4. Average of 0 -10 cm soil samples across East + West, Annex 5.3.						
5. Table 1.1.						
6. Annex 5.5. 909 mm per year.						
7. Mowed grass is retained and forms mulch.						

ANNEX 5.5 IRRIGATION WATER REQUIREMENTS

The calculation of irrigation requirements either daily, seasonally or annually involves assembling information on:

- The growing plants stage of growth.
- The amount of available moisture held in the soil.
- The depth to which the bulk of the roots extend into the soil.
- A crop factor.
- Evaporation figures.
- The effectiveness of irrigations and rainfall events.

These factors are viewed from two perspectives, namely at the project feasibility level and that of an operator of an irrigation system. But first some comments on climate change.

Annex 5.5.1 Impact of climate change

Information emanating from a range of reliable sources e.g. the 2007 Intergovernmental Panel on Climate Change (IPCC) contains predictions about rises in temperatures. For the New South Wales / ACT area, temperatures are predicted to rise by 1.5 Celsius by the 2030 summer based upon the 50th percentile and medium emissions modelling. Internet accessed 14 December 2007, http://www.climatechangeinaustralia.gov.au/nswacttemp1.php.

A warming climate will lead to changes in precipitation, wind patterns and the frequency and severity of extreme weather events. Whilst predictions on modelling of rainfall are not as strongly made as those for temperature they never the less conclude that there will be less. In the North East Region of Victoria which borders onto the South West Slopes of NSW, the following scenario for 2030 has been provided:

- Spring. Precipitation decrease likely with the range of predictions from +3 to -15%.
- Summer. Precipitation uncertain. (+15 to -15%).
- Autumn. Precipitation uncertain. (+10 to -10%).
- Winter. Precipitation decrease likely. (+3 to -10%), (DSE, 2004).

In the Project Planning section that follows comparisons are made between the standard average data and that of a slightly less and slightly more than average rainfall. These are intended to provide some sense of what might be the influence of climate change.

Annex 5.5.2 Project planning

The Bureau of Meteorology (BOM) collects extensive climate records from across the country and has data for some sites extending beyond 100 years. Rainfall registrations are the most commonly recorded climatic element. Evaporation is much less commonly collected. Typically, sites with evaporation data are those operated by the Bureau, e.g. BOM site number 072150, Wagga Wagga or those where there is a high local interest, e.g. agricultural research station in scheduling irrigations or at a water resource regulating site such as the Hume Weir (BOM site number 072023).

In the first instance, aggregated rainfall and evaporation data from the Wagga Wagga (averaged over 66 years) and from the Hume Weir (85 years) sites were sourced and averaged to represent an ‘estimated’ Culcairn locality. (Annex Table 8). This ‘estimated’ data was then compared to the data set used by the Department of Primary Industries (DPI), Albury in producing monthly agronomy reports, referred to as ‘synthesised’ Culcairn. The DPI has sourced rainfall data from the BOMs Silo Program® for Culcairn of 110 years, to which has been added evaporation figures since 1970, synthesised from the differences in

surrounding measured data i.e. Hume weir and Wagga Wagga, (Pers. comm. Janet Wilkins, District Agronomist, NSW Department of Primary Industries, Albury, 13 December 2007). The average data from 1970 to 2006 only, is presented in Annex Table 9.

The synthesised data was chosen for this project for the reasons that it is in regular use within monthly reports issued from the Albury office of NSW DPI and has been derived from a more rigorous process than that of simple averaging of two BOM sites. Note. The DPI uses the long term average, i.e. since 1889 as a basis for comparing monthly figures whereas a shorter period - from 1970 - has been applied for planning the project so as to match up with evaporation records.

Inclusion of percentile data reveals the extent of variation between an actual years rainfall to that of the average. For example, by the end of September 2007, Culcairn had received 342.6 mm which was 77% of the long term average for the first nine months of the year of 451 mm. Another illustration is to compare September's rainfall of 16.6 mm to the long term September amount which is 57 mm. For September 2007 the rainfall was 29% of the long term average which places that month in the 20th percentile or the second driest group of September's since 1970. In Annex Table 9, the 40th, 50th and 60th rainfall percentiles by month are provided.

