12. Hydrology, hydraulics and surface water quality

12.1 Introduction

This chapter reviews the potential impacts of the proposal on flooding and water quality within the project area's locality. Included in this review are an assessment of the existing drainage patterns of the corridor and an assessment of the known water quality values within adjoining waterways. This assessment identifies impacts that the proposed corridor upgrade may have on the current level of flood immunity (i.e. trafficability) of the road network, and potential impacts to neighbouring properties and water quality within the project area.

12.2 Methodology

This assessment has been carried out as a desktop study, supplemented by some further data collection. Data sources include:

- discussions and site visit with Sunshine Coast Regional Council (SCRC) officers
- site visits by PB during works undertaken to date
- flood mapping published by SCRC
- review of topographic information and survey supplied by the client
- publications by the Intergovernmental Panel for Climate Change and CSIRO
- stormwater drainage GIS data from SCRC
- water quality information sourced from the Healthy Waterways Partnership
- Mooloolah River: environmental values and water quality objectives: Basin No. 141 (part): including all tributaries of the Mooloolah River — report released in March 2007.

Assessment of catchment extents and current capacities of the underground drainage system and overland flow path capacities (including road flow widths) have not been undertaken, and these will form a large component of future design and planning works.

12.3 Preliminary analysis — waterways

12.3.1 South East Queensland Natural Resource Management Plan 2009–2031

The South East Queensland Natural Resource Management Plan 2009–2031 (SEQ Regional Plan) has been prepared in partnership with members of the South East Queensland Regional Coordination Group. The SEQ Regional Plan is 'a statutory plan expressing state interests in regional land use planning, including planning and management for natural resources' (SEQRCG 2008, p. 3).

The desired regional outcome (DRO 11) for water from the SEQ Regional Plan is outlined below:

"Water in the region is managed on a sustainable and total water cycle basis to provide sufficient quantity and quality of water for human uses and protection of environmental health. (SEQRCG, 2008, p. 34)"

The principles to support DRO 11 outlined in the SEQ Regional Plan are as follows (SEQRCG 2008, p. 34):

- total water cycle management — Water is acknowledged as a valuable and finite regional resource that must be managed on a total water cycle basis
- waterway health — Protect and enhance the ecological health, environmental values and water quality of surface and groundwater, including waterways, wetlands, estuaries and Moreton Bay
- water supply planning — Supply sufficient water to support a comfortable, sustainable and prosperous lifestyle while meeting the needs of urban, industrial and rural growth, and the environment
- drinking water catchment protection — Manage risks in drinking water catchments to maintain water quality
- supply rural water in an efficient and sustainable way.

The DRO 11 directly associated with the CoastConnect — Caloundra to Maroochydore project is Waterway Health.

12.3.2 Waterways

For much of the corridor's length, the terrain is generally flat, low-lying coastal land that has been developed for residential, industrial and commercial use. Terrain of higher elevation and steeper slopes exists through Caloundra, Battery Hill and Alexandra Headland.

The corridor traverses the Mooloolah River catchment and encounters various waterways including Tooway Creek, Currimundi Creek, Tokara Canal, Lake Kawana, Parrearra Channel, Wyuna Canal, Mooloolah River and Tuckers Creek. An extensive canal system also exists off the Mooloolaba River between Buddina and Mooloolaba. The northern part of the corridor passes through the Cornmeal Creek catchment. Cornmeal Creek discharges to Maroochy River less than 1 km upstream of its ocean outfall.

Underground drainage networks exist throughout the study area. These networks generally discharge to the waterways mentioned above, but a small number of drainage systems discharge directly to ocean outfalls.

The major waterways and percentages of the proposed corridor located within their associated catchments are as follows:

- Currimundi Creek (38 %)
- Mooloolah River (35 %).

The remainder of the proposed corridor is located in areas that directly discharge to oceans (12.5 %), to a freshwater lake located in Section 6 (8 %) and to Cornmeal Creek (6.5 %).

The location of these waterways in relation to the corridor alignment is shown in Figure 12-1. The minor waterways associated with the proposed corridor are discussed in more detail in Section 12.5.

