Chapter 4 Wetland Planning

4.1 Making a Decision to Use Wetlands

Wetlands can fulfil a wide range of uses, benefits and objectives in the landscape (DLWC 1998, Lawrence & Breen 1998). For instance, wetlands can:

- regulate catchment hydrology
- act as groundwater recharge zones
- regulate sediment transport and stream erosion processes
- regulate runoff water quality
- be used to treat urban stormwater and sewage
- provide a range of economic products (eg. fish, rice, timber, pasture)
- provide habitat for flora and fauna
- be a natural component of the landscape
- provide landscape values within the built environment
- provide visual and recreational amenity
- can have cultural or historic values.

However, many of these objectives and uses may be conflicting. For instance a wetland built to remove heavy metals from highway runoff is inappropriate as a long-term habitat for wildlife. Similarly the deliberate provision of water bird habitat in water quality improvement wetlands is inconsistent with water quality improvement objectives and may result in secondary contamination of the water. Consequently, the objectives for any wetland application have to be clearly stated so that any conflicts can be identified and objectives logically prioritised (see also Section 5.8 Design For Uses Other Than Treatment).

The decision to use a FWS constructed wetland for wastewater treatment requires a similar set of questions to be resolved (Richardson & Nichols 1985, Reed & Kubiak 1985, DLWC 1998). The main issues to consider revolve around:

- the required standard and consistency of treatment
- the quality of the influent to be treated
- the ecology of the receiving water for the effluent
- the area of land available and the surrounding landuses.

Required Effluent Standard and Consistency

The required standard and consistency of treatment is a major issue in the consideration to use a constructed wetland for wastewater treatment. The wetland treatment processes, while similar to those in conventional treatment systems, are essentially uncontrolled with respect to management options.

When things go wrong in conventional wastewater treatment plants, some remedial actions can be taken. Active management intervention is much more difficult in constructed wetlands. Constructed wetlands are primarily natural systems and respond to the unpredictability of the environment in the same way as natural systems. A consequence is that the consistency of wetland performance is going to vary seasonally. Also, if the initial design of the wetland can't support the necessary treatment processes, there is little opportunity for management intervention to improve the system performance short of system redesign.

Constructed wetland exhibit a lower limit of wetland effluent quality that can be practically achieved by the treatment processes. This limit is termed the background concentration. Table 5.16 in Section 5.1 – Wetland Size provides indicative values of background concentrations for a range of parameters.

Influent Quality

The quality of the influent to any wastewater treatment wetland is crucial to the performance of the system. The organic load to all wastewater treatment systems is a prime consideration. The design process will normally address this issue. As a result, most FWS constructed wetlands will require some kind of primary treatment to be part of a successful design. Best performance for nutrient removal will be achieved when wetland organic loading is low (eg. secondary treated effluent quality). FWS constructed wetlands should not be used to treat raw sewage.

The main aspect about influent quality is its suitability for treatment in wetlands. Many of the treatment processes in wetlands revolve around the growth and metabolism of wetland organisms. For example, if the influent waste is nutritionally imbalanced for biological treatment in wetlands, treatment alternatives need to be considered or some wetland design modifications made. Domestic wastewater is generally well suited to biological treatment in wetlands. However, food processing wastewaters are typically very high in BOD and low in nutrients, whereas animal wastewaters are typically very high in nutrients. Both are difficult to treat in any

biological system and will normally require some pre-treatment prior to discharge into a constructed wetland.

Some care should be taken in employing wetlands to treat wastewaters containing industrial wastes. While wetland processes may be quite robust to many toxicants and continue to function, some toxicants, such as metals, may accumulate in the sediments. Over time this may result in the wetland becoming a contaminated site.

Ecology of the Receiving Water for the Effluent

The nature of the receiving water for any wastewater treatment operation is a crucial consideration in the choice of treatment system. If the ecology of the receiving water is highly sensitive to the quality of treated effluent, then wetlands are not the first choice. However it will depend on what the receiving water is sensitive to. For example, if phosphorus is an issue, aerobic conditions in the wetland should be maximised. Whereas if nitrogen is an issue, alternating aerobic/ anaerobic conditions should be encouraged. The protection requirements of the receiving water introduce the issue of area available for a wetland treatment system.