The eight-steps in calculating the Gross application of irrigation water per month as presented in Annex Table 10 are as follows:

Step 1. Insert monthly average rainfall figures from Annex Table 9.

Step 2. Calculate the effective amount of rainfall per month by subtracting 5 mm from the average during summer, autumn and spring at Step 1.

Step 3. Insert monthly average evaporation figures from Annex Table 9. Evaporation affects plant water use. The higher the evaporation, the higher the usage of water by plants.

Step 4. Apply a Crop Factor. The crop factor relates plant water use to evaporation and is determined by the growth stage, plant vigour and the amount of groundcover. A crop that uses the same amount of water as is lost by evaporation will have a crop factor of 1.0 or 100% of the evaporation. As there is no regional crop factors for turf a surrogate has had to be used which in this project is an irrigated perennial pasture. Perennial pastures contain species that are growing all year round which is analogous to a mixed sward turf of kikuyu and couch grass in spring and summer and autumn and ryegrass and annual medics and clovers in the winter. A crop factor of 0.80 applies to perennial pastures in northern Victoria, (DSE/DPI, 2004). This is comparable to a slightly higher figure of 0.85 reported by Lacy, (1991) for irrigated perennial pastures for Leeton.

Step 5. Calculate evapotranspiration. Multiply the mean monthly evaporation by the Crop Factor with resultant figure a combination of evaporation from the soil and transpiration losses from the 'crop' for the month.

Step 6. Calculate irrigation requirement. Subtract from the Evapotranspiration figure (Step 5) the amount of effective rainfall (Step 2) with resultant being the 'net' irrigation requirement in mm.

Step 7. Establish efficiency of application of water by irrigation system. Well-designed in-ground sprinkler systems are capable of achieving a high level of uniformity of application. When the irrigation interval between irrigations is established using to-day's array of computer-based technology, it is possible to achieve orders of efficiencies at the high end of the range from 65 to 92%. For this project a figure of 85% has been selected.

Step 8. Calculate gross application amount. Multiply the irrigation requirement (Step 6) by application efficiency (Step 7) by applying the following formula

Gross application = Irrigation requirement (mm) x (1/application efficiency).

The amount of water applied per irrigation is established from the soil's available water holding capacity and the rooting depth of the plant. The refill point varies with most scheduling systems based upon keeping the soil moisture level above 50% of the available water. This rule has been adopted in the project with further discussion appearing in Annex 5.5.3.

Annex Table 8: Culcairn 'estimated' meteorological data

Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean rainfall (mm)	43.0	39.9	41.7	46.8	56.1	59.2	66.0	64.2	56.3	64.1	47.6	46.5	631.2
Decile 1 monthly rainfall (mm) for years 1941 to 2007	5.8	2.8	2.7	10.1	10.2	19.7	26.9	17.0	21.4	16.1	12.6	4.2	426.4
Decile 5 (median) monthly rainfall (mm) for years 1941 to 2007	29.4	29.8	29.4	32.6	46.4	55.3	62.1	65.6	52.1	58.5	39.5	35.1	634.1
Decile 9 monthly rainfall (mm) for years 1941 to 2007	93.8	84.4	95.3	102.7	120.6	101.2	117.8	106.8	98.1	117.4	92.7	100.2	839.7
Mean monthly evaporation (mm)	275.9	232	182.9	103.5	54.25	34.5	34.1	52.7	79.5	130.2	187.5	252.65	1,619.7

Source: Bureau of Meteorology weather sites of Hume Weir and Wagga Wagga averaged. Internet accessed www.bom.gov.au, 13 December 2007.

