storm water quality improvement devices in townsville

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report authorisation

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Improvement Devices
In Townsville

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contents

04

introduction

Stormwater quality treatment devices aim to reduce the adverse impacts of pollution on the aquatic environment by achieving improvements in water quality. In part this can be achieved by the use of different treatment measures that reduce the level, and the concentration of pollution.

The use of Gross Pollutant Traps (GPT) and wetland systems (natural and constructed) is now recognised as a necessary component in the design and construction of new housing developments, inner city buildings, shopping centres and other residential and commercial developments. These measures are best used as part of an overall treatment-train solution to ensure stormwater run-off meets specific water quality objectives identified as part of a Water Sensitive Urban Design planning process.

The term Stormwater Quality Improvement Devices (SQIDs) is usually applied to conventional 'hard' engineering devices such as GPTs. SQIDs usually treat the larger sized particles and have little impact on soluble pollutants and suspended sediments. 'Soft' engineering measures, such as constructed wetlands, are now acknowledged as the most appropriate measures to reduce the finer water quality pollutants.

This report describes the types of proprietary SQIDs and 'natural' SQIDs used in the Townsville urban context to filter and remove pollutants from stormwater run-off and improve the water quality of the receiving waters.

Soft engineered SQIDs generally incorporate 'natural' components in their design and are the main focus of Water Sensitive Urban Design (WSUD). WSUD is a framework for, or way of thinking about, the planning and design of urban environments that takes into account the many demands and opportunities for water quality improvement and environmental protection (ARQ, 2006). The four main objectives of WSUD include:

- Reducing potable water demand;
- Minimising wastewater generation and reusing treated wastewater;
- Treating urban stormwater to meet water quality objectives; and
- Preserving the natural hydrology of catchments.

Hard engineered systems are often incorporated in the treatment train at the end-of-line but are also incorporated in-line and at the pollutant point source. Within Townsville, there are three main companies that provide SQIDs/GPTs for installation within the stormwater system. These companies are Ecosol, Humes and CDS Technologies.

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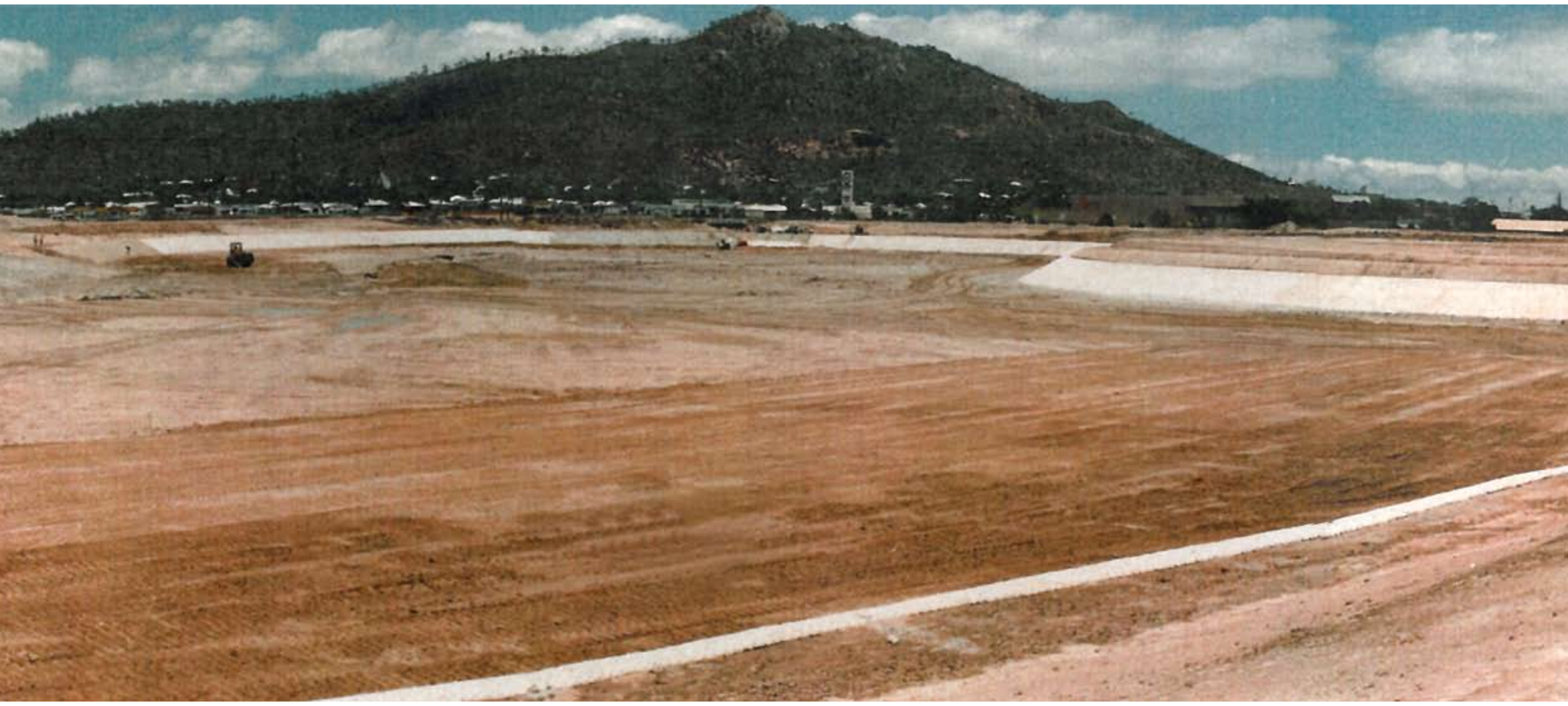
1. sediment basins and wetlands: soft engineering systems

Natural and constructed wetland systems have become an integral part of the stormwater filtration process. These measures are used concurrently as part of an overall treatment-train solution that help ensure treated stormwater flows meet Water Sensitive Urban Design (WSUD) standards and achieve specific water quality objectives.

There are a number of Basins and wetlands (both natural and constructed) in the Townsville region:

- Lakes I and Lakes II, West End
- Fairfield Waters Wetland / Retention Systems
- Bohle River Wetlands / Town Common Wetlands
- Reid Park
- Louisa Creek Project
- Riverside Gardens Sediment Basins
- Mundy Creek
- Ross Creek
- Ross River
- Dalrymple Road and Woolcock Street Swales
- Macarthur Parkway

1.1 lakes I and
west e



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ADJACENT PAGE, TOP: The final lake profile, 300,000 cubic metres of earthworks were completed in four months (TCC, 1989) BOTTOM LEFT: Location of Lakes I and II. BOTTOM RIGHT: The base flow rock treatment system provides both low-flow continuous water treatment and recirculatory tertiary treatment (i.e. from lake via filters to artificial wetland and back to lake). THIS PAGE: Landscape drawing showing location and connection of the lakes to each other and the Woolcock canal.

Located either side of Woolcock Street in West End, Townsville, the two artificially-created lakes were designed primarily as detention basins for flood management, but which now also incorporate constructed, storm-water treatment train/wetlands to remove pollutants from the storm-water which flows in from the surrounding residential and light industrial areas. [Refer to Map 1 & Appendix 5].

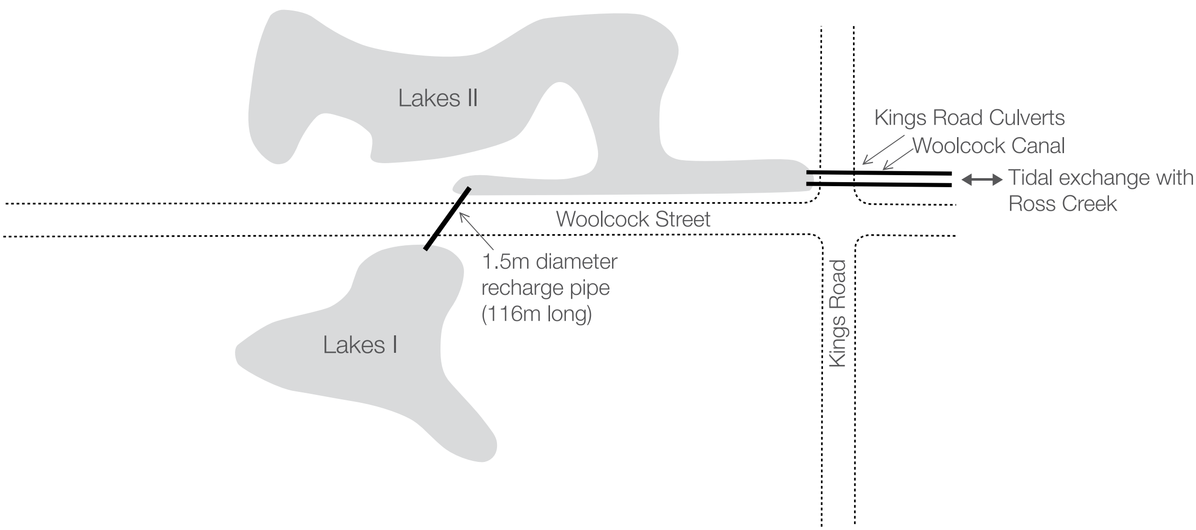
The areas where the Lakes are now situated were initially large salt flats that functioned as flood-water detention basins and formed part of the Woolcock St Storm Water Flood Mitigation program. However it became apparent over time that the salt flats would constantly overflow during the wet season and cause local flooding and damage to the surrounding areas.

