LAKES EMP 2002

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THIS DOCUMENT FORMS PART OF Townsville City Council USQMP FOR SITE BASED OPERATIONAL MANAGEMENT OF CURRALEA AND PARADISE LAKES.

LAKES EMP INDEX

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EMERGENCIES: REFER TO EMERGENCY RESPONSE MANUAL (RECREATIONAL WATERS & FISH KILLS)

CURRALEA AND PARADISE LAKES

ENVIRONMENTAL MANAGEMENT PLAN

1.0 THE LAKES ENVIRONMENTAL MANAGEMENT PLAN INTRODUCTION

This Environmental Management Plan was formulated to address water quality issues affecting the ecosystem and public amenity of the Townsville (City Council's) Lakes (particularly Curralea Lake). This Environmental Management Plan builds on the *Lakes Environmental Management Strategy 1999* and Townsville City Council's (**TCC**) *Urban Storm Water Quality Management Plan* (**USQMP**) for the Lakes.

Note: This document fulfils the requirements of Environmental Management Strategy 1 Action 1.

Strategy 1 Action 1- Prepare an Environmental Management Plan for the long-term management of the Lakes, implementing regular maintenance, monitoring and community education measures.

OBJECTIVES:

- To improve the standard of water quality within the lakes system
- To continually enhance community amenity of the lakes and surrounding parklands
- To enhance the ecological habitat of the lakes system
- To maintain an affordable flood mitigation system
- To provide a maintainable system.
- To provide cost effective solutions conditional on funding priorities.

This Environmental Management Plan has been compiled to meet the above objectives by:

1. Defining clear roles and responsibilities of TCC departments
2. Developing and implementing cost effective maintenance programs designed to provide and maintain the desired level of visual amenity and environmental health of the Lakes aquatic & terrestrial ecosystem
3. Developing and implementing a monitoring program which will provide early warning of environmental concerns

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4. Developing and implementing remediation programs for improving the water quality after contamination
5. Complementing and integrating flood mitigation and contamination management measures within the Lakes urban catchment and enhance water quality outcomes (ie USQMP)
6. Facilitating conformity with current legislation, regulations and guidelines, in particular as they relate to environmental (aquatic and terrestrial ecosystem) protection and public health and safety
7. Enhancing the aquatic ecosystem health of the Lakes by improving the surrounding terrestrial park lands and stormwater run-off management practices
8. Developing an effective communication and community education package (refer 8.0 Community-**flier, facts sheet and brochure**)

Note: This Environmental Management Plan is a dynamic document. In order to achieve the many objectives of flood mitigation, recreational amenity, habitat enhancement and water quality control this Environmental Management Plan must be reviewed periodically to reflect the latest best environmental management practices (BEMP) and Lakes System/integrated catchment management (ICM) knowledge.

2.0 BACKGROUND

2.1 Curralea and Paradise Lakes - Development History and Drainage Catchment

- The artificial Lakes and Woolcock canal includes part of the north-western Ross Creek catchment and others (refer attached **Catchment Plan**), and has been designed to reduce peak flow from the Townsville suburbs of Hyde Park, Gulliver, Currajong and Vincent.
- The surface area of Curralea Lake covers around 7.5 ha and has a depth of 1.9 to 2.5 metres (150ML). It was constructed in 1987 as part of a stormwater drainage upgrade and flood mitigation scheme.
- The second stage of the Lakes development, Paradise Lake was completed in 1994 as part of this flood mitigation scheme.
- Paradise Lake has a surface area of 10 ha and a water depth between 1.5 and 1.9 metres (200ML).
- Both Lakes are subject to restricted tidal influences, regulated by tide gates and flow restrictions caused by the Woolcock Street Canal and weir.
- The tidal gates at Woolcock Street prevent the ingress of seawater and subsequent inundation of large areas of low-lying land behind the gates.
- While the Woolcock Street canal leads directly into Paradise Lake, Curralea Lake is connected via a 116m 1.5m diameter pipe and a floodway under Woolcock Street adjacent to Castletown.
- The pipe was designed to allow for a total water exchange over 15 days, depending on tidal movements.
- **Maps 1 & 2** show the number of stormwater drains, which drain run off into both Lakes.
- The Lakes, while constructed primarily to mitigate floods as flood retention basins in these low-lying areas, have also acted as sediment/debris and contaminant traps for urban stormwater run-off. Thus reducing the amount of contaminant entering Ross Creek and Cleveland Bay.
- Widening of Woolcock Canal to improve drainage of floodwaters was started in November 2002.

The Lakes effectively and efficiently protect the downstream Ross Creek and ultimately the Great Barrier Reef Marine Park (GBRMP) from much of the urban litter and contaminants released from the upstream catchment.

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2.2 Environmental and Recreational Value Review

- The Lakes are stormwater retention basins, and collect the litter and debris commonly associated with our urban environment.
- However, the water body has over the years developed a viable aquatic ecosystem of substantial environmental and recreational values eg. fishing.
- The Lakes are also home to a significant number of birds including several duck species and pelicans.
- Public use includes recreational activities such as fishing, canoeing and non-motorised model boat racing.
- The open parklands adjacent to the Lakes provide a popular destination for community barbeques, lunchtime rest stops, exercise activities and school excursions.

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3.0 LAW REVIEW

- The law in Queensland recognises that we all have a general environmental duty (**GED**) and responsibility to protect our environment and community infrastructure.
- Several pieces of legislation, enacted to protect our waterways or drainage system, make it an offence to discharge litter, debris and contaminants into a place where it can damage the environment or infrastructure:

The Environmental Protection Act 1994

- This Act obliges all Queenslanders to minimise or prevent environmental harm by taking all ***reasonable*** and ***practicable*** steps to prevent litter, air, water and soil/land contamination.
- Under section 126 of the EPA 1994 it is an offence to place a contaminant (ie. litter, rubbish, chemicals etc.) in a position where it can enter a drain or waterway.