Annex Table 9: Culcairn, 'synthesised' meteorological data - 1970 to 2006

Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Average rainfall (mm)	48.9	37.6	34.2	46.6	49.1	51.6	62.9	63.1	56.6	55.1	41.3	44.1	591.1
40th Percentile rainfall (mm) for years 1970 to 2006	21.7	21.6	20.0	28.3	31.7	41.9	44.6	55.3	45.5	37.6	38.0	25.5	411.8
50th Percentile rainfall (mm) for years 1970 to 2006	28.8	35.4	25.8	32.0	37.4	46.2	57.4	67.8	49.2	54.2	39.2	31.0	504.4
60th Percentile rainfall (mm) for years 1970 to 2006	37.1	38.5	34.4	40.6	48.8	52.8	68.8	76.2	56.2	65.9	48.0	44.7	612.0
Average monthly evaporation (mm)	258.4	212.4	174.1	96.9	52.7	32.9	34.8	52.0	78.3	126.9	180.4	243.6	1,543.2

Source: Adaptation of data provided by Janet Wilkins, District Agronomist, NSW Department of Primary Industries, Albury. E-mail 13 December 2007.

Annex Table 10: Irrigation water requirement for Culcairn sporting ovals and grounds

Element	January	February	March	April	May	June	July	August	September	October	November	December	Total
Mean rainfall (mm) [1]	48.9	37.6	34.2	46.6	49.1	51.6	62.9	63.1	56.6	55.1	41.3	44.1	591.1
Estimated effective rainfall (mm) [2]	43.9	32.6	29.2	41.6	44.1	59.2	66.0	64.2	51.6	50.1	36.3	39.1	557.8
Mean monthly evaporation (mm) [1]	258.4	212.4	174.1	96.9	52.7	32.9	34.8	52.0	78.3	126.9	180.4	243.6	1,543.2
Crop factor (irrigated perennial pasture)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.80
Evapotranspiration (mm)	207	170	139	78	42	26	28	42	63	102	144	195	1,235
Net irrigation requirement (mm)	163	137	110	36	-2	-33	-38	-23	11	51	108	156	677
Application efficiency [3]	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Gross application (mm)	192	162	129	42	0	0	0	0	13	60	127	183	909
Number of irrigations of (mm)													
10	19	16	13	4	0	0	0	0	1	6	13	18	91
15	13	11	9	3	0	0	0	0	1	4	8	12	61
20	10	8	6	2	0	0	0	0	1	3	6	9	45
25	8	6	5	2	0	0	0	0	1	2	5	7	36

Notes

1. Synthesised Bureau of Meteorology data from the differences in surrounding measured data, i.e. Hume Weir and Wagga Wagga.
2. Five mm subtracted from mean rainfall for summer, autumn and spring seasons.
3. Typical range is 65 to 92% for sprinkler. A figure of 85% selected on basis of high standard of management being practiced with modern technological equipment.

Annex 5.5.3 Scheduling of irrigations

Deciding when to next irrigate is simplified by having a plan - called a schedule. Such a plan is based upon access to daily records of evaporation and rainfall. It is practiced by those managing the watering of crops or pastures or turf. In the planning phase of projects annual average data is typically used as this is sufficiently accurate for the purpose.

Matching the timing of irrigations to plant water demand will improve the performance of the turf species and in turn the appearance and the softness-hardness feel of the land, minimise accessions to the groundwater and reduce risks of runoff.

Scheduling matches plant needs and irrigation timing. Through the use of daily evaporation figures and some simple arithmetic it is possible to accurately determine when to irrigate.

The six-steps in calculating a scheduling program for irrigations as presented in Annex Table 11, are as follows:

Step 1. Establish the type of soil. From the analysis of the soils across the ovals and grounds the soils have a sandy loam texture. (See Annex 5.3).

Step 2. Calculate the available water within the soil. Sandy loam soils have in general an available water content of 105 mm per metre. Sands have 50 mm and medium clay's 160 mm per metre of soil. The depth to which the bulk of the plants roots occur in the soil is related to texture and structure. A readily available water content of 50 mm and a rooting depth of 300 mm have been assumed for the turf's grasses and legumes.

Step 3. Calculate the readily available water. Assume only half or 50% of the Available Water is deemed Readily Available water.

Step 4. Establish the rooting depth. For pasture species effective rooting depth is between 200 and 300 mm; lucerne typically 1 metre.

Step 5. Calculate the interval between irrigations. Multiply the readily available water (Step 3) by the effective rooting depth (Step 4) with result being 15 mm.

Step 6. When to irrigate? When the total plant water use adds up to 15 mm - the irrigation interval - then it is time to irrigate. The plant water use figure is derived from adding the present day's water use with that of the previous days, less any effective rain. The day following irrigation the soil is saturated with plant water use minimal. Water use on this day is recorded as zero.