The Townsville City Council investigated the issues, utilising both council staff and independent consultants, and identified the construction of brackish water ornamental lakes in these basins as being the best way to minimise flooding in the area.

Each lake would be 2m deep and interconnected via culverts under Woolcock Street. Water would be maintained in the lake during the dry season by a recharge system fed by Ross Creek via the open concrete canal running the length of Woolcock Street. With appropriate controls on the Woolcock canal, the lakes could be maintained at RL 0.4m just above mean sea level, and the surrounding land to the lakes would be shaped to enable it to store the predicted '50 year' flow volume above this normal operating level.

The lakes are underlined at the base, with a concrete or rock revetment wall for stability on the sides, and no permanent construction would be allowed in the area unless it was constructed above the estimated 50 year flood level (Townsville City Council, 1989).

Curralea Lake (Lakes 1) was originally constructed in the late 1980's for stormwater flood management purposes but has since become the gross pollutant trap for the catchment. The treatment train installed at the head of the lake consists of a sediment basin downstream of the multiple-barrel stormwater outlet, an artificial wetland for low-flow treatment, and lakes water circulation and treatment with a rock- lined entry point into the lake providing a secondary treatment of drain seepage flows. However, it



also has significant fish habitat values which are inconsistent with its GPT characteristics (SOE-Townsville website, 2008).

The second lake, Keyatta Lake [Lakes 2], a 25 hectare Lake Wetland/Detention basin, was constructed in the early 90's with little or no consideration to environmental function. All of the hypersaline salt marsh soil that was dug out of the site was stored on the surrounding foreshore area, and as a result, for over 10 years little natural regeneration had occurred of the terrestrial, estuarine or freshwater flora.

In conjunction with this, the stormwater flowing into the lakes from the surrounding residential and light industrial areas was untreated, and adding to water quality problems within the lakes themselves. Consequently the Lakes Savanna Wetland Project was undertaken to mitigate some of these issues.

The project was initially funded by the Federal Government's Urban Stormwater Initiative [USI], and is a constructed wetland system that consists of a linear storm-water treatment train system incorporating a litter trap, rock-lined channel, gross pollutant trap with tri-lock and a freshwater wetland and another rock lined channel. The edges of this system were extensively planted with native sedges and grasses, which apart from enhancing the visual aspect of the area, also act as gross pollutant traps while helping to remove nutrients from the water at the same time.

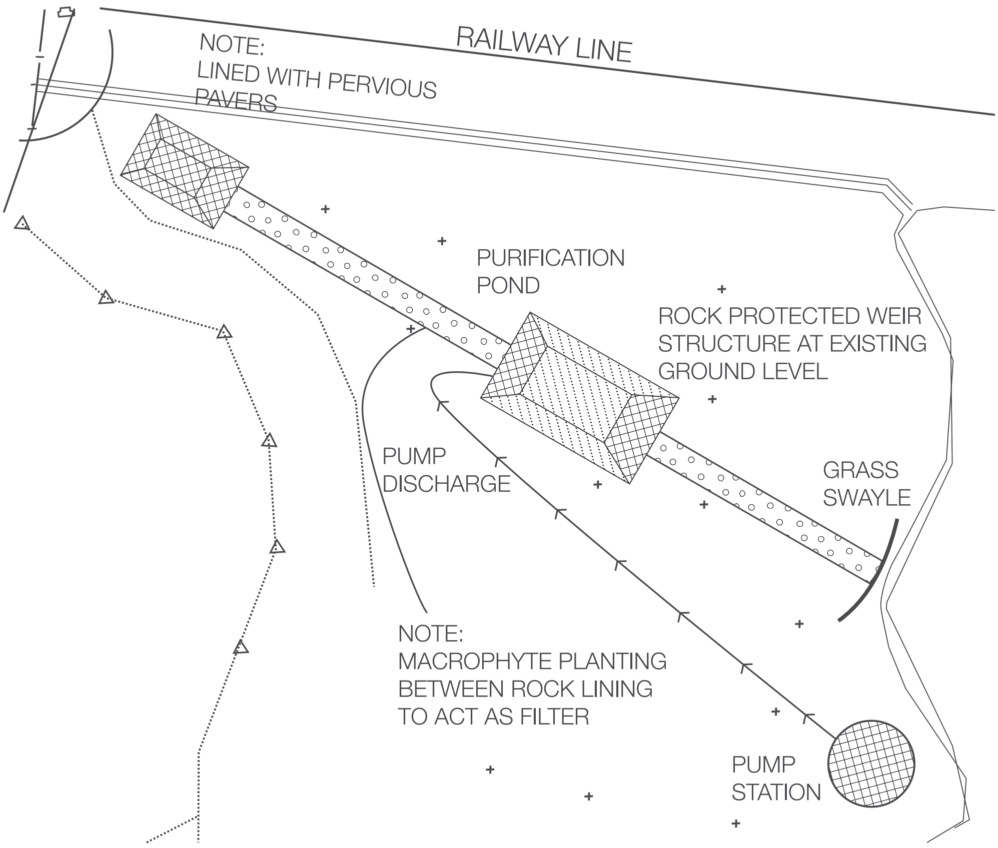
Despite these measures being implemented, there have been a number of undesirable events that have occurred within the Lakes systems in past years. During rainfall events, high levels of nutrient and phosphorus often enter the lakes, which in turn can cause algae blooms. This occasionally leads to dissolved oxygen levels being significantly affected, with associated changes in the chemical dynamics of the system, resulting in large fish kills in the lakes.

Under these conditions, the quality of the whole system suffers and as such, both short and long term remediation and monitoring is required (SOE-Townsville website, 2008).

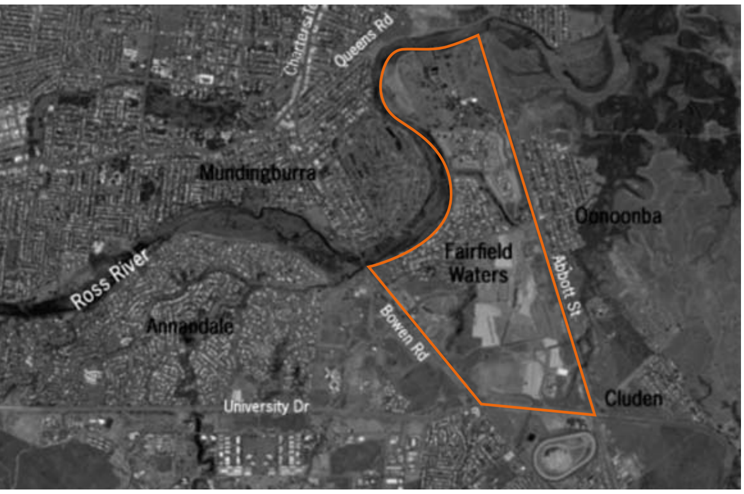
Council has since devised remediation works to reduce the risk of fish kills. This includes the installation of windmill pumps to allow free flowing of water and reducing 'dead zones' within the lakes, and the installation of water pumps capable of providing aeration to large parts of the lakes.

Stormwater and Transport Department of Townsville City Council, continue to monitor the water quality of the Lakes, of which these can be seen in Appendix 6 (The Lakes Catchment Water Quality Testing).

ADJACENT PAGE: The constructed wetland component of the treatment train at the Lakes II (Keyatta Park) site. THIS PAGE: TOP AND ABOVE: The treatment train at Lakes II. BELOW: Rock-lined water treatment system from artificial wetland to Lakes 1.



1.2 fairfield waters wetland/retention systems



Fairfield Waters Estate is located within the current suburb of Idalia, Townsville. The estate will incorporate three (3) wetland areas to act as recreational zones and stormwater quality improvement devices.

The wetlands are almost completed surrounded by residential areas with a small commercial section located on the southern section of Fairfield waters.

The first constructed wetland had incorporated the natural lagoon which was on site. These constructed wetlands acts as a protective buffer for the natural lagoon and Ross River by slowing stormwater discharge, catching silt and polishing tail waters. The biomass productivity of the constructed wetland varies in response to climatic conditions and nutrient loading.

The constructed wetland is in essence a large silt trap for the surrounding catchment, principally residential, before the water passes into the Pony Club lagoon or Ross River. As such the principle management objective for the site is to maintain the functionality of the silt trap to maintain the water quality of the downstream lagoon.

The secondary objective of the constructed wetland is to provide habitat for native wildlife and retain natural features where practical to support functional wetland and riparian environments.