Area of Available Land

The land area available for a wetland system and surrounding landuses are crucial considerations in the decision to use a wetland treatment system. Within the water balance constraints of any particular site, if sufficient area is available a wetland treatment system can meet most treatment requirements. In many wetland applications, land costs and construction costs are the major limitation to wetland treatment viability.

Surrounding landuse is an important consideration in the placement of any wastewater treatment system. In general it is appropriate to apply the same buffer requirements as conventional systems. In general, insect pests like midges and mosquitoes will represent some risk. These organisms readily occur in a range of conventional treatment plants (eg. trickling filters, sludge drying beds) but consideration needs to be given to their control in the design of wetland systems (refer to Section 7.3 Mosquito Control).

Advantages and Disadvantages of FWS Constructed Wetlands

In general, the final decision on whether to employ wetland technology has to be made in the context of the overall treatment process (ie. what other (primary) treatment measures are being employed) and the area available for use. In most situations, a system can be made to work if area is available. **Table 4.1: Advantages and Disadvantages of Using Constructed Wetlands for Wastewater Treatment** outlines the general advantages and disadvantages of using constructed wetlands.

Table 4.1: Advantages and Disadvantages of Using Constructed Wetlands for Wastewater Treatment

Advantages	Disadvantages
Wetland operational costs are low.	Wetland capital costs are medium to high.
Energy and material inputs to wetlands are low.	Wetland land requirements are high.
A wide range of treatment processes are available in wetlands. Wetlands can tolerate a wide range of pollutants and toxicants.	Operational control over treatment processes is limited in wetlands. Wetlands will accumulate toxic substances in the sediments and may become contaminated sites.
Wetlands are a natural and sustainable approach to wastewater treatment.	Wetlands are natural ecosystems and typically have seasonally activity patterns which may result in seasonal variations in performance.
Wetlands can have multiple beneficial uses. Under some circumstances constructed wetlands for wastewater treatment may act as useful wildlife habitats.	Under some circumstances, wetland beneficial uses may be conflicting. Attracting some wildlife to wetlands constructed for wastewater treatment may result in decreased treatment performance through secondary contamination of water or through physical damage of wetland vegetation by wildlife. Depending on the particular site, the use of trees and shrubs can interrupt flight paths and sight lines and reduce the systems habitat value for certain species.

Sources: Richardson & Nichols 1985, Reed & Kubiak 1985, DLWC 1998

Wetland Planning - Further Reading

Hammer, D A 1992: "Creating Freshwater Wetlands", Lewis Publishers, Boca Raton, 298p.

Marble, A D 1992: "A Guide to Wetland Functional Design", Lewis Publishers, Boca Raton, 222p.

Department of Land & Water Conservation, NSW 1998: "Constructed Wetlands Manual".

4.2 Site Analysis

Proper site selection and evaluation is important for optimal design, construction and long term management. General factors that should be considered include:

- land availability and town planning zoning
- treatment objectives
- location and site access
- prevailing winds and other climatic data
- surface water and groundwater hydrology
- topography
- soils and geology
- buffer areas
- flood protection.

Larger areas of reasonably flat and appropriately zoned land are required for siting wetland systems compared to other wastewater treatment works. A gently sloping topography will also reduce construction earthworks costs and minimise erosion and drainage works.

The specific treatment objectives must be confirmed when planning and siting wetlands. This will determine wetland sizing and configurations.

All-weather site access is important for the purposes of construction, operation, maintenance and monitoring.

From experience, it has been found in Queensland that wetland sites are typically low lying areas with poorly drained, low nutrient soils. This suggests that some unsuitable materials may have to be excavated and removed off-site and also clay seals placed within water retaining areas. Zones of more permeable soils would create seepage paths into the underlying soils and the groundwater. Soils high in organic material, nutrients, and metals are likely to impose BOD and contaminant loadings on the wetland.