In Annex Table 11 an illustration is provided of scheduling using Hume Weir rainfall and evaporation for November 2007. Leading findings from this illustration are:

- Fewer irrigations required. Rainfall was well above average (95 mm compared to average for Culcairn of 41 mm) assuming Culcairn received amounts equivalent to Hume Weir. On average, 8 irrigations of 15 mm each are required in November. (Annex Table 10).

- Irrigation scheduling is a skill. The skills increase over time as the irrigation manager becomes attuned to the changes in the moisture content of the soil (sampling through auger holes or monitoring by instruments) and the weather forecasts.

- Potential for runoff. On two occasions an irrigation was scheduled, namely on 4 and 22 November as plant water use had reached the fill point of 15 mm. The rains would have refilled the soil profile on both occasions with excess running off the ovals and grounds. This illustrates the necessity for a planned approach for managing risks associated with coincidence of substantial rain events occurring during or shortly after an irrigation. At the Billabong High School runoff containment strategies will need to be structured to suit the areas adjacent to the buildings - Areas #2 and #3 - and for the oval - Area #1.

Annex Table 11: Irrigation scheduling illustration

Irrigation scheduling sheet for	(November 2007)	(month)	Notes
Type of soil	Sandy loam		(a)
Available water	105	mm	(b)
Readily Available Water (=½ x b)	52.5	mm	(c)
Crop/pasture type	Turf		(d)
Effective root depth [1]	0.3	metres	(e)
Irrigation interval (= c x e)	15.75	mm	(f)

1	2	3	4	5	6	7	
Date	Crop Factor	Evaporation (mm) [2]	Plant Water Use (mm)	Rain (mm) [2]	Effective Rain (mm)	Total Plant Water Use (mm)	Comments
1	0.8	*3.2*	*2.6*			*2.6*	
2	0.8	*3.8*	*3.0*	*2.0*	*0.0*	*5.6*	
3	0.8	*4.2*	*3.4*	*2.4*	*0.0*	*9.0*	
4	0.8	*5.4*	*4.3*	*45.6*	*40.6*	*0.0*	Potential for runoff
5	0.8	*1.6*	*1.3*	*1.2*	*0.0*	*1.3*	
6	0.8	*5.8*	*4.6*	*4.6*	*0.0*	*5.9*	
7	0.8	*4.6*	*3.7*			*9.6*	
8	0.8	*5.8*	*4.6*			*14.2*	
9	0.8	*6.8*	*5.4*			*19.7*	Irrigate
10	0.8	*6.2*	*5.0*			*0.0*	
11	0.8	*5.8*	*4.6*			*4.6*	
12	0.8	*6.2*	*5.0*			*9.6*	
13	0.8	*6.0*	*4.8*			*14.4*	
14	0.8	*7.0*	*5.6*			*20.0*	Irrigate
15	0.8	*7.6*	*6.1*			*0.0*	
16	0.8	*7.0*	*5.6*			*5.6*	
17	0.8	*8.4*	*6.7*			*12.3*	
18	0.8	*6.0*	*4.8*	*1.0*	*0.0*	*17.1*	Irrigate
19	0.8	*6.2*	*5.0*	*0.2*	*0.0*	*0.0*	
20	0.8	*7.6*	*6.1*			*6.1*	
21	0.8	*9.6*	*7.7*			*13.8*	
22	0.8	*2.6*	*2.1*	*34.2*	*29.2*	*15.8*	Potential for runoff
23	0.8	*3.4*	*2.7*	*3.6*	*3.6*	*0.0*	
24	0.8	*6.2*	*5.0*			*0.0*	
25	0.8	*7.6*	*6.1*			*6.1*	
26	0.8	*7.0*	*5.6*			*11.7*	
27	0.8	*7.4*	*5.9*			*17.6*	Irrigate
28	0.8	*6.2*	*5.0*			*0.0*	
29	0.8	*5.4*	*4.3*	*0.4*	*0.0*	*4.3*	
30	0.8	*3.2*	*2.6*			*6.9*	
Total		*170.6*		*95.2*			

Notes

1. Effective root depth range from 20 to 30 cm with maximum selected as short-term moisture deficits do not incur an economic penality such as a drop-off in grain yield.
2. BOM Hume Weir, November 2007.