Enabling the concept of Water Sensitive Urban Design (WSUD), further filtration systems have been utilised with a series of end-of-line Gross Pollutant Traps installed at the stormwater outflows points around the lakes. Incorporating hard engineering and soft engineering measures within a single treatment train, these GPTs along with the lakes system act to maximise the capture of gross pollutants before entering the Ross River.

PREVIOUS PAGE: Location of Fairfield Waters. TOP: Gross Pollutant Trap (Ecosol) located near the banks of the constructed wetland. This acts to further filter gross pollutants from entering the lakes, and ultimately the Ross River. ABOVE LEFT: The natural wetland within Fairfield Waters; this wetland has been incorporated into the overall design plan for Stormwater quality management. Located on the northern section of the Fairfield Waters Estate. ABOVE: Constructed wetlands. These wetlands act as both stormwater quality improvement devices and a recreational area for residents.

TOP, ABOVE AND LEFT: A new wetlands currently under construction: this is located on the southern part of the Fairfield Waters Estate near Fairfield Central Shopping Centre.

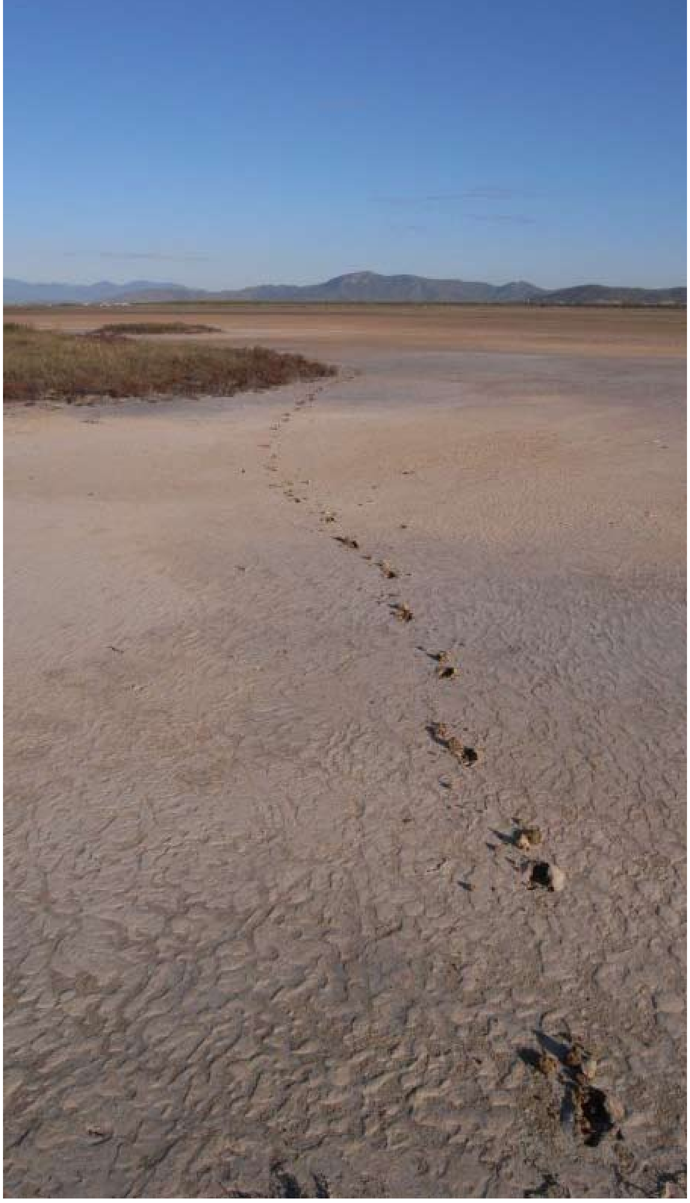
1.3 bohle wetlands/ town common conservation park

About 4400ha, 5km north-west of Townsville, The Townsville Town Common area consists of a flat expanse of coastal wetland from which the residual Many Peaks range rises in the north. Much of the area is an Environmental Park, but the area also includes the Commonwealth land adjacent to the Townsville RAAF base. The Bohle River marks part of the western boundary of the area and the Townsville Town Common was once an integral part of this formerly extensive Bohle River basin. The Common now stands isolated in an urban environment.

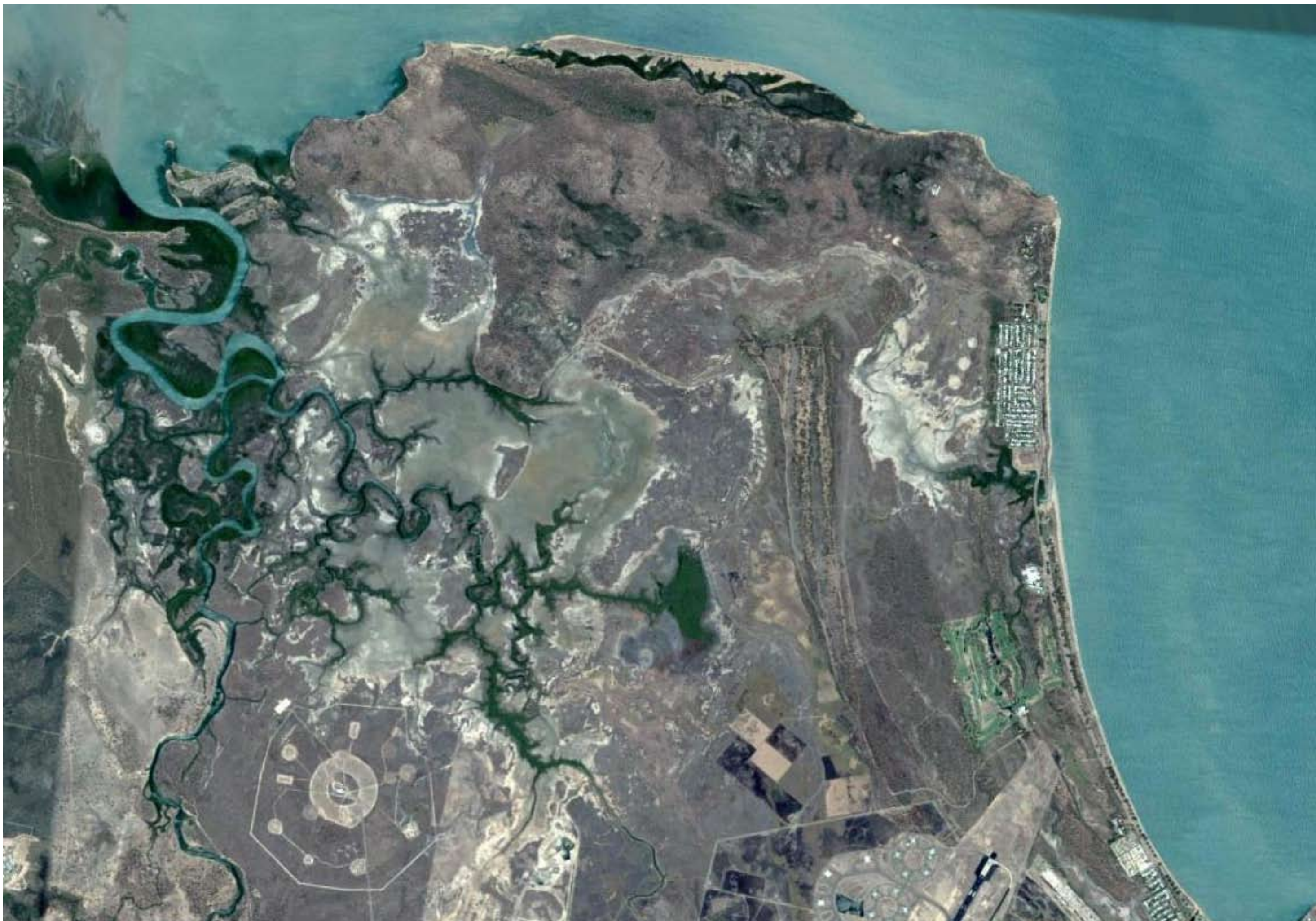
Deposition of sediment from the Bohle has been a major influence on shaping the landscape of the area, as has the fluctuating periods of marine erosion and aggradations during sea level changes. The flat wetland expanse consists of a series of progressively less saline communities from mudflats to saltpan, brackish swamp, freshwater swamp and finally grassland and woodland areas. The soils of the coastal plain are of three major types: calcareous sands comprising low beach ridges; deep siliceous sands; and solodised solonetz soils and saltpans of strongly gleyed clays. The most frequently occurring soils on the peaks are shallow gravelly litho sols with deeper red and yellow podzolics on lower slopes. Mangrove forests occur behind the beach ridges of Shelley Beach and along the Bohle River.

Despite being somewhat degraded, the wetland communities still function in a relatively natural manner and sustain large and diverse populations of waterfowl during winter months and provide refuge during years of drought. The area is predominantly grassland sand couch (*Sporobolus virginicus*) and is relatively undisturbed. Four vegetation communities are found in the area. The upper tidal reaches of the creeks of this area support a mangrove community of Rhizophora along the creek and a Ceriops zone inland. Zonation of mangroves is often interrupted by bare salt pans. Salt-marsh communities often surround the salt pans. Located higher than the salt-marsh community, and nearer the coast, is a salt-meadow community that occurs in a narrow strip.