The Environmental Protection (Water) Policy 1997

Section 42 requires that LG/TCC develop and implement a USQMP by January 2003, and this must include any number of a range of specified measures, which are designed to improve water quality (WQ). (Refer **Appendix 7 EPP(W)**)

Section 31 and 32 of this policy, which applies to all Queenslanders, prohibits the release to or placement of contaminants, including sediments, in a position where they can enter a gutter, stormwater drain or ultimately water. (Refer **Appendix 7 EPP(W)**).

Under the EPP(W) legislation the Environmental Protection Agency has the power to investigate and give on the spot fines or prosecute infringements.

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4.0 CURRENT STUDIES, INVESTIGATIONS & IMPLEMENTATION

The following studies and investigations have been undertaken to increase our knowledge, determine/identify additional environmental management techniques to improve water quality and mitigate flood retention capacity of the Lakes system.

Strategy 2- conduct studies and investigations to consolidate our knowledge and improve management.

4.1. USQMP and Lakes Environmental Management Strategy- Projects and Implementation

Strategy 1 Action 1

The Environmental Management Strategy outlined 5 Strategies and 14 Actions and is to be implemented over the longer term.

In 1998 Council commenced the TCC USQMP and developed the Lakes Environmental Management Strategy (EPS 1999: to address water quality and public amenity issues, refer **attached pages**).

4.1.1 USQMP

- Townsville City Council's Urban Stormwater Quality Management Plan (refer **attached pages** and/or the intranet/web site for the full document) identified a number of priority sites across Townsville in order to determine where initiatives needed to be implemented to improve water quality. The implementation of these initiatives depends on the availability of funding and resources.
- The Lakes are the subject of ongoing engineering and environmental reviews which are conducted by Council staff and consultants.
- The Lakes were assigned a priority 1 status under Council's USQMP (TCC USQMP 1998 SKM) and subsequently Council has commenced the implementation of a Lakes – Ross Creek CBD Urban Waterway Project with funding from Environment Australia (refer- **Appendix 6**) and Townsville City Council.

4.1.2 Lakes Environmental Management Strategy

- As a response to community concerns regarding fish kills there has been an ongoing program to manage the Lakes. The strategy (refer attached pages) includes a number of actions which are identified and discussed with in this Environmental Management Plan.

4.1.3 Gross Pollutant Trap Studies

- In accordance with Council's USQMP Priority Sites (Lakes), Citiworks commenced a program of installing Gross Pollutant Traps (**GPT**) in 2000. The first was established at Currajong Park within the drainage system leading in to the Lakes to prevent litter and some contaminants entering.
- The GPT units selected are placed into the existing system and are capable of collecting gross litter (ie. cans, paper and plastic), soils/sediments and contaminants such as oils.

4.1.4 Artificial Wetland Installation

- In addition to this trial, EMS and Citiworks in conjunction with USI has constructed a treatment wetland in the primary Curralea Lake catchment Hughes Street drainage channel. A similar Pollution Control System (**PCS**) has been constructed on the primary Paradise Lake catchment Hughes Street drainage channel.
- The treatment train is designed to treat first flush rainfall events by retaining gross pollutants, sediments and dissolved nutrients.
- The system will be monitored to assess the reduction of pollutants entering the Lakes.
- The treatment train also treats water from the lake via a sand and granular activated carbon (**GAC**) filter, which should also, aid in the reduction of pollutants with in the lake.
- It also provides circulation in an otherwise poorly circulated area and a base flow treatment path via rock lined channels.

4.2 Litter survey* - Curralea Lake *Strategy 2 Action 2*

- The litter survey commenced in April 1999 with the installation of 3 litter curtains and 1 litter boom in Curralea Lake.
- The type of litter captured is dependent on the type of litter curtain and the frequency of clearance.
- The results of the litter survey have determined the most common type of litter found in a particular area.
- From this data Council can determine the pollutant's source and/or target education/information campaigns to reduce the amount of rubbish entering the lakes.

4.3 Sediment fauna/flora biodiversity study*- Curralea Lake

Strategy 2 Action 3

- Biodiversity studies of bottom sediment samples, representing all areas of Curralea Lake, were collected and examined for fauna and flora diversity and contaminant accumulation.

- This study program was initiated in February 1999 to provide a measurement of contaminant loadings and distribution from drainage inflows in to Curralea Lake
- It was designed to assist in the selection of appropriate ongoing monitoring sites.

4.4 Fish Survey *Strategy 2 Action 4*

- Sunfish/ Queensland Department of Primary Industries (**DPI**) fish tagging studies* (tbc) found the Lakes to be a barramundi breeding ground.
- During the period 1990-93, 25 fish species were found in Curralea Lake (Milward & Webb 1990; Webb 1994).
- A baseline survey of fish species in both Lakes and the Upper Ross Creek immediately below the tidal gate commenced in May 1999.
- The most prevalent (80%) fish species in fish kills prior to 2002 was found to be the introduced cichlid tilapia. In 1999 Council commissioned a six-month study by A.C.Webb from the Austarlian Centre for Tropical Freshwater Research (**ACTFR**) at James Cook University North Queensland (**JCUNQ**) which recorded 10 species of fish including barramundi.
- On the 23 January 2002, 19 species of native fish species totalling 12 tonnes died in Curralea Lake due to an algal bloom removing the available dissolved oxygen.
- This included over 50 barramundi around 1 m in length, including one specimen up to 1.7 m and assessed at nearly 60 kg in weight.