The presence of acid sulfate soil conditions poses problems in terms of impacts on wetland construction, on water quality and on the wetland performance.

It is desirable to have an adequate buffer area around each wetland to act as a riparian zone and minimise the impact of possible odours. This buffer zone however can have the potential of increasing birdlife which can be a hazard to airport operation.

As with any wastewater treatment facility, it is desirable to determine the prevailing winds and site wetlands on the downwind side of residential areas. Local daily rainfall, temperatures and evaporation data may be required to assess water balance in the wetland (see also Section 3.1 Hydrology).

Wetlands sited in drainage paths and near waterways should incorporate appropriate drainage diversion or bypass systems to avoid impacts during storms. It is not desirable to site wetlands over shallow aquifers that have a potential as a drinking water source. A general hydrogeological assessment should be undertaken to include the following:

- depth to aquifer and groundwater quality
- fluctuations in water levels
- underlying soil type and permeability
- groundwater movements, flows and usage.

Constructing a wetland near an area heavily infested with weeds can cause future maintenance problems.

4.3 Legislative Requirements

This section is intended as a guide only. Local governments should make their own enquiries regarding the specific circumstances associated with individual constructed wetlands projects.

> This section also covers only development approvals and associated environmental licensing. Other approvals may be associated with land access, tenure, workplace health and safety or other operational issues.

Development approvals for the construction of constructed wetlands can generally be classified into three broad areas of concern:

- Planning Approvals – (*Integrated Planning Act 1997)*
- Environmental Approvals – (*Environmental Protection Act 1994*)
- Natural Resource and Heritage Approvals – (various Acts eg *Fisheries Act 1994,*

Heritage Act 1992, Cultural Records (Landscapes Queensland and Queensland Estates) Act 1987, Water Resources Act 1989, Nature Conservation (Wildlife) Regulation 1994). Note that the *Water Resources Act* is being revised.

The application of these approvals will depend on the specific circumstances surrounding individual proposals. The key questions for the proponents of constructed wetlands and their development approvals include:

- How does the proposal relate to the local government's Strategic Plan and associated land use zoning, planning objectives, codes, local laws and development assessment requirements?
- Could the proposed work be of environmental concern in regard to air, noise, odour, surface or groundwater pollution?
- Could the proposed work impact on other natural resources eg – fisheries, endangered or vulnerable flora or fauna, water resources and the stability of stream beds and or banks etc?
- Are there any cultural heritage matters that might affect the proposal (ie items of local, state or even national historic or cultural significance – including for Aboriginal and Torres Strait Islanders)?

Planning Approvals

Development may require planning approval in accordance with the local Planning Scheme requirements and the *Integrated Planning Act 1997* (IPA)

Development is defined in IPA (s 1.3.2) and includes:

- Building works (includes demolishing or moving a building to make way for the wetland)
- Plumbing or drainage works (includes sewerage and stormwater installations)
- Operational works (includes excavating or filling land)
- Reconfiguring a lot (eg subdivision or amalgamation of land) and
- Material change of use of premises (the start of a new use for land or a material change in intensity or scale of a current use).

Both IPA (Schedule 8) and the Local Government Planning Scheme (including the zoning of the proposed wetland site) will need to be referred to in order to identify what development aspects of the project will need approval and what level of "assessment" will be required. Note that Schedule 8 of IPA is being gradually amended as more "approvals" from various government agencies and their associated legislative responsibilities are integrated with the planning legislation.

In terms of assessment requirements, development may be:

- Exempt – no approval required.
- Self-Assessable – no formal approval application required but development must conform to relevant standards. These were previously "as of right" uses.
- Code Assessable – formal development application required and assessed in relation to relevant code, if any. These were previously uses that were "permitted with conditions".
- Impact Assessable – formal application and public notification or referral required. These were previously uses that were prohibited and required rezoning, or required planning consent.