The fourth community is located within the deep water lagoons of the wetland (Anon. 1984). As annual rainfall within the Townsville region varies greatly, the extent to which the wetlands fill varies considerably. The result is that the distribution of wetland vegetation varies greatly from year to year. As a general rule, the sedges grow in the poorer environments where nutrients are more limited and the grasses prefer the richer environments. The introduced para grass (Urochloa mutica) is now the dominant species over most of the wetlands in the vicinity of the airport. However, in places where water is semi-permanent, Typha sp. is dominant. Conservation Volunteers Australia continues to test water quality testing on site. The results can be found in Appendix 8 (Town Common Water Quality Tests)



BOTTOM: Aerial view of the Townsville Town Common. BELOW AND LEFT: Photos of the Townsville Town Common.



TOP: Location of Reid Park GPT located within square. ADJACENT PAGE, TOP ROW: The Reid Park GPT in 2006. SECOND ROW: Comparison photos show the site in July 2008. Note how the mangroves are beginning to colonise the site. THIRD ROW: Stormwater moves from the GPT to the artificial wetland through these pipes. FOURTH ROW: View of the rock constructed (gabion baskets) tidally flushed artificial wetland. This system was excavated back into landfill which, although expensive, is the only practical way of improving options for recreating water treatment complexity prior to drainage discharge to Ross Creek.

1.4 reid park

Townsville has grown in area a great deal since its inception. Consequently, what used to be the outskirts of town has become more and more part of the inner city. Land uses of the past, such as landfills, can therefore be found in the middle of built up areas such as landfill sites under Reid Park (SOE-Townsville website). The Reid Park GPT is located behind the Townsville Civic Centre with GPS Co-ordinates S 19O 16.156, E 146O 48.277.

Built into a former inner city landfill site, this tri-lock lined gross pollutant trap feeds water into a constructed tidal saltwater wetland for sediment removal. Both the GPT and the wetland are tidally flushed..

The gross pollutant trap was dug out of an old land fill site and provides both gross pollutant and primary sedimentation. The GPT is very low in the landscape and is tidally flushed. Stormwater moves from the GPT to the artificial wetland through these pipes. Similarly, during high tide, these pipes conduct water to tidally flush the GPT.

This trial artificial wetland abuts the mangroves on Ross Creek immediately downstream of the GPT and sediment basin. Due to site constraints (landfill, tidal flooding and lack of space) this wetland compresses treatment functions and incorporates combined rock filtering and saline wetland characteristics (note: mangrove plants and grasses have since been planted and this will be supplemented by natural mangrove colonisation. In the future, these mangroves are expected to be extracted under permit thereby removing pollutants.

FIFTH ROW FROM TOP: Photos taken near the completion of the project in 2006. BOTTOM: Tri-lock makes a tough surface on the batter of the GPT. The tri-lock is sealed to prevent groundwater intrusion from landfill and saltwater intrusion into the landfill.

1.5 louisa creek project

Louisa Creek traverses western Townsville and is a significant creek for the city with regards to drainage of stormwater runoff. Louisa Creek is an urban waterway that receives substantial volumes of urban runoff from residential, commercial and industrial areas. The creek supports locally rare vegetation, good stands of lowland riparian vegetation and woodland, a diverse range of indigenous aquatic fauna and flora, including many species of waterfowl and is a recognised fish habitat area. It is the principle biological linkage across the urban and industrial landscape between the coastal Town Common wetlands and the Mount Louisa/ Hervey's Range Uplands. It is also the main tributary to the Town Common's nationally significant wetlands on both State and Commonwealth (Defence) land (EPA, 2003)

Site Description	**Uses and Issues**
Wildlife habitate corridor: Riparian Corridor - minor drainage line	Urban open space
Heritage Listing & Zoning: Currently unassigned	Site of Townsville City Council supported community riparian rehabilitation projects.
Natural Habitat Quality: Transformed and/or Degraded Habitat	Exotic vegetation invasion
Conservation Value: Low - Medium fish and waterfowl habitat and associated flora and fauna	Urban and industrial development in catchment
Diverse indigenous aquatic fauna	Site is contiguous with Blakey's Crossing and the Town Common
Locally rare vegetation e.g. Dog's Balls *(Grewia sp.)*	Upper catchment for conservation park
Good stands of lowland lowland riparian vegetation and woodland including stands of blue gum *(Eucalyptus tereticornis)*	

Source: http://www.soe-townsville.org/external_inlandwaters/Louisa_Creek.html

There are two main components to the Louisa Creek infrastructure. These are referred to as the Camuglia St. and Greg Jabs Court sections.

Water Quality Testing is arranged and tested by Conservation Volunteers Australia. Their results can be seen in Appendix 7 (Louisa Creek Water Quality Testing).

1.5.1 Camuglia Street Pollution Control System

The Camuglia Street Pollution Control System is designed to treat the runoff from 145 hectares of predominantly light industrial land within the greater Louisa Creek catchment. The system incorporates two combined primary sediment and gross pollutant basins, a secondary treatment basin and pond, and a system of wetlands. The system is designed so that during low flows, water moves slowly through these gross pollutant basins and wetlands, depositing sediment and debris. In high flows, stormwater flows through the gross pollutant basins but then straight over the top of the wetland systems (EPA, 2003).
Prior to the construction of the sediment pools and GPTs, Sinclair Knight Merz Consultants were contacted to supply the Camuglia St concept plan. They had developed a number of engineering parameters for the habitat pool. These included:

- Residual dry season surface water levels in Louisa Creek, near Camuglia Street, are approximately RL 2.2m

- Deep pools are to be constructed to contain 2.5m of water in the dry season

- Pools are required to have water mixing to prevent stratification and build up of algae.

- Flooding is not to be exacerbated by constricting high level flows i.e. relatively broad cross section without obstructions in the path of high flows.

- A property boundary is located approximately 15m from the North Eastern bank of Louisa Creek limiting work in that direction.

- Existing 450mm diameter RPC stormwater pipe enters Louisa Creek from the North Eastern bank is to remain in place.

- Retaining walls to 1m high or rock protection could be used to achieve steep banks but not have been considered part of the design.

- Restrict the area of shallow slope zones to suppress weed problems, but maximise stability and natural features of the pool i.e. earth and vegetation, rather than rock and concrete stabilisation. This has cost and environmental outcome implications and benefits to Council.

The schematics for the pool design are as follows:

- Pool banks will be battered back at 2h:1v to maintain slope stability. The soil at the pool location has been classified as sand and sandy clay and not suitable for long term stable steep embankments.

- Pools are to be excavated to a floor of RL-0.3m.

- The sides of the pond batter down at 2:1 from RL 3.5m to -0.3m the width varies from 3m to 8m (refer to Appendix 9, Camuglia St Cross Section Details)

- High flows from Camuglia St stormwater discharge may cause erosion on the North-eastern bank of the pool. Monitoring will be required to determine if additional erosion protection is needed.

- A 1.5 m riffle area is to be provided upstream of the habitat pool and will span the low flow region of the creek.

- Rocks provided for the riffle zone will be graded between 200mm and 400mm diameter to

- prevent transportation downstream. Allow small spaces between rocks for fish movement (refer to Appendix 9, Camuglia St Riffle Area).

- Small mounds are to be constructed along the bank to allow for large shade trees to be planted.

- Excavated spoil from Louisa Creek can be used to form mounds where possible of stockpiled for use as part of the primary stormwater treatment works.

- Future sediment removal from the bed of the pool may be required from time to time to maintain depth of 2.5m.

- Vehicle access to the South-western bank of the pool is via Camuglia St. A 3m wide corridor is to be maintained from Camuglia St to the pool.

- Continually monitor pool shape on North-eastern bank opposite stormwater drain outlets for evidence of significant erosions due to stormwater release. Banks may require natural stabilisation at a later date.