4.5 Flood Management Studies & Implementation *Strategy 2 Action 5*

- Citiworks has investigated methods by which the flood retention capacity of both Curralea and Paradise Lakes can be reduced by widening Woolcock canal and improving the outflow of floodwaters.

4.6 Water Quality

4.6.1 Water Quality Modeling Studies *Strategy 4 Action 9*

- A salinity and volume exchange model was produced as a result of information obtained by Dr Jonathon Harris of consultants Maunsell Australia.

4.6.2 The Chironomid midges Study

- Following an ACTFR study (see below), Townsville City Council has subsequently entered into a contract with DPI Bribie Island Aquaculture Research Centre to undertake a trial experiment in relation to the control and reduction of non-biting midges in Curralea Lake.
- The trial experiment has been undergoing final preparation and is planned to be initiated in **2003**.

- The midges (otherwise known as gnats) become more prevalent during the summer months with the influx of freshwater water and organic materials, which are fed upon by the midges.
- The trial will be undertaken using cages stocked with mullet. Mullet are a naturally occurring fish in Curralea Lake; however they are currently in low numbers.
- In other locations where midges have also been a problem, mullet have been observed to reduce numbers through predation of the midge larvae growing on bottom sediments.
- Four cages will be located within Curralea Lake, and monitored over a period of approximately one month.
- Observation of numbers within and outside the caged areas of midges will provide researchers with vital information on the midges, and as such will provide EMS with important information in regards to controlling the midges in the future.

An Investigation into nuisance midges at the Lakes Stage 1 ACTFR Report 01/06.

- The dominant midge in the aquatic samples is *Kiefferulus "tinctus"* which occurred in high abundances in early 2001. *Chironomus spp. w*as present but not in high abundance. All the chironomids found contained the respiratory pigment haemoglobin and are generally associated with disturbed and low dissolved oxygen conditions.
- The conditions in Lakes 1 are limiting the biodiversity in the system through factors such as lack of suitable habitat, toxic contaminants, warm temperatures and low dissolved oxygen levels (eutrophic). Consequently the more tolerant chironomids are flourishing in this warm, food rich environment unchecked by competitors and predators.

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5.0 ISSUES REVIEW

Active maintenance and management for water quality is essential to improve ecosystem health.

5.1 Water Quality *Strategy 4 Action 9*

- Regular monitoring by the Citiwater Laboratory, EMS and Citiworks has shown that the Lakes water quality has deteriorated since its construction, especially when sediments have been mobilised by rain events and industrial and residential contaminants and litter have accumulated in the Lakes system.
- Toxic blue green algae (cyano-bacteria) and flagellate blooms in the Lakes have resulted from a combination of high temperatures at the onset of summer, nutrient enrichment (N & P), animal faeces from urban run-off and widely variable salinities after rainfalls, on a regular basis since 1993.
- Subsequent bacteria, algae and aquatic plant blooms resulting from nutrients and deteriorating water quality due to increased biological oxygen demand (**BOD**) from the breakdown of organics, and diminished dissolved oxygen (**DO**) has led to recent major fish kills and temporary closure of the Lakes to swimming or other primary recreational contact.
- Public Health signs warning people not to swim are still in place around the lakes and wetland ponds. DO was not monitored until recently as resulting fish kills from low DO has been a recent phenomenon.
- Regular weekly water quality monitoring commenced in 1990 to safeguard public health.
- Monitoring data is collected from a site in Curralea Lake, a site in Paradise Lake and a site within the Woolcock Canal.
- A discussion of the monitoring program can be found in **Appendix 4**.
- Water analysis shows the Lakes are fresh, brackish or marine for prolonged periods of time.
- Rapid fluctuations result from low to high intense rainfall events.
- These frequent significant changes in habitat status (ie. marine to fresh and vice versa) are believed to have had a detrimental effect on the established Lakes ecosystem.
- Run-off from infrastructure, industrial and domestic premises after heavy rain events has washed considerable amounts of contaminants into these water bodies.
- Active management initiatives commenced in 1998 when sediment and associated nutrients and contaminants were removed.
- The ongoing maintenance, monitoring and remediation programs resulting from this Environmental Management Plan are designed to improve water quality significantly over time.

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5.1.1 Alga/Diatoms

- Blooms of microorganisms are normally a direct result of dramatic water quality changes. However, even a seemingly minor first flush event with a high nutrient load can with the right physical conditions provide a suitable environment for organisms to proliferate.

5.1.2 Monitoring Disolved Oxygen (DO)

- Following a major fish kill event it has been determined that it is critical to maintain the DO threshold above a point that will allow aquatic life to survive and reduce the detrimental impacts of a bloom, which will remove the available DO both in the growth and death phases.
- As the temperature increases above 19^{O}C, the ability of aquatic organisms to extract DO becomes even more difficult.
- This temperature is frequently exceeded during the wet season and even after cooling rain events.
- It is also critical to keep DO levels as high as possible to minimise the potential for the release of hydrogen sulphide and ammonia (H_2S and NH_3) from bottom sediments.
- The production of H_2S and NH_3 could lead to toxic conditions for human health and aquatic life.