Constructed wetlands of a certain size or on certain land may also require formal referral and information coordination through relevant State agencies. Such "referral coordination" applies to development applications for the material change of use for a designated development or development on prescribed land.

Designated developments include:

- Works for creating or extending bodies of water with a maximum surface area of water of more than 5 000 m^2.
- Any developments identified in a local planning policy as a designated development. eg, impounded or excavated water bodies including any artificial lake or other artificial water body having a surface area in excess of 2 000 m^2 (Brisbane City Council).

Prescribed land includes:

- areas below the floodline adopted by the local government, if development involves filling an area of more than 5 000 m^2
- areas of critical habitat for native wildlife as identified under a conservation plan under the Nature Conservation Act 1992
- catchment areas under the Water Resources Act
- coastal Management Control Districts
- existing wetlands, whether fresh, brackish or marine.

The assessment process may also require consideration of State Planning Policies, (such as Development and the Conservation of Good Quality Agricultural Land). Depending upon the level of assessment required it may also involve the referral to, or even

concurrence of, relevant State agencies, particularly those that have separate approval or permit responsibilities.

Environmental Responsibilities and Licensing/Approval

The *Environmental Protection Act 1994,* and associated *Environmental Protection Policies* (EPPs), have direct applicability to constructed wetlands. Specific environmental issues and responsibilities include:

- The prevention of "environmental harm" – (general environmental duty under the Environmental Protection Act 1994).
- The licensing and approval of "environmentally relevant activities". These activities are listed in Schedule 1 of the Environmental Protection Regulations 1998 and are activities with a known potential to cause environmental harm.
- The management of "contaminated land". Certain activities are listed as Notifiable Activities - Schedule 3 of the Environmental Protection Act 1994, where there is a known risk of land contamination. Note that the only listed activity relevant to constructed wetlands is a sewage treatment site with a design capacity for more than the equivalent of 50 000 persons.
- Management of stormwater runoff.
- Environmental monitoring.
- Environmental programs and policies.

Environmental harm is defined as any adverse effect, or potential adverse affect on an environmental value, including environmental nuisance.

Environmental value is defined as a quality or physical characteristic of the environment that is conducive to ecological health, public amenity, public safety or other quality defined under an EPP. Environmental nuisance can be seen to be interference with these values caused by noise, dust, odour, light, contamination or other effects defined by the regulations.

Constructed wetlands used for the treatment of wastewater have a recognised potential for environmental harm unless designed, constructed and operated appropriately. The potential for environmental harm can range from nuisance effects caused by occasional odour to direct impact on environmental values such as water quality and ecological health of downstream surface or groundwater systems.

For this reason, constructed wetlands for sewage treatment are scheduled as environmentally relevant activities - *"(h) a special sewage treatment works having a peak design capacity to treat sewage of 21 or more equivalent persons."* *(Environmental Protection Regulation 1998*, Schedule 1, pp. 51). Accordingly, an environmental license or approval will generally be required for wetland construction, depending on their capacity.

Construction of wetlands requires particular procedures and 'tests' to be addressed by the administering authority in making environmental management decisions. These relate to wastewater releases to surface water, construction of wetlands, natural biological controls and impact monitoring for environmental impacts.

An application for an environmental license can either be lodged:

- On an individual basis, to the Environmental Protection Agency (EPA); or alternately.
- In association with an application for material change of use, if required, to the relevant local authority. In this case, the Environmental Protection Agency will be a referral agency ('Concurrence Agency') for the environmental licensing components of the integrated development application.

The *Environmental Protection (Water) Policy 1997* (or EPP Water) outlines the relevant environmental values and water quality objectives for water bodies. The EPP Water applies to all Queensland waters, whether natural or artificial. Management goals and processes for waters, activities and contamination are outlined, as well as the requirements for environmental plans.

The EPP Water contains a number of requirements for considering particular proposals, and in meeting environmental values. These requirements link to the environmental licensing processes and the general statutory duty to protect the environment from environmental harm.

On this basis, an environmental license for a constructed wetland may be issued with conditions regarding environmental values, water quality objectives etc associated with the wetland.