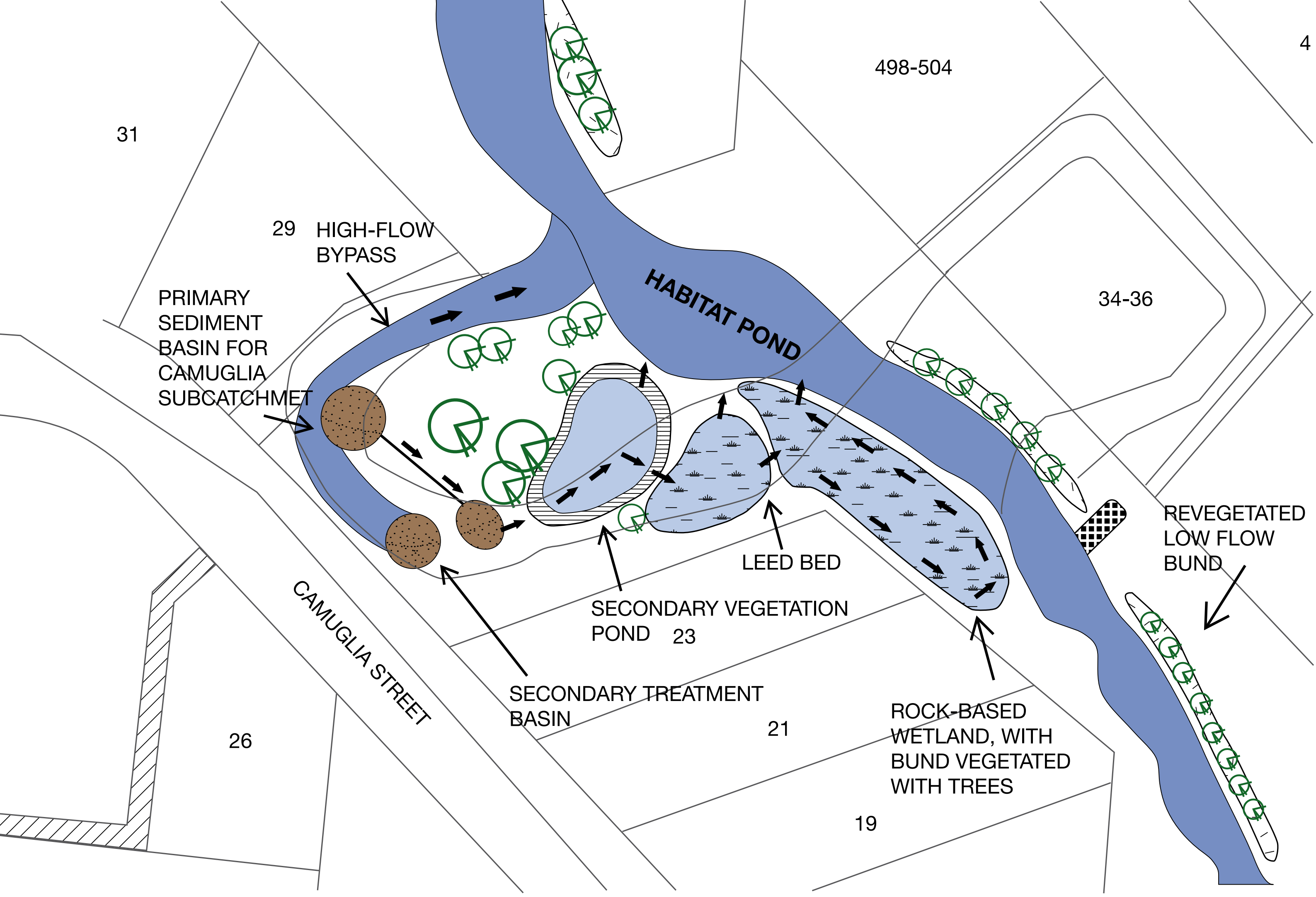
- Pool embankments to be lined with topsoil after being cut and covered with jute matting to provide temporary soil stabilisation for planting of juvenile vegetation.

- The footprint areas of likely standing water in the pool estimated as follows:

  >2.0m depth = 200m2
  1.0 – 2.0m depth = 600m2
  0.3 – 1.0m depth = 200m2
  <0.3m depth = 100m2

- Total volume of spoil to be excavated is approximately 1100m3

- The channel between the primary stormwater treatment pond and Louisa Creek requires fill and stabilisation works



where significant erosion has occurred. Design bed level of the channel after construction of the primary treatment pond is approximately RL 2.8m and top of bank of RL 4.0m. (Sinclair Knight Merz, 2000)

Two lots in the light industrial zone have been used in developing this innovative stormwater management system. The system incorporates a primary treatment basin, tertiary treatment pond, and wetland.

The system is so designed that during low flows, water moves slowly through the GPT and wetlands, depositing sediment and debris.

In high flows, stormwater flows through the GPT but then straight over the top of the wetland systems. An interesting feature of this system is that the entry point of the stormwater into the GPTs is only 300 mm above mean sea level. The challenge of maintaining flows has been overcome by innovative engineering and local knowledge (SOE website).

TOP: Landscape Drawing of the Camuglia Street Wetland (Original illustration from www.soe-townsville.org) ADJACENT PAGE, FROM TOP: One of the two Primary Sediment and Gross Pollutant basins. (Source: www.soe-townsville.org); secondary sedimentation tank which discharges to the detention basin; retention of existing trees (very large and old riparian melaleucas) was applied as a contraint to the Pollution Control Systems to demonstrate that significant ecological features can be retained and assist with the aesthetic and environmental values of engineered water quality management solutions. (Source: www.soe-townsville.org)

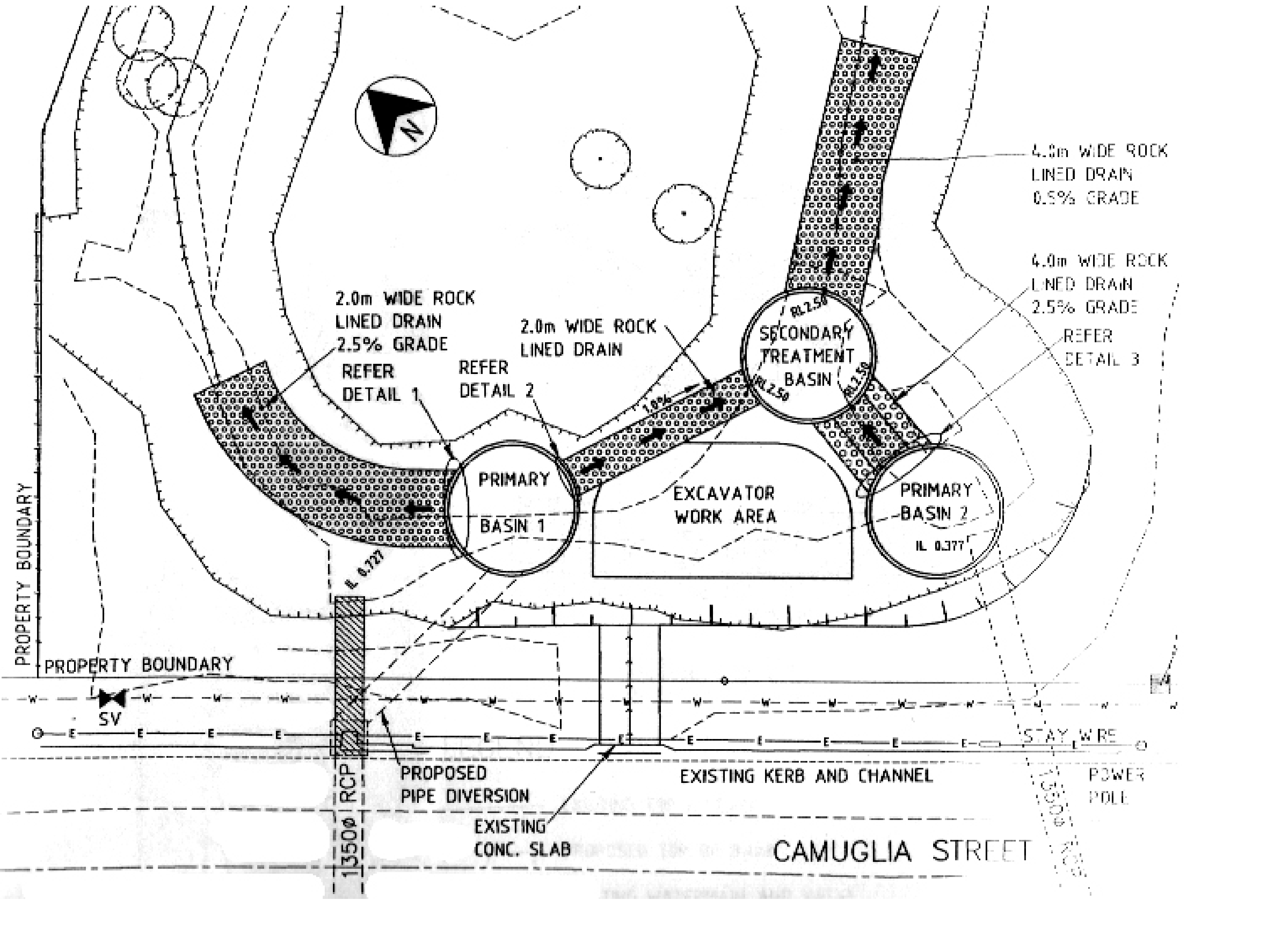
1.5.2 Greg Jabs Court Section

This former Council trapezoidal drain had become choked with water weeds (typha and para grass). This drain services a light industrial area and became an ineffective hydraulic corridor.

A recent management project saw the grasses removed from the drain, riparian vegetation planted along the banks, and a stormwater management system constructed.

This system consists of a gross pollutant trap, two rock ripples, and three constructed ponds.