Source: Adaptation of Smith and Gibbs, (1997).

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ANNEX 5.7 GLOSSARY

Glossary terms sourced from Hughes, (1999), unless otherwise recorded.

Acidity. All soils with a pH below 7 are acid. However, the growth of most plants is unaffected until pH drops below about 5. As pH levels drop and soil acidity increases, plant growth declines.

Application efficiency. Figures typically quoted on average application efficiencies of different systems are: surface 60 to 90%; sprinkler 65 to 90% and drip 75 to 90%, (Fairweather, 2005). These efficiencies can be misleading. It is the management of the system for the particular soil and crop combination that is the critical issue as to the in-field efficiency.

Available water. See Plant available water.

Cation exchange capacity (CEC). Cation exchange capacity is the term used to describe the capacity of the soil to hold ‘exchangeable’ cations. These cations can be held on the exchange sites of clay minerals, or by organic matter. CEC is therefore a measure of the soil’s ability to hold nutrients for later use by plants.

Crop water requirement (CWR). Crop water requirement is the total depth of water required to satisfy evapotranspiration (ET) of a disease free crop, growing in non-restricting soil conditions including soil water and fertility and therefore achieving full production potential in a given environment, (FAO 1999).

Crop water requirement does not consider whether the water is from soil storage, rainfall, irrigation or elsewhere. **Irrigation requirement** (IR) is taken to mean the depth of water required, at the farm gate, to meet crop water requirement. It is that part of the crop water requirement not met by rainfall, stored soil water or elsewhere. It includes losses that occur *on farm* in delivering water to the crop.

Crop factor. The proportion of water used by a crop in relation to a Class A Pan evaporimeter. Often expressed as a decimal relationship. For example, a crop factor of 0.6 indicates water use is 60% of Pan Evaporation, (DSE/DPI, 2004).

Dispersion. Dispersion is the breakdown of soil clay minerals into single particles in solution. The opposite is flocculation. It usually occurs where a soil contains too great a proportion of exchangeable sodium, or is too low in organic matter.

Drainage properties of soils.
A ‘well drained soil’:

- Generally less than 30% clay in the subsoil
- Located on sandhills and red brown earths

- One suited to irrigated lucerne.

A ‘moderate to slow draining soil’:

- Generally 30 to 45% clay
- Located on red brown earths and well structured clays.

Effective rainfall. Not all of the rain that falls is accounted for when constructing a water balance. Effective rainfall is defined as the total amount of rainfall which is available for the crop to use (i.e. does not include water which runs off irrigated areas, infiltrates past the root zone, directly evaporates from the soil surface or rainfall outside of the crop growing season), (DSE/DPI, 2004).

In the hotter months of the year small falls of up to five millimetres do not enter the soil as they are evaporated from the surface of the plants and soil. In the cooler months the evaporative influence is lower. It is also very seasonally dependent.

The calculation of effective rainfall is seasonally and site specific, however values typically adopted are: in the spring, summer and autumn periods, subtract five millimetres from the monthly total; during the winter, all rainfall is considered to be effective, (Smith and Gibbs, 1997).

Electrical conductivity (EC). EC is the measure of the concentration of ions (both cations and anions) in the soil solution or in water. See Salinity.

Evaporation. Evaporation removes water from the soil by heating it and vaporising it into the air. If the soil is very wet, water loss by evaporation is rapid. However, as the soil dries, evaporation becomes increasingly slower.

Evapotranspiration. The amount of water lost to the atmosphere through evaporation from the soil surface and transpiration from plants (mm/d). (DSE/DPI, 2004).

Exchangeable sodium percentage (ESP). Exchangeable sodium percentage is simply the amount of exchangeable sodium in a soil as a percentage of the total exchangeable ions in the soil. An ESP of more than six (6) defines a sodic soil.