Legend

- CoastConnect Corridor
- Section Designation
- Roads
- Waterbody
- Cadastre

Source:
SEQ Detailed Geology, Department of Natural Resources and Mines 2007

0 1 2 3 4
Kilometres

CoastConnect corridor locality and drainage map

File: J:\A605-TPL\PROJ\2134227A_SCO_CALOUNDRA\10_GIS\Projects\Water\RP_corridor_locality_drainage_map.mxd Author: GL Checked: RB Date:18/05/2009

Currimundi Creek

Currimundi Creek catchment shares its northern boundary with the Mooloolah River catchment. Currimundi Creek extends westwards to Corbould Park Racecourse, passes under Nicklin Way and discharges to the ocean (see Figure 12-2). The lower reaches are periodically impounded by a sand bar, which occasionally is removed by council dredging operations. When the sand bar is in place, the lower reaches are referred to as Currimundi Lake.

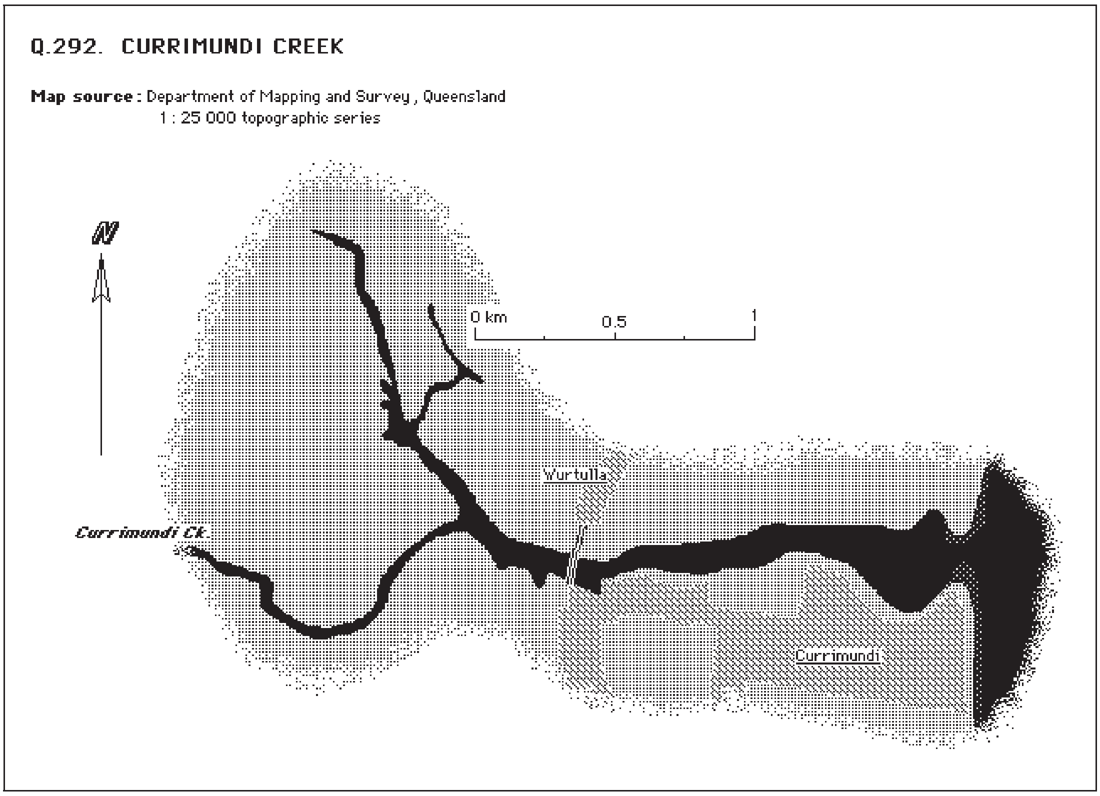


Figure 12-2: Currimundi Creek outline adopted from DMS (2009)

Creek flows to Currimundi Lake have been extensively modified by urban development (CLPCG 2009). Sections of the corridor that impact on the Currimundi Creek catchment are discussed in more detail in Section 12.5.

Mooloolah River

Mooloolah River is approximately 148 kilometres long. The major tributaries include Sippy, Addington and Mountain creeks.