Fundamentally, water quality objectives from the EPP Water do not apply to "waste water in a storage". On this basis, it is more likely that the environmental values would apply to the receiving waters downstream of the constructed wetland, rather then to the water in the wetland itself. The environmental values

of the receiving waters, in turn, determine the quality of the effluent that may be discharged from the constructed wetland. The environmental values would need to be established on a case by case basis.

The administering authority (EPA or Council) is required to consider particular requirements when making an environmental management decision about an activity. The following activities are relevant to constructed wetlands, and are covered under the Policy:

- release of wastewater to a surface water
- construction of wetlands for wastewater treatment
- use of natural biological controls in treatment of wastewater; and
- impact monitoring.

In particular instances, sections relating to acid sulfate soils may also apply.

Wastewater releases to surface water

If considering the release of wastewater to surface water, such as natural wetlands, an administering authority must consider:

- whether the size of the initial mixing zone will adversely affect an environmental value
- whether concentrations of contaminants in the initial mixing zone are acutely toxic to the biota
- the existing quality of the surface water
- the cumulative effect of the releases concerned
- future releases to the surface water, and
- the water quality objectives for waters outside the initial mixing zone.

An outfall to the surface water may be required if it will achieve visual or water quality improvements. The administering authority, most likely the EPA, can impose particular requirements for dilution levels, the initial mixing zone, or limiting waste water releases into coastal or non-coastal waters to specific tidal or flow occasions.

Construction of wetlands for wastewater treatment

This section applies to the construction of a wetland for wastewater treatment in a natural wetland. A key test is that the administering authority (or EPA) must decide whether:

"the existing ecological values, or the ecological values likely to exist after rehabilitation, of the natural wetland are so significant that the artificial wetland should not be constructed in the natural wetland."

This decision is to be decided based on a consideration of:

- the significance of the natural wetland
- the ecological values of the wetland, and if the values have been degraded by the substantial loss of invertebrates, invasion by exotic plants, or loss of ecological functions
- the potential to reverse degradation by cost-effective remedial or rehabilitation measures
- potential improvements to downstream water quality; and
- alternative sites for construction of a wetland.

Use of biological controls in wastewater treatment

If a constructed wetland is to utilise natural biological controls (involving the addition of naturally occurring bacteria, fungi or micro-organisms), the EPA must also consider any available safety information, the likely effect or the controls and if there are any potential pathogens in the controls [s. 23. (1-2)].

Impact monitoring

As the constructed wetland will require the release of treated wastewater to water, the EPA needs to consider the monitoring of environmental impacts. Particular considerations relate to the protocols for monitoring the water. Such impact monitoring is generally only required for large or hazardous activities, large or complicated releases, or to confirm the conclusions of an environmental impact assessment, decide future disposal strategies or where there is concern regarding particular contaminants [s. 27. (1-3), pp. 21].

Where the EPA or other authority requires impact monitoring, the authority must consider the proposed activity, level of harm and water quality objectives to decide the frequency of monitoring and relevant indicators.

Environmental Plans – Sewage Management

A local government that operates a sewerage system is required to develop and implement a sewage management plan to minimise unnecessary flows into the system. For the plan, the local government is required to consider water quality objectives and to maintain acceptable health risks.

In preparing such a plan, the following matters need to be considered:

- ways of reducing infiltration to sewers
- ways of avoiding unintended stormwater flows

- alternatives to expanding or remediating an existing system

[s. 40. (1), pp. 28-29].

These considerations may be necessary in terms of the broader sewerage system and construction of wetlands by local governments.

Other Statutory Approvals

The location of proposed wetlands sites will determine if other statutory approvals or permits are required. For instance, a site located in an identified heritage area or affecting a watercourse will require another layer of assessment and approvals. (Note – these approvals are gradually being integrated through amendments to IPA into the IDAS process, generally meaning a single development application to local government and referral to relevant agencies for information and concurrence if necessary).