Fertilizers. Fertilizer is the general term given to products that add nutrients to the soil. Manufactured fertilizers are produced synthetically in factories where raw materials are treated to create new chemical compounds. Superphosphate, for instance, is produced from rock phosphate and sulphuric acid. Organic fertilizers are derived from decomposition or digestion of plant or animal materials, including plant composts, composted manures and animal by-products.

Gypsum. Gypsum (Calcium sulphate) occurs naturally as crystals in several areas of southern NSW and north west Victoria and is mined. This gypsum is of variable quality and contains impurities. It is often quite lumpy and coarse, which makes it slow to dissolve and difficult to spread. Not withstanding, it is used frequently due its ready availability. Gypsum is also available as a by-product of phosphatic fertilizer production. Such gypsum is of higher quality than mined product but its availability regionally limits its use.

Gypsum is used as a soil softening or ameliorant agent on sodic soils. It works in two ways:

1. It creates a salt solution in the soil water and clays tend not to swell or disperse as much in salt solutions.
2. The calcium cations in gypsum replace the exchangeable sodium cations on the clay. By this process a sodic clay is changed to a calcium clay, less prone to swelling and clay dispersion.

Hydraulic conductivity. Hydraulic conductivity is a measure of the movement of water through the soil profile. It determines where the water goes after infiltration and how quickly.

The hydraulic conductivity depends largely on soil texture and structure: it reflects the size, arrangement and number of pores.

Infiltration. Infiltration refers to the movement of water from outside the soil, through the soil surface and into the soil profile. Cracks are an obvious mode of entry with ant or worm holes and old root paths being less obvious pathways.

Irrigation requirement. See Crop water requirement.

Leaching. Leaching is the washing of salt out of the plant root zone and further into the soil. It is essential that salts applied in irrigation water are leached below the root zone. Most of the leaching occurs due to winter rainfall.

Lime. Lime is crushed and sieved limestone (calcium carbonate) and is most commonly used on strongly acid soils to make the soil more alkaline. The carbonate in lime neutralises the acidity in soils and so raises the pH.

Megalitre (ML). Volume of water needed to cover an area of one hectare with 100 mm water. Standard unit of flow measurement in Australian irrigation industry.

Moisture content. The ability of a soil to hold moisture mainly depends on its texture class. Total water holding capacity varies from about 130 mm / metre of depth in a coarse sand to about 400 mm / m of depth in a heavy clay and to about 480 mm / m in a well structured loam.

The volume of water held between permanent wilting point and field capacity (termed plant available water) also varies according to soil texture and structure. A well-structured loam is likely to hold the most plant available water: 175 mm / m of depth.

Nitrogen. Chemical symbol N. Nitrogen is a key element in plant growth. Soils high in organic matter are generally higher in nitrogen too.

Organic matter. Soil organic matter consists of any living or dead plant and animal material. Organic matter is important for both the chemical and the physical properties of the soil. Organic matter helps bond soil particles together, creating and maintaining soil structure. It also contains nutrients that are essential for plant growth.

pH. The term pH stands for a measurement of the number of hydrogen cations in a solution. The ‘H’ stands for hydrogen, and the ‘p’ indicates a negative logarithmic scale. This means that a solution with a pH of 7 has ten times more H^+ cations than a solution of pH 8. The pH scale goes from 1 to 14, with 7 being neutral. A solution with a pH greater than 7 is alkaline, while a solution with a pH less than 7, is acid.

Phosphorus. Phosphorus is a nutrient that is vital for seedlings and young plants.

Plant-available water. Plant-available water capacity is the term used to describe how much available water stored in a particular soil which can be readily used by the plants before moisture stress occurs. This is often referred to as readily available water (RAW). Available water is the water in the soil between field capacity and permanent wilting point and thus available to plants. Sandy soils hold very little water at field capacity because most of their pores are large. Clay and organic soils have a much higher field capacity water content because they contain many micropores. Soils of intermediate texture, the clay loams, tend to have the highest levels of available water.

Salinity. Salinity refers to the concentration of all salts in the soil solution or the water. Although the most common salt in most Australian soils is sodium chloride (common table salt), any readily soluble salt (including fertilizers) may contribute to soil salinity.