CLOCKWISE FROM TOP LEFT: Greg Jabs Court Section, June 2008; the bank wall that divides the treated stormwater from Louisa Creek; stormwater is treated within the swale; treated water then filters throough to the discharge point; Gross Pollutant Trap; treated stormwater enters into the pond for further sediment treatment before entering the Louisa Creek.


4.0m WIDE ROCK
LINED DRAIN
0.5% GRADE
4.0m WIDE ROCK
LINED DRAIN
2.5% GRADE
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DETAIL 3
2.0m WIDE ROCK
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DETAIL 2
2.0m WIDE ROCK
LINED DRAIN
SECONDARY
TREATMENT
BASIN
RL 2.50
PRIMARY
BASIN 1
EXCAVATOR
WORK AREA
PRIMARY
BASIN 2
IL 0.377
IL 0.727
PROPERTY BOUNDARY
PROPERTY BOUNDARY
SV
STAY WIRE
POWER
POLE
PROPOSED
PIPE DIVERSION
EXISTING KERB AND CHANNEL
EXISTING
CONC. SLAB
1350ø RCP
CAMUGLIA STREET

1.6 riverside gardens sediment basins

Riverside Gardens Estate, within the suburb of Douglas, was unique in terms of the way its stormwater system was designed at the time. Instead of the using the traditional method of running all stormwater through pipes and then out to the rivers or ocean, Riverside Garden's stormwater runs directly into its local ephemeral creeks, with the deeper holes acting as sediment basins for trapping gross pollutants.

Significant amounts of the natural riparian vegetation remain intact along these creek systems, and subsequently also still provide the environmental and ecological functions associated with them.

Because of the nature of using already existing creek lines, no engineering designs were drawn up, and also, given the ephemeral nature of the creeks, water testing in these areas are considered to be of limited value and consequently not undertaken.

The sediment basins are currently cleaned out using an excavator once every year after the wet season.

Locations of the sediment traps can be seen in Appendix 10 (Riverside Gardens Sediment Trap Locations).

FOLLOWING PAGE, TOP AND MIDDLE ROWS: The various sediments identified within RIverside Gardens. These traps require yearly cleaning. BOTTOM ROW: Progress work on one of the sediment traps. The silt and organic matter is removed to a depth of approximately 1.5m, or until the ground water is reached.

1.7 mundy creek

The Mundy Creek wetlands originally consisted of a tidal mangrove creek fed by a string of freshwater swamps full of waterlilies brolgas and barramundi. Over the years much of these wetlands have been drained and reclaimed for urban development, with most of the system being straightened into channels. What remained of the freshwater sections also suffered badly from exotic weed invasion, para-grass in particular, which has impacted negatively on the environmental aspects of this area as well.

However under the guidance of the Townsville City Council and Conservation Volunteers, the Mundy Creek Natureway has been established and the environment is being rehabilitated through weed control and revegetation with local native plants.

These wetlands connect the suburbs of Garbutt, West End, Belgian Gardens and Rowes Bay and consist of a channelised tidal mangrove creek [with its new environmental values of naturally regenerated mangrove, saltwater grassland, and sedgeland communities], and freshwater wetlands bordered by areas of remnant grasslands, Eucalypt/ Melaleuca woodlands, and urban development.

Although this system has been heavily modified over the years, it still functions as natural pollution trap to some degree, and the revegetation of this area now being undertaken will not only improve the aesthetic /amenity values, but also the environmental functions. The shading of the water by the reintroduction of the riparian vegetation will restrict the growth of para-grass and other exotic weeds, and at the same time provide a buffer zone to the wetland, which then increases the area available for pollution absorption of both sediment and nutrients, directly benefiting water quality outcomes.

ADJACENT PAGE, CLOCKWISE FROM LEFT: Mangrove lined banks near Belgian Gardens Cemetery, with remnant Eucalypt woodland in background; Paragrass growing in the upper reaches of the creek; freshwater sedge wetland in Garbutt; brackish water where mangrove and sedgeland areas meet. THIS PAGE: Mangrove lined banks along Mundy Creek close to the beach at Rowes Bay.

1.8 ross creek

Ross Creek stretches from Cleveland Bay through the central business area of Townsville and inland for about 5km before ending at Bicentennial Park, which adjoins the northern bank of Ross River near the boundary of Hermit Park and Railway Estate.

It is believed that Ross Creek was originally the main channel of Ross River, but that at some time in the past, before European settlement, erosion and wet season flooding led to the formation of the current river mouth. Consequently, Ross Creek became a tidal anabranch that continued as an overflow channel only during times of flood.


South
Townsville
Creek
Boundary St
Railway Estate
Railway Ave
Ross River


MUSEUM

This however ended in the early sixties when the creek was effectively cut off from the river by the construction of the Queens Road levee bank. Today the creek is a tidal estuary which only receives freshwater flows from the surrounding suburbs, which includes the Lakes Stages 1 and 11 which also drain into this system via an open concrete channel running parallel to Woolcock Street.

The creek system consists of three distinct land use areas along its length.

The first of these is from Cleveland Bay up to Lowths Bridge and is dominated by the Townsville Harbour and the central business district. The banks of this area are predominately rock and concrete walls with little of the intertidal vegetation and habitat left intact.

The second area is from Lowths Bridge to Boundary street and is dominated by the old rail yards [much of which is soon to become residential precincts], on both sides of the creek. This area is much less impacted, with significant stands of mangroves and associated mudflats.

The third area is from boundary Street to Bicentennial Park, and is mostly buffered from the surrounding residential areas with parkland bordering the edges, and top end of the creek system. There are also significant stands of mangroves and mudflats in this area as well.

As with Mundy Creek, this system has been heavily modified but still retains some important ecological functions and values, particularly in the middle and upper reaches of the creek where there are still significant areas of mudflats and mangrove vegetation.

PAGE 31 TOP: Mangrove lined upper reaches of Ross Creek with Ross River in the background (Source: http://lh6.ggpht.com) BOTTOM: Ross Creek within the Townsaville Region. THIS PAGE, TOP: Townsville CBD in the lower reaches of Ross Creek. BOTTOM LEFT: Central area of Ross creek adjacent to the railway yards. BOTTOM RIGHT: The mouth and harbour area of Ross Creek.

1.9 ross river

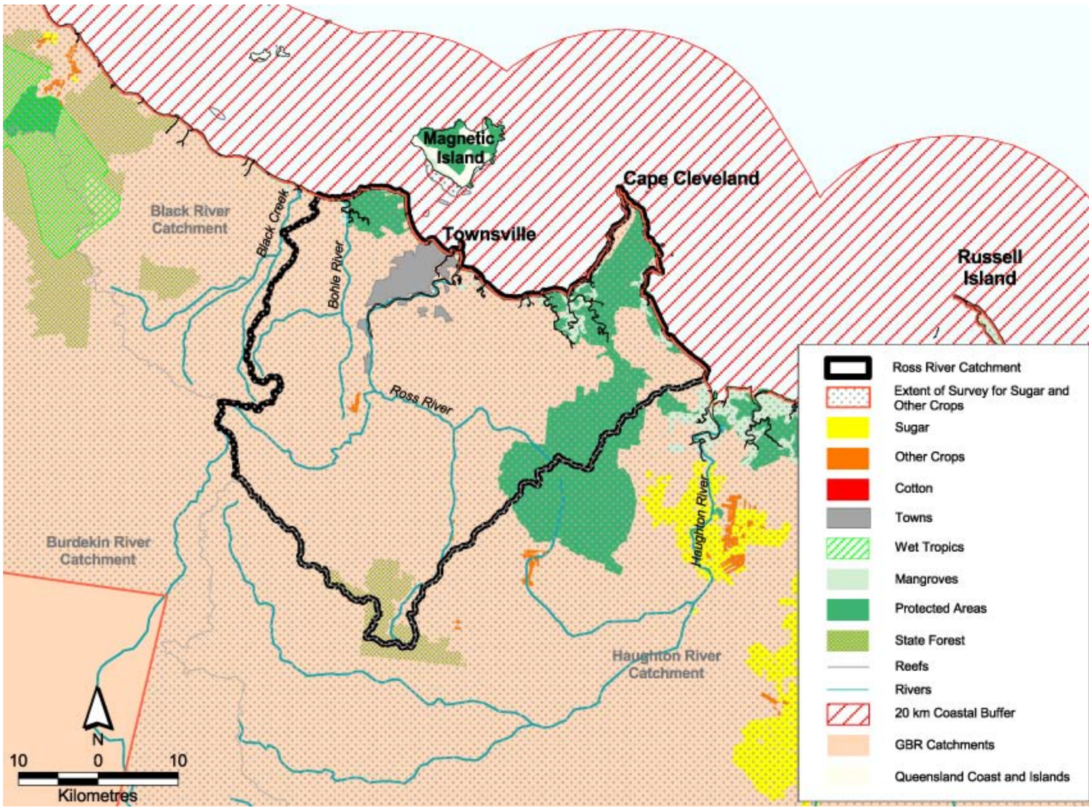
Ross River and its tributaries wind their way from the relatively pristine forests of the coastal mountains immediately inland from Townsville, and pass through the woodlands of somewhat degraded grazing land, areas of sand and gravel extraction, and rural residential subdivisions before ending up in the major source of Townsville's water supply, Lake Ross, some 20 km south-west of the city centre.