5.1.3 Increase Salinity

- It is essential to the health of the aquatic ecosystem that has established within Curralea Lake that the water becomes more saline by seawater flushing.
- Seawater flushing improves buffering of the lakes water and contributes to its ability to compensate for rapid changes brought on by the influx of contaminated surface water ("*dissolution is important*" *pers comm.* Dr Riku Kosketa Senior Water Quality Scientist GHD 8/2/2002)
- The only way to maintain better salinity is to improve the input of seawater from the canal.
- A salinity model was investigated by EMS with Maunsell Australia as part of USI and may help to determine methods to improve salt water flushing. Citiworks are also using the model to look at ways of improving DO.

5.1.4 Fish Migration

- Fish within Lakes 1 will not move out through the low flow pipe under Woolcock Street even if the conditions become unacceptable to their survival. Australian fish are not known for swimming through a dark pipe for distances greater then 10m (DPI studies). Barramundi will only swim 5m.
- The primary reason for installing aeration pumps is to provide a dissolved oxygen source for the immediate relief of the fish trapped within the Lakes.
- During the construction of the parallel Woolcock canal up to 2 pumps were used on both Lakes to overcome the lack of seawater flushing and aeration.

5.1.5 Litter

- A large amount of litter from fast food outlets, shopping centres, industrial facilities and domestic sources enters the Lakes through the drainage system each year.
- Plastic bags, shopping trolleys, aluminium cans, fast food wrapping material of significant volumes and green-waste (including grass) has been removed during clean-up operations by Commonwealth funded Community Jobs Program (**CJP**) volunteers, Citiwaste and by the community on Clean Up Australia Days (10 March 2002).
- This litter poses a serious risk to fauna, leads to water pollution as materials decompose and release chemicals, and impacts on public health and safety and community amenity/ aesthetic values of the area's parks.
- Clean-up operations to date have been very time consuming and costly due to the large area over which litter is distributed through wind and wave action.
- Sharps (hypodermic needles) entering the stormwater system should be disposed of through existing WH&S procedures.
- Debris/litter removal has also sometimes been inefficient, as Council are not easily able to enter or access areas immediately adjacent to or within private property to collect the debris on the lakeshores.
- However, it is primarily the owners responsibility to collect and dispose of litter etc. washing up on their own property.
- Litter collection devices have been installed at selected drainage outlets significantly reducing the amount of debris in the water body, ensuring easier, more efficient clean up and maintenance, and improve visual amenity.

5.1.6 Sediments (SOD)

- There has been no definitive analysis of the oxygen demand of bottom sediments within the Lakes.
- Part of a study by Citiworks, in conjunction with JCU, was conducted to assess potentially contaminated bottom sediments.
- Unfortunately there was insufficient data to make an assessment regarding SOD.
- Anecdotal evidence suggests that there is a high SOD, however this requires further investigation.

5.1.7 Nutrients (BOD)

- After first flushes, the Lakes receive grass/green-waste, faeces and other organic matter, fertilisers which release nutrients (N and P) into the system as well as having a very high biological oxygen demand when they breakdown or are used up by algae etc.

- In the breakdown of organic matter nutrients are also released into the system and this compounds the growth of algae and other aquatic plants.
- The levels of nutrients may be many times beyond what is acceptable to secondary water contact under Australia and New Zealand Environment and Conservation Council (**ANZECC**) Guidelines for Marine and Fresh Water Quality 2000.

5.1.8 Flushing

- As part of a study carried out by Maunsell Australia, Dr Jonathon Harris conducted a review of the exchange capacity.
- This study concluded that the low flow pipe joining the Lakes provided a 15 day exchange of volume between the lakes.
- However, this flushing process does not appear to have any effect on the water quality within the lake.
- It is only during tides above RL 0.41m AHD (= tide level - 1.856) that seawater enters the Lakes system.
- The greatest flushing occurs during the onset of the wet season, but this creates a greater water quality challenges with regards to new contaminants and contaminated bottom sediment re-suspension.

5.1.9 Circulation

- As in 5.1.8 sea water exchange allows very little real circulation of Curralea Lake waters.
- Windy days provide greater re-oxygenation and temperature control of surface waters, but this does not appear to translate to uniform mixing of waters.
- Part of a study by Citiworks, in conjunction with JCU shows significant stratification of DO through the vertical profile within the lake.

5.2.1 Contaminants

- Part of a study by Citiworks, in conjunction with JCU has shed some light on the presence of contaminants in bottom sediments and highlighted the need for more intense investigations to gain a real understanding of the bottom line.
- This is necessary before any dredging works are undertaken which could create a greater environmental problem by stirring up stabilised/contained contaminants.

5.2.2 Flooding

- The Lakes development is located in an area, which was saltpan that was subject to tidal inundation.

- It is difficult to manage water quality when the system changes dramatically due to both seawater and stormwater flooding episodes.
- The water table can be much higher after even minor rain events.
- The Lakes, built for flood mitigation, have demonstrated their capacity to accommodate urban stormwater run off up to moderate rain events.

Note: Due to the limited space available for storage capacity and that the lakes are in the intertidal zone, the drainage efficiency during flood events is significantly compromised by high tides.

6.0 PLANNED MAINTENANCE: PROGRAMS AND PROCEDURES

6.1 Maintenance of Gross Pollutant Traps & Pollution Control Systems (PCS) *Strategy 3 Action 6*

- Citiworks is responsible for the installation and maintenance of PCS/GPT's.
- GPT's, including trash racks, sediment traps, gully traps, are inspected on a twice yearly basis for litter/debris accumulation and removal (refer Appendix 1).
- PCS's are monitored twice yearly and cleaned out as required.

6.1.2 Litter Curtains

- Several floating litter curtains have been installed at major litter entry points within the Lakes at key waste accumulation sites identified by the litter surveys.
- The curtains are designed to accumulate floating litter in one place facilitating easy clean up while enhancing aesthetic appearance of the water body (refer Appendix 1).
- EMS currently cleans these curtains out when necessary.