Specific legislation and associated approvals include:

- Section 33 of the *Cultural Records (Landscapes Queensland and Queensland Estate) Act* – Applies to the protection of Aboriginal and Torres Strait Islander archaeological or historic items or sites. Penalties apply for unauthorised interference (s.56).
- *Queensland Heritage Act 1992* – provides for a register of cultural heritage places in Queensland and for the regulation by the Heritage Council of development affecting such places.
- Section 86 of the *Harbours Act 1955* – provides for the EPA to sanction works or structures in, on, over, through, or across tidal lands.
- *Coastal Protection and Management Act 1995* – provides for the preparation of Coastal Management Plans and for coastal protection and tidal works notices.
- *Rural Lands Protection Act 1985* – provides for action to be taken to control the spread of "Declared Plants".
- Section 70 of the *Water Resources Act 1989* – provides for the protection of the physical integrity of watercourses including the protection of riparian vegetation and the control of excavation or the placement of fill within the watercourse. Note that the *Water Resources Act* is being revised.
- Section 126 of the *Fisheries Act 1994* – provides for the approval of any barrier or restriction to fish movement. Approval is also required under the general provisions for the use of explosives.
- Nature Conservation (Wildlife) Regulation 1994 – provides for a Schedule of rare, endangered or vulnerable flora and fauna species and their associated protection.
- Section 43 of the Standard Sewerage Law, *Sewerage and Water Supply Act 1949* – deals with the interference with path of stormwater and applies to site drainage around constructed wetlands.

The provisions of the *State Development and Public Works Organisation Act 1974* may also apply if a project is deemed to be a 'significant project' by the State. A particular process needs to be followed under this Act for impact assessment and community consultation to allow a project to occur. The Act is expected to be incorporated into the *Integrated Planning Act 1997* in March 2000.

Commonwealth Legislation and Agreements

It is possible that some proposed works could potentially affect Commonwealth Government responsibilities for environmental protection or specific Commonwealth land tenure.

Australia is a signatory to several international water bird agreements designed to protect the habitat of these species. Currently the obligation to implement these agreements (JAMBA, CAMBA and RAMSAR) is through controls specified in State and Territory legislation.

New laws are being developed to clarify the role of the Commonwealth in environmental protection. *The Environment Protection and Biodiversity Conservation* (EPBC) *Act, 1999* is expected to commence operation in July 2000. The EPBC Act will be triggered if an action affects a matter of national environmental significance including:

- World Heritage Areas
- Declared RAMSAR Wetlands
- Listed Threatened Species or Ecological Communities
- Listed Migratory Species (eg CAMBA or JAMBA birds)
- Nuclear actions
- Commonwealth Marine areas.

Following the commencement of the EPBC Act the only other major Commonwealth legislation that may influence the location or approval of constructed wetlands is the *Australian Heritage Commission Act 1975*. This Act provides for the listing and protection of the National Estate as registered heritage sites, including both natural and man made places or structures. The Australian Heritage Commission maintains a register of listed and nominated sites and its advice should be requested where considered necessary.

4.4 Effluent Reuse

The beneficial use of reclaimed wastewater is a desirable option rather than discharging to a receiving water. Local government and industry are under pressure to comply with the *Environmental Protection Act 1994* and the *Environmental Protection (Water) Policy 1997*. This legislative aspect combined with the extended drought situation that has prevailed over Queensland for much of the 1990's has highlighted the need to improve effluent quality and to seriously consider irrigation and other forms of effluent reuse.

The Queensland Government in currently developing a strategy to determine sustainable and safe options for water recycling (DNR 1998). The final strategy is due for release in January 2001.

Effluent reuse is a highly ranked option in the Government's strategies for water conservation and environmental protection (Beavers, 1996). If however inadequate focus is directed at site characteristics, water quality and system management, these benefits could be lost through effluent runoff and land degradation and result in possible environmental pollution.

The beneficial reuse of effluent must consider the following aspects:
- reliability of supply
- water quality in general
- microbiological quality
- general public and operator health issues, which are probably the most critical aspects
- public and operator safety
- management
- site characteristics
- possible land degradation
- system sustainability.