From here it flows for several kilometres through the outer suburbs of Townsville on one side (Condon, Kelso etc), and a large area of relatively natural bushland (under the control of the Defence Department), on the lower slopes of Mt Stuart on the other side, before this too eventually gives way to the urban areas of Riverside Gardens and Douglas.

This suburban sprawl continues on both sides of the river for several more kilometres, well into the tidal reaches, until Rooney's Bridge, where on the southern side, the development stops and gives way to mangroves backed by a mosaic of woodland areas for the last few kilometres until the river discharges into Cleveland Bay. Whereas the northern side continues to be flanked by the suburbs of Railway Estate and South Townsville, with some industrial areas towards the mouth of the river, including marinas, dry dock facilities and the Townsville Port area etc, until it too reaches the same point of discharge into Cleveland Bay as well.

Prior to the dam being built, three weirs had been constructed across the river for water storage for the city. This has changed the environmental flows, and where once there were large flows during the wet season that scoured the deeper holes and washed most of the sediment out and into the ocean, the river now functions as a series of lakes rather than seasonal, dry tropics river. The river would once have dried up into a series of deeper holes, flowing little, if at all during the dry season, whereas now with the weirs, the river has become filled with sediment and shallow in comparison, while at the same retaining a higher water level year round.

ADJACENT PAGE, FROM TOP: Mouth of the Ross River looking upstream; looking out to Cleveland Bay from the mouth of Ross River with industrial areas on the left; Lake Ross spillway looking downstream; Loam Island (left)- Riparian vegetation in central section of the river upstream from Black Weir; Loam Island (right) - Overflow inlet beside the main channel of Ross River; Lake Ross - Upper reaches of Ross River.



ADJACENT PAGE, FROM TOP: Mouth of the Ross River looking upstream; looking out to Cleveland Bay from the mouth of Ross River with industrial areas on the left; Lake Ross spillway looking downstream; Loam Island (left)- Riparian vegetation in central section of the river upstream from Black Weir; Loam Island (right) - Overflow inlet beside the main channel of Ross River; Lake Ross - Upper reaches of Ross River.

There are still considerable areas of remnant riparian vegetation along much of the urban sections of the river and over the last fifteen years a number of government funded and community groups have undertaken revegetation on the banks to a large part the mid to lower sections of river.

Although this system has also been heavily modified, it still retains some important ecological and environmental functions and values, particularly in the upper freshwater reaches of the river where there are still significant areas of riparian vegetation and surrounding bushland, both above and below the dam, and also on the southern bank from Rooney's Bridge to the mouth of the river where there are extensive mangrove forests, and remnant bushland adjacent to it.

Ross River Catchment

Description	
Area (km^2)	1707
% Gauged	56
Mean Discharge Yr (km^3)	0.5
Rainfall (mm)	1027
Runoff (mm)	287
Runoff/Rainfall Ratio	28

Landuse	
Population	106445
Clearing (km^2)	1229
% Cleared	72
Area under Grazing (km^2)	1481
Area under Sugar (km^2)	<10
Area under Horticulture (km^2)	<10

1.10 dalrymple road & woolcock street swales

There are broad shallow swale drains along the length of Dalrymple Road from the Woolcock Street intersection up to the Nathan Street intersection. These were originally designed to be grass swales which could be mowed during the drier months of the year. However at the Nathan street end of Dalrymple Road there is an almost constant inflow of water from the surrounding business/industrial area, and the drains are rarely dry. As a consequence a freshwater sedgeland has naturally regenerated along the length of the swales in this area. The Woolcock Street end has less water inflow from the business/industrial area and consequently at this time of the year is dry and still functioning as a grass swale as intended.

These sedgelands act as a natural sediment and pollution trap, helping to filter and remove nutrients from the incoming water, while at the same time also helping to protect against erosion, and although the drains were not originally designed to function in this manner, they are an example of how natural systems can be utilised as part of a treatment train approach in stormwater management across the city.

The Woolcock Street swale drains are much deeper with steep sides and have been extensively colonised by bullrush [Typha domingensis], with a number of trees and palms becoming established along the edges as well. These too function as natural sediment and pollution traps, but due to the amount of vegetative material produced by the bullrush under urban runoff conditions, it needs to be actively controlled / removed at times to ensure that adequate water flows are maintained for high rainfall events.

1.11 macarthur parkway annandale

The following extract is derived from the former Townsville City Council – Citiworks website.

The Macarthur Park Parkland and Drainage Improvement Project has greatly enhanced this area visually, and has transformed the environmental standards and drainage systems of this important asset to the Annandale community.

Commencing on Tuesday 12 September 2006, the works have greatly improved the parkway's sustainability and the quality of stormwater to Ross River.

This Council Management Plan has upgraded the overall maintenance and drainage of the Macarthur Park system and this has contributed to controlling weed issues and stabilising erosion.

The project included the construction of a wetland which has been rehabilitated with native trees, sedges, and water lilies to provide habitat for water birds and increase recreational activities for this popular residential area.

This project was specifically designed to eliminate damage susceptibility as Macarthur Park had incurred severe weather damage over past years.

The project was divided into 4 stages with Stage 1 and 2 commenced during September 2007, and taking approximately 6 - 8 weeks to complete. Stage 3 and 4 were due to commence towards the end of 2007.

The Macarthur Park Parkland and Drainage Improvement Project has been developed by the Townsville City Council in conjunction with Parks Services, Environmental Management Services, and Citiworks Townsville (http://previous.townsville.qld.gov.au/citiworks/macarthur_park.asp)


Humes™

The following information is sourced from the Hobart City Council 'Water Sensitive Urban Design'.

Whilst WSUD generally involves moving away from 'hard' engineering approaches, there is often a place for such systems within a WSUD development. 'Hard' engineering, in this practice note, refers to pre-cast gross pollutant traps. These systems usually fit into a WSUD treatment train as pre-treatment devices for other WSUD techniques such as ponds and wetlands, examples of these can be seen in developments such as Fairfield waters and Riverside Ridge.

Many WSUD systems require removal of coarse sediments and gross litter to ensure effective performance and operational longevity. GPTs and sand filters are also commonly utilised in retrofit scenarios where space and budgetary constraints usually preclude larger WSUD elements.

2. gross pollutant traps: hard engineering systems

2.1 in-line GPTs

There are numerous proprietary inline GPTs on the market. These devices are designed to target gross pollution, coarse sediments and sometimes free oils. They remove pollutants via two main processes, filtration and separation. Filtration units employ a screen to filter flow through, thereby removing any material larger than the screen's aperture. Separator units use hydrodynamic separation, baffles and gravity to remove pollutants from flow.

In-line GPTs require gross pollutants to move through the stormwater pipe, increasing the risk of drain blockage.

Advantages of in-line devices are the ability to retrofit them to heavily built-up environments and their small footprint. In-line GPTs are installed underground within a stretch of stormwater pipe. Examples of these in-line GPTs are common throughout Townsville such as within Domain Central car parks, Soropti-mist Park (Rowes Bay) and other such areas.

2.2 end-of-line GPTs

These devices usually employ a screen to filter flows of gross pollutants. They are installed on the end of stormwater pipes where stormwater is discharged to a receiving waterway.

Outlet GPTs usually involve significant head loss through the trap; however has a strong advantage in that captured material is stored dry between rainfall events.

2.3 at-source GPTs

Stormwater entry-pit traps are filtration and storage baskets that are installed into existing stormwater entry-pits. As stormwater enters a drainage entrance, it is first filtered through a filtration basket that captures all gross pollutants, allowing the filtered water to carry on to the stormwater network. They have also been found to be effective in the removal of coarse sediments

These devices have numerous advantages such as relatively cheap installation costs and dry pollutant storage, also without gross pollutants entering the stormwater pipes, this decreases the likelihood of pipe blockages.

2.4 media filtration systems

Sand filters and proprietary ‘filter cartridge’ devices rely on water percolating through a filter media, such as sand or perlite to filter pollutants. They have been found to be extremely effective in the removal of coarse and medium sediments from stormwater, however they are relatively maintenance intensive.

They may be installed at the ground surface or underground. Because some medium and fine sediments are trapped by these filters (proportion governed by filter media) they are also effective in trapping a significant proportion of nutrient, heavy metal and hydrocarbon pollution.

3. gross pollutant trap locations

The table on the following pages shows where the following Gross Pollutant Traps have been installed around the Townsville region. This also includes some that are not yet installed but will be in the very near future. Where possible, GPS co-ordinates are also given.

Each GPT make is identified and if possible, the model unit is shown as well. This graph does not include GPTs found on defence force land.