6.1.3 Sediment Removal *Strategy 4 Action 10*

- Sediments and soils from gardens, building sites and roads enter the Lake waters via the stormwater system after rain events.
- These sediments also carry with them contaminants, including oils from vehicles and machinery.
- Once in the water, they sink to the bottom where they accumulate further run-off contaminants.
- Removal of run-off sediments may assist in minimising the pollutants that have build-up, however, disturbing them may also re-mobilise contaminants.
- This needs further investigation to determine the best course of action.
- A Contingency Plan (Appendix 5) may be initiated when conditions deteriorate beyond certain KPI's/threshold triggers (DO < 4, pH > 9, T > 30oC etc. refer **table**).
- Cost benefit analysis for future works needs to be undertaken.

6.1.3.1 Identification of Built-up Sediments

- Citiworks has previously removed sediments via sludge pumps in accordance with procedures outlined in the *Lakes Remediation Program* (Angelika Hesse, EPS, TCC April 1998).
- Citiworks has conducted a bed level survey of sediment build-up in both lakes in order to assess the current situation and use the information as a baseline for future measurements.
- Citiworks will then decide whether further dredging needs to take place (refer Appendix 1).

6.2 MAINTENANCE OF PARKLANDS BY PARKS SERVICES

6.2.1 Mowing

- Parks Services staff is responsible for the regular mowing of most of the Parkland surrounding both Lakes.
- To prevent rubbish, grass clippings and mulch materials from entering the waters, a 5-m grass buffer from the waters edge should be trialed by **Parks Services after the next wet season**.
- This buffer will only be mowed when the grass is greater than 15cm (intervention level) at a height of not less than 10cm.
- Should a side throw mower be used the cut grass clippings are to be directed away from the water for the width of the buffer zone.

6.2.2 Land-based Litter/debris Removal

- Parks staff will also remove all land-based litter/debris and dispose of it to Vantassel Street Landfill.

6.2.3 Weed Infestation Treatment - Land based

- If weed infestation is identified around the lakes during Parks Services routine monitoring program, chemical or physical control methods may be employed during removal/destruction.
- Herbicide treatment is applied by certified staff and may include spot application, brush-cutting or chemical spray.
- Chemical sprays must not be deployed on windy days and the chemicals/herbicides selected must be instantly biodegradable on contact with soils or water.

6.3 MAINTENANCE OF LAKE WATERS

6.3.1 Litter and Debris Removal from Waters

- Citiwaste will be responsible for the clean up of rubbish, litter and animal carcasses, including dead fish, within the Lake basins. Garbage bins are emptied weekly.
- Litter accumulated in the litter/debris curtains will be collected regularly and be removed by EMS to Vantassel Street Landfill.

6.3.2 Fish Kill Events

- Under EPA ***Fish Kill and Reporting Investigation Manual*** (DEH) 1998 small fish kill events are the responsibility of Townsville City Council.
- This requires Townsville City Council to determine what caused the fish kill and clean-up after the event.
- Large fish kill events are to be reported to the Environmental Protection Act who are the lead agency for determining cause and directing process of clean-up.
- DPI is to be informed and will provide veterinary necropsy to help determine cause of fish kill.
- As per the *Emergency Response Manual Appendix 2 Response Procedure for Fish Kills* (**refer attached sheets**) there is a proforma to follow in dealing with notified fish kills.
- Regular monitoring of the Lakes is necessary to minimise poisoned fish from being inadvertently eaten by birds and leading to their deaths from botulism.
- In the event of fish and bird kills, Citiwaste will remove carcasses from the Lakes shore and litter curtains as soon as possible after notification is received and investigations by EMS/EPA as to the cause have been completed.
- Regular inspection by EMS and removal of carcasses by Citiwaste will occur until environmental conditions have improved.

Note: In the event of a fish/bird kill Council may assist in the removal of carcasses from private land. Please contact Council on phone: 4727 9310 for assistance or DPI on phone: 47 222 656

6.3.3 Remediation: Aeration and Circulation

6.3.3.1 Increase DO (Aeration)

- During low levels of DO (based on the monitoring program) Citiworks will undertake aeration of the lakes.
- The use of a pump capable of providing aeration for part of the lake and providing DO levels above 4ppm during the night is essential to provide fish relief.
- Large capacity pumps were used in January 2002 for two weeks after a major fish kill event.
- Pumps were again emplaced in October when conditions deteriorated, and from early November until late December 2002 during canal widening to avoid fish kills. This response to low DO and pre-emptive aeration has apparently been successful in avoiding fish kills.
- Citiworks hire the pump(s), supply diesel and provide site supervision.
- Council should consider the continued aeration of the Lakes with the minimum use of one pump per lake, as required, during low levels of DO in consultation with EMS based on assessment of environmental conditions in the Lake.
- Citiworks hired the pump for 8 hours per day at a cost of around $380/working day or $500/day for weekends ($5,800 per fortnight or $30,000/annum based on the use of 2 pumps).

6.3.3.2 Increase Circulation & Buffering (seawater)

- Keeping the Lakes as marine systems and improving the turnover of the Lakes with seawater input keeps the system healthier.
- When marine systems become fresh and nutrient rich they are prone to the development of toxic cyano bacteria/blue green algae.
- In order to improve the overall aquatic water quality of the lakes, increasing inputs of tidal seawater is important to increase the buffering capacity of the system.
- This has been achieved to some degree by keeping the tidal gates open for a longer period after high tides.