In water and in soil, salinity is usually measured by its electrical conductivity (EC), which is a measure of the concentration of ions in water or in the soil solution. The international

standard for measuring salinity is decisiemens per metre (dS/m), but several other units of measurement are still in use.

List of dS/m equivalents

1 dS/m = 1 000 EC (µS/cm) (micro Siemen per cm) = approximately 640 ppm = 1 mS/cm (milli Siemen per centimetre).

Conversion for units used to measure salinity

To convert EC (µS/cm) to deci Siemen per metre (dS/m), divide by 1 000.
To convert parts per million (ppm) or milligrams per litre (mg/L) to deci Siemen per metre (dS/m), divide by 640.
To convert dS/m to EC, multiply by 1 000.

The conversion from parts per million to dS/m varies a little, above and below 640 ppm, depending mainly on the type and relative concentration of salts present in the water, (Yiasoumi, *et al*, 2005).

Salinity ratings. Based upon Total dissolved salts (TDS) in water is 640, then the salinity rating for irrigation water is:

Salinity rating for irrigation water	TDS (mg/L)	ECw (EC units) [1]
Low	0 - 175	0 - 270
Medium	175 - 500	270 - 780
High	500 - 1 500	780 - 2 300
Very High	1 500 - 3 000	2 300 - 4 700

Source: Pope and Abbott, 1989. Note 1. ECw - Electrical conductivity of water. Humans can taste 1 500 EC units. Salinity of sea water is about 55 000 EC units.

The above ratings should be used as a guide only. In determining if water is suitable it is important to consider also the sodicity of the soil as well as its drainage, plant species and irrigation method.

Sand. Sand refers to particles between 0.02 and 2.0 mm in diameter. Sand comprises mainly quartz particles that will not break down further.

Silt. Silt is the particle size fraction in soils that lies between sand and clay (i.e. between 0.002 and 0.02 mm in diameter). Silty soils are prone to hard setting and crusting.

Sodification. Sodification is the build-up of sodium in the soil. Sodium in the water can be the cause of surface crusting, poor internal drainage and low soil aeration.

Water containing salt that has a Sodium Adsorption Ratio of more than 3 is termed saline–sodic water. The main danger in using water with a high SAR is a dramatic loss of soil structure when fresher water is reused in surface irrigation. If water with a high SAR and moderate to high salinity is used, the sodicity builds up but the soil structure remains stable due to the electrolytic effect of the salinity keeping the clay flocculated.

The ***Sodium adsorption ratio*** **(SAR)** value measures the relative concentration of sodium to calcium and magnesium ions. High concentrations of sodium in irrigation water can result in the degradation of well-structured soils, i.e. a loss of structure. Calcium is the most important ion for effective binding of the soil particles into stable aggregates, a characteristic of good soil structure. Where the SAR value is 3 or higher the water is said to be sodic.

Soil sodicity can be treated by applying gypsum and / or lime.

Soil profile. Soil profile refers to the sequence of horizons (layers) down to and including the parent material. The A horizon is the topsoil and the B horizon is the subsoil. Observing the soil profile can help in the management of soils through an appreciation of its advantages and limitations.

Soil solution. The water that is in the soil pores, or coats the pores as the soil dries out, is always a solution of cations and anions. Since plants take up nutrients in solution, the types and proportions of these ions determine the ease with which a plant can take up nutrients. Salinity, alkalinity and acidity are all a result of imbalances in the soil solution.

Structure. Soil structure refers to the arrangement of the sand, silt and clay particles and organic matter to form aggregates, as well as the arrangement of pores within and between aggregates. It has an important effect on the distribution of water and air in the soil and is therefore important for the ease with which plant roots can exploit the soil for water and nutrients. Texture, moisture content, organic matter, clay type, cultivation and even the root systems of crops can affect soil structure.

Texture. Texture is a measure of the proportion of sand, silt and clay and organic matter in a soil. Organic matter and the clay minerals provide the bonds that hold a soil together. In clay soils the clay minerals do most of the bonding. However, as the proportion of clay in a soil decreases, organic matter becomes increasingly more important. Loams (which have roughly equal proportions of sand, silt and clay) are generally good topsoils. However, if these soils lose organic matter, the particles can repack to form a very dense layer and become hard setting.