Healthy Waterways (2009) describes Mooloolah estuary as follows.

"The estuarine section of the Mooloolah River has been radically changed by development. Concrete walls, jetties, abutments and piers line the lower reaches of the riverbanks meaning that the natural vegetation has been lost. Although the piers may provide some alternative habitat for fish and other life, the canal developments have created an extensive, convoluted system of channels, which prohibits effective flushing by the tide. Sections of the corridor that impact on the Mooloolah River catchment are discussed in more detail in Section 12.5."

12.4 Preliminary analysis — hydrology/hydraulics

The preliminary analysis of hydrology/hydraulics associated with the proposed corridor addresses:

- the existing situation in relation to the proposed corridor alignment
- potential impacts and mitigation measures in relation to the proposed corridor alignment.

12.4.1 Existing situation

Corridor-wide considerations

The assessment of the existing situation for the preliminary analysis of hydrology/hydraulics associated with the proposed corridor includes the following sections:

- Sections 1 and 2 – Caloundra to Currimundi
- Section 3 – Nicklin Way
- Section 4 – Kawana Town Centre
- Section 5 – n/a (planning and delivery of this section is being lead by the Sunshine Coast Regional Council)
- Section 6 – Alexandra Parade
- Section 7 – Maroochydore.

Much of the engineering works will comprise the widening of road pavements to provide additional bus lanes and additional bus stops. Road widening may adversely impact the allowable flow width limits, which are set out in the Queensland Urban Drainage Manual (QUDM 2008).

Further works are expected at road intersections and local accesses. Land resumptions are required at some locations.

Sections 1 and 2 — Caloundra to Currimundi

The proposed road widening associated with these sections is generally limited to the provision of additional bus stops. The existing drainage system in this area is old and unlikely to be adequate for 10-year average recurrence interval (ARI) events and greater (i.e. 50- and 100-year ARI events). This deficiency in drainage capacity is likely to have been exacerbated over the years as urban redevelopment containing higher densities has significantly increased impervious areas.

The low points located along the bus corridor where flooding is likely are:

- Moreton Parade and Mahia Street intersection
- Edmund Street and King Street intersection
- Edmund Street between Headlands Court and William Street.

The bus stops located where flow width may be greater than the QUDM limit of 0.45 m are:

- Edmund Street between Russell and William streets
- Rinaldi Street
- Moreton Parade between Dingle Avenue and Upper Gay Terrace.

The following waterways and associated catchment areas are located within these sections:

- northern part of Buderim Street drains to Coondibah Creek
- southern part of Buderim Street and Beerburrum Street drains to Bunbubah Creek
- area between Beerburrum and Rinaldi streets drains to Tooway Creek
- remaining area south of Rinaldi Street drains to a number of piped coastal outfalls.

The watercourse crossings for the proposed corridor within this section are:

- the bridge over Coondibah Creek on Buderim Street (adjacent to Currimundi Primary School), which is low and subject to inundation. SCRC proposes to upgrade the bridge to increase flood immunity
- Bunbubah Creek where it flows under Beerburrum and Cooroy Streets, occasionally inundating adjacent roads. The anticipated depth of flooding is not currently known
- Tooway Creek Bridge, which is due to be reconstructed by SCRC.

Section 3 — Nicklin Way

This area has flat topography with the exception of the area immediately north of the Buderim Street intersection. The proposed corridor crosses two major waterways: Currimundi Creek and Tokara Canal (which flows into Currimundi Creek). Currimundi Creek acts as a bypass for the Mooloolah River in high flooding events. The crossings for Currimundi Creek and Tokara Canal have adequate flood immunity (100-year ARI) at present. The elevation of the existing corridor along the majority of Nicklin Way ranges from approximately 2.8 metres AHD to 3.6 metres AHD.

It appears that the road drainage network does not have the required 10-year ARI capacity. The size of drainage pipes affected by the proposed works is in the range of 375–525 millimetres diameter.

The gully pits are generally spaced at approximately 80–120 metre intervals (as determined from SCRC's internet-based mapping system). This is likely to result in:

- flow width problems – resulting in flow widths greater than 0.45 metre at bus stop locations, thus exceeding QUDM recommendations
- flooding depths impacting on trafficability in isolated locations.