	Approximate Location	Make	Model	GPS Reference*	Land Use
1	Cnr Stokes St & Walker St, Townsville City	Ecosol	RSF 100	S19° 15.471 E 146° 48.885	Commercial
2	Castletown Shopping Centre	Ecosol	RSF 100	S19° 16.264 E 146° 47.381	Carpark
3	Stuart St, Townsville	Ecosol	RSF 4200		Residential
4	Blackward Baker Warehouse	Ecosol	RSF 4200		
5	Domain Central	Ecosol	RSF 4300	S19° 16.558 E146° 45.438	Carpark
6	Domain Central	Ecosol	RSF 4300	S19° 16.2558 E146° 45.438	Carpark
7	Domain Central	Ecosol	RSF 4300	S19° 16.563 E146° 45.385	Carpark
8	Domain Central	Ecosol	RSF 4300	S19° 16.554 E146° 45.383	Carpark
9	Domain Central	Ecosol	RSF 4300	S19° 16.569 E146° 45.480	Carpark
10	Domain Central	Ecosol	RSF 4300	S19° 16.700 E146° 45.424	Carpark
11	Domain Central	Ecosol	RSF 4300	S19° 16.705 E146° 45.461	Carpark
12	Domain Central	Ecosol	RSF 4300	S19° 16.569 E146° 45.428	Carpark
13	6-8 Lucas St, Currajong	Ecosol	RSF 4300	S19° 16.563 E146° 46.909	Industrial
14	72 The Strand, Townsville	Ecosol	RSF 4300	S19° 14.861 E146° 48.761	Commercial
15	72 The Strand, Townsville	Ecosol	RSF 4300	S19° 14.921 E146° 48.723	Commercial
16	Blue on Blue, Magnetic Island	Ecosol	RSF 4300		Residential
17	Domain Central	Ecosol	RSF 4300		Carpark
18	Domain Central	Ecosol	RSF 4300		Carpark
19	Domain Central	Ecosol	RSF 4300		Carpark
20	Riverside Ridge, Townsville	Ecosol	RSF 4300	S19° 19.509 E146° 44.528	Residential
21	Riverside Ridge, Townsville	Ecosol	RSF 4300		Residential
22	Mike Carney Toyota, Townsville	Ecosol	RSF 4300		Carpark
23	Cnr Hugh St & Atlee St, Currajong	Ecosol	RSF 4300	S19° 16.317 E146° 46.936	Industrial
24	Fairfield Waters Medical Centre, Kokoda Sst	Ecosol	RSF 4300	S19° 18.417 E146° 48.351	Residential

	Approximate Location	Make	Model	GPS Reference*	Land Use
25	Blue on Blue, Magnetic Island	Ecosol	RSF 4450		Residential
26	Riverside Ridge, Townsville	Ecosol	RSF 4450		Residential
27	Lakeland Dr, Fairfield Waters	Ecosol	RSF 4450	S19° 18.703 E146° 49.048	Residential
28	Townsville Airport Expansion	Ecosol	RSF 4450		Residential
29	Lakeland Blvd, Fairfield Waters	Ecosol	RSF 4450		Residential
30	Breakwater Marina Car Park	Ecosol	RSF 4450		Residential/ Industrial
31	Cnr Oonoonba Rd & Fairfield Waters Drive, Townsville	Ecosol	RSF 4450	S19° 18.223 E146° 48.725	Residential
32	Riverside Ridge, Townsville	Ecosol	RSF 4450	S19° 19.568 E146° 44.940	Residential
33	Fairfield Waters, Townsville 1.3D2	Ecosol	RSF 4450		Residential
34	481 Woolcock Street, Hastings Deering	Ecosol	RSF 4450	S19° 15.999 E146° 45.284	Industrial
35	Riverlea Estate, Smith Rd Condon	Ecosol	RSF 4450	S19° 19.975 E146° 42.657	Construction
36	Riverlea Estate, Smith Rd Condon	Ecosol	RSF 4450	S19° 19.925 E146° 42.661	Construction
37	Riverlea Estate, Smith Rd Condon	Ecosol	RSF 4450	S19° 169.875 E146° 42.666	Construction
38	Riverlea Estate, Smith Rd Condon	Ecosol	RSF 4450	S19° 19.823 E146° 42.655	Construction
39	Jay St, off Webb Dr, Bohle	Ecosol	RSF 4600		Construction
40	Riverside Ridge, Townsville	Ecosol	RSF 4600	S19° 19.564 E146° 44.940	Residential
41	Lakeland Dr, Fairfield Waters Stge, Townsville 1.3D1	Ecosol	RSF 4600	S19° 18.606 E146° 49.030	Residential
42	Lakeland Dr, Fairfield Waters Stge, Townsville 1.3H1	Ecosol	RSF 4600	S19° 18.643 E146° 48.940	Residential
43	Breakwater Marina Carpark	Ecosol	RSF 4600		Industrial
44	Fairfield Waters Shopping Centre	Ecosol	RSF 4600		Commercial
45	Waterways Garden, Stage 2, Bohle	Ecosol	RSF 4600		Residential
46	Waterways Garden, Stage 2, Bohle	Ecosol	RSF 4600		Residential
47	25-31 Weston St, Bohle	Ecosol	RSF 4600		
48	Spotlight Townsville	Ecosol	RSF 4600		Industrial

	Approximate Location	Make	Model	GPS Reference*	Land Use
49	Soroptimist Park, Townsville	Ecosol	RSF 4750	S19° 14.604 E146° 47.726	Residential
50	Riverside Ridge, Townsville	Ecosol	RSF 4900	S19° 19.325 E146° 44.908	Residential
51	Townsville Airport Expansion	Ecosol	RSF 4900		Industrial
52	Lakeland Dr, Fairfield Waters	Humes	Humeceptor (unknown)	S19° 18.397 E146° 48.963	Residential
53	Lakeland Dr, Fairfield Waters	Humes	Humeceptor (unknown)	S19° 18.557 E146° 48.954	Residential
54	Wiltrading Lot 2 Hubble Taylor Place, Sth Townsville	Humes	Humeceptor STC9		Residential/ Industrial
55	Wiltrading Lot 2 Hubble Taylor Place, Sth Townsville	Humes	Humeceptor STC9		Residential/ Industrial
56	Domain Central, behind Bunnings Warehouse	Humes	Humeceptor (unknown)	S19° 16.836 E146° 45.371	Carpark
57	Pumari St Drain	CDS	Unknown		Industrial
58	Riverside Gardens	CDS	Unknown		Residential
59	Freshwater Drive, Riverside Gardens	CDS	Unknown		Residential
60	Metalcorp - 15 Bolam St, Townsville	CDS	Unknown		Industrial
61	Stuart Rail Terminal, Townsville	CDS	Unknown		Industrial
62	Grand Mercure, Woolcock Street	CDS	Unknown		Commercial
63	Central Apartments, Flinders Street West	Humes	Humeceptor (unknown)		Development
64	Townsville RSL, Charters Towers Road	Humes	Humeceptor (unknown)		Commercial
65	Coles CBD, Ogden Street	Humes	Humeceptor (unknown)		Commercial
66	Bowen Road Unit Development	Humes	Humeceptor STC2		Residential
67	Bowen Road Unit Development	Humes	Humeceptor STC2		Residential
68	Pioneer Park, Riverway, Townsville				Open Space

* GPS locations are accurate within 20-30 feet

	Approximate Location*	Make	Model
1	Lavarack Barracks Stage 4	Ecosol	RSF 4200
2	Lavarack Barracks Stage 4	Ecosol	RSF 4200
3	Lavarack Barracks Stage 4	Ecosol	RSF 4200
4	Lavarack Barracks Stage 4	Ecosol	RSF 4200
5	Lavarack Barracks Stage 4	Ecosol	RSF 4200
6	Lavarack Barracks Stage 4	Ecosol	RSF 4200
7	Lavarack Barracks Stage 4	Ecosol	RSF 4200
8	Lavarack Barracks Stage 4	Ecosol	RSF 4200
9	Lavarack Barracks Stage 4	Ecosol	RSF 4200
10	Lavarack Barracks Stage 4	Ecosol	RSF 4200
11	Lavarack Barracks Stage 4	Ecosol	RSF 4200
12	Lavarack Barracks Pit 1/59	CDS	Unknown
13	Lavarack Barracks Pit 1/97	CDS	Unknown
14	Lavarack Barracks Pit 8/88	CDS	Unknown
15	Lavarack Barracks Pit 1/1	CDS	Unknown
16	Lavarack Barracks, Combat Training Facility	CDS	Unknown
17	Lavarack Barracks GPT 2/100	CDS	Unknown
18	Lavarack Barracks GPT 2/104	CDS	Unknown
19	Lavarack Barracks GPT 2/110	CDS	Unknown
20	Lavarack Barracks GPT 1/1	CDS	Unknown
21	Ross Island Barracks	Humes	Humeceptor
22	Ross Island Barracks	Humes	Humeceptor
23	Ross Island Barracks	Humes	Humeceptor
24	Ross Island Barracks	Humes	Humeceptor

* These GPTs are located on Australian Defence Force Land. Their exact location within the bases is unknown.

A map for the GPT locations for Fairfield Waters can be found in Appendix 11.

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