Secondary standard wastewater can be further treated in a wetland and the resulting effluent reused for the following applications (Greenway & Simpson, 1996):
- irrigating golf courses, playing fields and recreational areas
- irrigating pastures and fodder crops
- irrigating sugar cane
- irrigating selected treelots
- creating lakes and wetlands in resort areas
- scrubbing flue gases in sugar mills.

Other potential applications for reusing effluent and process waters emerging in Queensland and gaining recognition overseas include (Greenway & Simpson 1996, Beavers 1996):
- duckweed harvesting in wetland treated effluent which is then utilised as fish and stock feed because of the high protein content
- treatment of recycled water from the aquaculture industry in wetlands because of the limited fresh water resources in some areas
- production of zooplankton and crustacean in wetlands as fish food for the aquaculture industry
- providing environmental flows in creeks
- rearing of freshwater sport fish
- providing washing down waters, where a potable quality is not needed
- for watering roads and construction sites to minimise dust nuisance.

Over the years much of Australia's natural wetlands have become depleted due to residential and agricultural development, particularly in low lying coastal areas. As a result there has been a concerted effort to restore and replace some of the wetlands where suitable land is available. These wetlands act as wildlife refuges and as tourist attractions due to the emergence of the eco-tourism industry. If these types of wetlands are to be developed as systems using reclaimed wastewater, the following potential problems have to be addressed (Beavers, 1996):
- mosquito breeding in the shallow margins and the secluded areas of the wetland
- increase in salinity
- increases in flood levels
- decrease in groundwater quality under the wetland
- maintenance costs
- health problems.

Examples of Queensland Wetland Effluent Reuse

Over recent years a joint wetland system, treating effluent from Ingham and the Victoria Sugar Mill, has been established. The sugar mill intends reusing treated effluent in the following ways (Greenway & Simpson, 1996):
- irrigate farms in the area
- supplement water resources in a local creek
- flue gas scrubbing.

Blackall has a wetland system for polishing effluent. The Council has planned an effluent reuse scheme with the following applications:
- irrigating commercial treelots , that is, different species of flowering gums for export
- developing a riverbank eco-tourism complex, using native plants and trees from Western Queensland and irrigating with effluent

- irrigating community parks and gardens in the longer term.

Reuse Water Quality Standards
Typical water quality standards for the use of reclaimed wastewater (Beavers, 1996) are as given in **Table 4.3: Typical Water Quality Standards for the use of Reclaimed Water**:

Treated wastewater should be sufficiently free of faecal contamination and pathogenic micro-organisms to protect public health. Desirable guidelines for the microbiological quality of effluent to be reused have been set at three different levels (A, B or C), depending on the application type. These levels and applications are detailed in Tables 7.6 and 7.7 in the Interim Guidelines for Reuse of Reclaimed Water in Queensland (Beavers, 1996). Health warning signs should be erected in areas of public access where reclaimed wastewater is to be spray irrigated.

Constructed wetland treatment presents itself as an economic and technically viable option for reducing suspended solids, algal matter, organic matter, nutrients and harmful organisms. Wetlands are efficient in reducing the components present in effluents and process waters known to cause problems in reuse systems (Simpson, 1997). These components include suspended sediments, organic matter, microorganisms and some heavy metals.

Since constructed wetlands are natural systems and are subject to variations in terms of performance, this technology cannot be taken as being highly reliable. Effluent quality is influenced by natural variability so when effluent standards are restricted to consistently low levels, constructed wetlands are not necessarily a reliable option.

Table 4.3: Typical Water Quality Standards for the use of Reclaimed Wastewater

Parameter	Unit	Range
BOD	mg/L	<20
Suspended solids	mg/L	<30
pH		6.5 – 8.5
TDS	mg/L	<2 000
Chloride	mg/L	<1 100
Sulphate	mg/L	<1 000
Sodium	mg/L	<900

Note: Standards for metal concentrations are also provided in Beavers 1996.