6.3.4 Minimising Bird Deaths and Botulism

- Regular monitoring of the Lakes is necessary to minimise poisoned fish from being inadvertently eaten by birds and leading to their deaths from botulism.
- In the event of fish and bird kills, Citiwaste will remove carcasses from the Lakes shore and litter curtains as soon as possible after notification is received and investigations by EMS/EPA as to the cause have been completed.
- Regular inspection by EMS and removal of carcasses by Citiwaste will occur until environmental conditions have improved.

7.0 MAINTENANCE OF INFRASTRUCTURE:

7.1 PRIVATE DOMESTIC LAND

Where the lakeshore is part of private properties, maintenance on these private sites is not Council's responsibility.

Residents will be urged to take responsibility for their own environment and be given advice via fliers (refer 8.0 Community Responsibilities) and stormwater **brochure.**

Residents can assist Council in its endeavours to maintain a healthy, litter free ecosystem by:

- using fertiliser sparingly to prevent nutrient pollution of the waterway
- utilising a mower with catcher to prevent grass clippings entering the waters
- not using blowers to blow leaves into gutters or stormwater drains
- landscape their properties in a manner which does not allow sediment or mulch materials to wash into Lakes waters (ie. use logs, sleepers, rocks as bunds to contain mulch)
- landscape their property in a manner which will not interfere with the path of stormwater flow by: redirecting run-off to neighbouring properties or
- obstructing or filling in of drainage easements
- regularly cleaning their yards of animal droppings and disposing properly with other rubbish
- removing debris/litter to the Vantassel Street Landfill
- re-grassing and adding gypsum to bare patches to prevent soil erosion
- placing all litter in bins for weekly kerbside removal service
- notifying Council immediately if they become aware of illegal green waste/garbage dumping (noting registration numbers and make/model of vehicles if possible)
- using only biodegradable herbicides and pesticides
- using chemicals sparingly
- discarding all grey waters (pet washes, laundry suds etc,) **to sewer** and **not stormwater drains**
- washing the family car in a licensed car wash or on lawns where grasses can act as filters for contaminants
- storing all household chemicals safely
- cleaning up any spills of household chemicals immediately with dry sorbents and disposing of appropriately.

7.2 ON PRIVATE COMMERCIAL LAND

- A significant amount of litter and debris removed during maintenance activities at the Lakes was found to originate from shopping centres, fast food outlets and other commercial activities conducted in the vicinity of the Lakes.

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- Over 80% of litter removed from the Lakes consist of plastic bags, shopping trolleys, fast food wrapping/containers and soft drink cans.
- **It is the responsibility of all commercial and industrial operators to comply with the Environmental Laws outlined in section 4.**
- The environmental best practice efforts of some establishments such as the Mercure Inn, which has an established regular clean-up service for its part of the lakeshore, must be highly commended.

Note: Council may recover litter or rubbish clean-up costs from the person(s) who discarded the prohibited substance(s) to the waterway, where it can be established. (i.e shopping trolley's, plastic materials etc.)

8.0 Improving the health of our waterways - Community Responsibilities

Everyone can assist maintaining the health of our Lakes system and adjacent waterways.

- **clean your yard of animal droppings and dispose through the waste collection service**
- **always use a mower with catcher to avoid clippings being washed into our drains**
- **always contain mulch by placing it within a bund of logs, sleepers or rocks and well away from the waters edge or drainage system**
- **re-grass bare patches to prevent soil erosion**
- **always place your litter in the bins**
- **don't put green-waste/rubbish/chemicals (oil/thinners/paint/pesticides etc.) into/in a position where they can enter drains/creeks. This is especially important prior to the wet season and potential flood events. All containers containing chemicals should be kept in sealed containers and placed on shelving within cupboards, sheds or under houses where they will not be able contaminate stormwater.**
- **It is also advisable to wash/clean all items that won't fit into a washing machine in the bath so that the grey-water can be drained to the sewer rather than outside and into stormwater drains.**

You can be prosecuted under the EP Act 1994 for failing to stop the contamination of stormwater drains (refer 4.0 Law Review).

APPENDIX 1 INTERDEPARTMENTAL RESPONSIBILITY AGREEMENT
APPENDIX 2 ENVIRONMENTAL RISK - REFER FOLLOWING SHEETS

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APPENDIX 3 CURRALEA LAKE REMEDIATION

AIMS & OBJECTIVES:

Remediation in this program is primarily focussed on improving water quality by increasing DO levels, decreasing nutrients (N & P) and algal cysts, and improving sea water flushing

Increase DO

1. The use of an aeration pump capable of aerating the lakes surface waters and keeping DO levels above 4 ppm during daylight periods.
2. Citiworks provide a pump, diesel and site supervision.
3. Citiworks should consider the continued aeration of the lake on a daily basis and to run the pump intermittently after rainfall events for a least 48 hours.

Decrease Nutrients and Algal Cysts by GAC filtration

1. The use of granular activated carbon (GAC) produced by Pica Activated Carbon Australia PL (e-mail: pcullum@picarbon.com.au), can remove many toxic elements from the lakes by filtration.
2. $1m^3$ of GAC (340 kg in 17x 20-kg paper bags) in permeable geotextile bags placed on the lakes grassed areas behind sand bunds can be used for crude water filtration of pumped water (as per Angelika Hesse *Lakes Remediation Plan*).
3. The maximum active life of the GAC is approximately 6 months under the conditions within Curralea Lake (*pers comm*. Peter Callum, Pica Aust PL).

Increase Salinity and Flushing

1. The only way to improve the quality of the lakes and maintain better salinity/flushing is to improve the input of seawater from the canal.
2. The tidal gates have been raised to allow higher tidal flows over the weir and through the culverts and into the lake.
3. A pump capable of pumping seawater from the canal to the lake.

Minimising Bird Deaths and Potential Outbreaks of Botulism

1. Regular monitoring of the lake is necessary to minimise poisoned fish from being eaten by birds and leading to their deaths.
2. When fish deaths occur Citiwaste will remove the carcases to the Vantassel Street Landfill.

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APPENDIX 4 ENVIRONMENTAL MONITORING PROGRAM

Environmental Monitoring Program Quality Assurance

The monitoring regime implemented aims to achieve quality assurance of the data and confidence that objectives are achieved via:

- the selection of representative sampling sites,
- adequate sampling frequencies,
- sampling with sufficient spatial and temporal replication to allow for statistically valid conclusions
- proper sampling methods, ie.: bottle types, storage and/or preservation procedures
- appropriately quality-controlled laboratory analysis.(APHA, 19th Ed., 1995 methods unless stated otherwise)
- use of "spike" additions and determination of "spike recovery" percentages to ascertain accuracy
- appropriate post-analysis evaluation of data quality
- non-parametric or parametric statistical analysis (as appropriate) of biological and analytical monitoring data

Program Objectives

The Monitoring Program is designed to effectively:

1. detect any changes in water quality and/or biodiversity which may give rise to environmental or public health concerns
2. alert to accumulative build-up of contaminants in Lakes Stage 1 and 2
3. enable timely notification to the public of significant risk and closure of the lakes
4. facilitate swift, efficient remediation responses
5. provide a long-term record of ecosystem health
6. gain a better understanding of the Lakes systems biological processes
7. the biological monitoring component is designed to effectively detect cumulative biological ecosystem impacts from urban and industrial run-off/discharges to the Lakes aquatic and/or terrestrial environment
8. the monitoring program is designed to provide early warning of potential problems to facilitate protection of biodiversity and maintenance of the essential ecological processes

The water quality and biological monitoring programs have been developed selecting indicators best suited to represent the key elements of the Lakes complex aquatic ecosystem.
All indicators are robust indicators of environmental change and closely linked yielding maximum ecosystem health or change information cost effectively.
All indicators chosen are consistent with and comparable to national and international indicators.

Environmental Indicator Selection

The environmental indicators selected are:

1. **Biodiversity,**
   - species richness
2. **Aquatic Habitat Quality**
   - water quality - physical-chemical (including temp, salinity, DO and pH)
   - sediment quality
   - algae blooms
3. **Sentinel Accumulation.**
   - heavy metal concentration in sediments and biological tissue

Indicator 1 - Biodiversity

Species richness is an indication of ecosystem health. Determination of the number of species and subspecies recruited to establish monitoring structures (22.) will provide an indicator of the genetic diversity at the Lakes monitoring site.
The percentage of change in species/populations abundance over time will provide valuable information on environmental change alerting to ecosystem deterioration or improvement in ecosystem health.

Indicator 2 - Aquatic Habitat Quality

1. Algal Blooms
The frequency of algal blooms is usually considered to be related to land-based sources of nutrients. (Environment Australia, 1998) Algal blooms at Paradise Lake, in particular blooms of the toxic blue green algae Anabaena have increased in frequency and duration during the past few years.
Determination of the frequency and duration of algal blooms will provide a measure of aquatic habitat health.
Ongoing monitoring of bloom increases or reductions will also identify the efficiency/success of active management initiatives at the Lakes.

2. Water Quality
The key physio-chemical parameters (Table 2) selected will all contribute to the determination of the Lakes suitability for recreational activities and environmental health at any point in time. Refer *NH&MRC Guidelines for Use Sec 20.2*

Water quality monitoring will also allow for the identification of major pollutant in-put sites, indicate when fish kills can be expected and if these are related to man-made pollution incidents or as a result of natural causes (ie. sharp changes in temperatures etc).

Indicator 3 - Sentinel Accumulation
The heavy metals Cadmium, Copper, Lead and Zinc are, in elevated levels, are often associated with urban and industrial run-off.

Bioaccumulation of these metals in biological tissues of aquatic organisms (ie. mollusca, oysters) allows for accurate measurement of the biologically available fraction of these contaminants at a particular site. (ie. the amount absorbed and accumulated by aquatic fauna)
This indicator will allow the documentation of levels of, and changes in, heavy metal concentrations in biological sentinel accumulators.
As the Lakes are used regularly by the public for recreational fishing, it is important to ensure that concentrations of heavy metals can not accumulate in fish beyond levels regarded as safe for consumption.

APPENDIX 5 WATER AND SEDIMENT QUALITY MONITORING

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The water quality indicators (WQI) selected are:

1. Algal Blooms,
2. Sediment Quality (contamination)
3. Physio-chemical key indicators as per Table 2

TABLE 2 - Water and Sediment Quality Indicators & Program

Water Quality Indicator	Frequency	Replication
DO	Weekly	
Ph	Weekly	yes
Turbidity (NTU)	Weekly	yes
Algal Biomass	Weekly	yes
Conductivity (ug/l)	Weekly	yes
Chlorophyll - a (ug/l)	Weekly	yes
Phaeophytin (ug/l)	Weekly	yes
Total Pigment (ug/l)	Weekly	yes
Total Bacterial Plate Count (organisms/1ml)	Weekly	yes
E.coli (organisms/100ml)	Weekly	yes
Streptococcus (organism/100ml)	Weekly	yes
Faecal Coliform (organisms/100ml)	Weekly	yes
Total Coliform (organisms/100ml)	Weekly	yes
Phosphate	3 monthly	yes
Nitrogen (Nitrate & Nitrite)	3 monthly	yes
Ammonia	3 monthly	yes
Copper	3 monthly	yes
Lead	3 monthly	yes
Zinc	3 monthly	yes
Cadmium	3 monthly	yes
Sediment Quality Indicator	Frequency	Replication
sediment digestion		
Copper	3 monthly	yes
Lead	3 monthly	yes
Zinc	3 monthly	yes
Cadmium	3 monthly	yes

Bacteriological analyses such as total plate count and total coliforms will not provide much either.
The guidelines for environmental water are based on faecal coliforms and sometimes-faecal streptococcus.
TPC count is expected to be very high and total coliforms can exist in warm environmental water and may not be an indicator of contamination.
Faecal coliforms and E coli are useful. Streptococcus generally lasts longer in environmental water than coliforms so are used as an indicator if there is expected to be a quick die off of coliforms.
This does not seem to be the case in the lakes.
Peter Mockeridge, Douglas Laboratory Chemist, Citiwater, TCC.

1 Water Quality Monitoring Procedure

Citiwater's Douglas Laboratory as per Table 2 conducts regular water quality monitoring.

All anion and cation analyses except pH are performed on the sample after filtration through a 0.45um filter

Analytical methods are as per APHA, 19th Ed., 1995 or USEPA

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2 Incident Monitoring

In the event of fish kill or pollution events (ie. algal blooms, oil spills etc.) monitoring will be conducted daily until 4 consecutive water samples show that water quality has improved to levels set by the ANZECC guidelines for secondary contact. Providing that water quality was meeting those standards prior to the fish kill/pollution event.

3 Sample Collection

All samples are collected and treated as per the Department of Environment's ***"Water Quality Sampling Manual"***, Second Edition February 1995 by trained staff from Council's laboratory or a qualified Chemist.

4 Replicate Sampling

Replicate sampling and analysis of select key indicators will facilitate statistically valid analysis of data and sound interpretation and conclusions.

Sediment samples are collected at three monthly intervals from Curralea Lake and 2 sampling sites. (Map 1)
Continuous water quality monitoring via a permanently installed data logging device has now been agreed to be installed (Lakes meeting between Council and EPA 15/2/2002).
Sediment analysis for total heavy metals and alga
The sediment samples are dried at 105 ^{0}C, ground in a pestle and mortar and sieved through a 70u sieve.

Two 0.12 g portions of each sample are weighed into a Teflon bomb.
1.5ml of concentrated HCl and 0.5 ml of concentrated HNO_3 is added and the solution shaken until homogeneous.
The homogeneous sediment/acid mixture is digested by heating for 10 minutes in a microwave oven at medium setting.
The solution is then filtered through Whatman No 1 filter paper using Milli-Q (or deionised) water and made up to 10ml with this water in a volumetric flask.
The solution is then analysed by flame AAS or PDV to determine the total concentration of Cooper, Cadmium, Lead and Zinc.

APPENDIX 7 EPP(W) 1997 s.31 and s.32

Section 31. Prohibition on deposit/release of certain things—*rubbish; scrap metal, motor vehicle parts, bodies or tyres; building waste; sawdust; solid/liquid waste from on-site domestic waste water treatment system; cement/concrete; a degreasing agent, paint, varnish/paint thinner; any manufactured product/by-products/waste from a manufacturing process, that has a pH <6/>9; an insecti/herbi/fungi/biocide; oil. A person must not deposit/release a thing (A/A) into a roadside gutter, stormwater drain or a water: or in a place where it could reasonably be expected to move or be washed into a roadside gutter, stormwater drain or a water. A person does not commit an offence if deposit/release was authorised under an environmental authority, Environmental Management Program, EP Order or emergency direction. If a person is charged with an offence …, it is a defence … for the person to prove—that the deposit/release happened while carrying out a lawful activity; and the person complied with the GED by way of a COP/another way. Maximum penalty—for a thing is 20 PU's or 40 PU's if a contaminant.*

Section 32. Prohibition on build-up of sediment*—A person must not—release stormwater runoff into a roadside gutter, stormwater drain or a water that results in the build-up of sand, silt or mud in the gutter, drain or water; or deposits sand, silt or mud—in a roadside gutter, stormwater drain or a water; or in a place where it could reasonably be expected to move or be washed into a roadside gutter; stormwater drain or water and result in a build up of sand, silt or mud in the gutter; drain or water. Maximum penalty—20 PU's. A person does not commit offence … A/A.*

(1 PU/Penalty Unit = $75 i.e. 20 PU's=$1500).

Section 42. ***LG*** *must* develop *& implement a "****Urban Stormwater Quality Management Plan"*** *that improves SWQ consistent with WQ objectives for affected waters. "Townsville City Council" must consider including measures to minimise contamination by SW, maximum infiltration, reduce SW velocity & remove SW contaminants by flow rate mitigation, erosion control & infiltration areas, grassed/vegetated drain lines, vegetated buffers & conserving/restoring riperian vegetation, artificial wetlands, GPT's, retention basins & trash racks, & planning & design for SW systems, wrt local community needs, including minimising ecological impacts, acceptable health risks, aesthetics, protection from flooding, public safety & social concerns, making use of SW for recycling & conservation, making use of drain corridors for improved recreational values & open space/landscape areas, & investigation of opportunities to build contamination control measures & re-establishing riparian vegetation & aesthetic environments in degraded drains, & integrated planning (ICM & LUP), & implementing viable alternatives to releasing SW through outlets across beaches/poor circulating waters.*