Some existing low points located along the bus corridor where flooding is likely are:

- inlet pits from Jessica Boulevard to Mooloolah River (subject to storm surge and freshwater flooding)
- Stockland Park sports fields and the associated car park area.

The following waterways and associated catchment areas are located within this section:

- the southern part of Section 3 (i.e. between Buderim Street and Main Drive), which drains to Currimundi Creek and the associated canal area
- the remainder of Section 3, which drains to the Mooloolah River and the associated canal area (i.e. Parrearra and Wyuna Canal).

Section 4 — Kawana Town Centre

This section contains the most recent development and road construction; therefore, the existing drainage network was designed and constructed to current council standards, and appears to be satisfactory. The elevation of the existing corridor along this section approximately ranges from RL 3.0 metres to RL 3.5 metres. Generally, the inlet pits are spaced approximately in 40–50-metre interval, as indicated in the council's internet-based mapping system.

All of Section 4 drains to Currimundi Creek and the associated canal area.

Section 5 — Mooloolaba

The Sunshine Coast Regional Council will be undertaking water related investigations in this section.

Section 6 — Alexandra Parade

With the exception of Alexandra Headland this terrain is generally low-lying land. The elevation of the existing corridor along this section approximately ranges from RL 21.0 metres (at the Buderim – Mooloolaba Road intersection) to RL 3.3 metres, with the majority of the section being at the lower elevation.

The flow widths at the bus stops are likely to be greater than 0.45 metres and may exceed the QUDM recommendations.

The following waterways and associated catchment areas are located within this section:

- the northern part between Mari and Parker streets, which drains to a freshwater lake system approximately 300 metres inland from the coastline
- the area between Venning Street and the Alex Surf Club (Mari Street), which drains to ocean outfalls
- the remainder of Section 6 (i.e. southern part), which drains to the Mooloolah River.

Section 7 — Maroochydore

This section of the corridor is typically low-lying and generally flat. The elevation of the existing corridor along this section approximately ranges from RL 1.8 metres to RL 3.5 metres.

Historical local flooding has been witnessed within local streets adjacent to Aerodrome Road. Based on their elevation and flat grades, the bus stops along Aerodrome Road could experience flooding.

In this section, the corridor crosses one significant waterway — Cornmeal Creek at Sunshine Plaza.

The size of drainage pipes within the corridor affected by the proposed works is in the range of 375–900 millimetres diameter. However, the drain lines downstream of the corridor leading to Cornmeal Creek are up to 1,200 millimetres in diameter.

All of this section drains to Cornmeal Creek and associated tributaries/channels.

12.4.2 Potential benefits, potential impacts and typical mitigation measures

The assessment of the potential benefits, potential impacts and typical mitigation measures associated with the proposed corridor includes the following sections:

- Sections 1 and 2 – Caloundra to Currimundi
- Section 3 – Nicklin Way
- Section 4 – Kawana Town Centre
- Section 5 – n/a (planning and delivery of this section is being lead by the Sunshine Coast Regional Council)
- Section 6 – Alexandra Parade
- Section 7 – Maroochydore.

Corridor-wide considerations

Potential benefits

In the realignment of drainage systems required for the CoastConnect — Caloundra to Maroochydore project, all old infrastructure will be replaced — a corridor-wide benefit.

Potential impacts

The proposed corridor upgrade will require existing carriageways to be widened and road reserve widths to be increased in some sections along the corridor. The subsequent increase in the impervious area contributing to the drainage system is predicted to be relatively small, and hence the increase in run-off will also be small. It is estimated that run-off will increase by approximately 1 %–4 %.

Other potential impacts are:

- relocation of existing drainage structures (inlets and manholes) and underground drain lines
- reduced elevation of kerb and channel (if existing road crossfall is extended and no pavement overlay is used), which will reduce the hydraulic head available for the drainage system and potentially reduce pipe capacities
- service clashes when realigning drainage pipes, gullies and kerbs
- relocation of street furniture, such as lighting poles, signs and bollards.

It is anticipated that grading of any extensions to the existing drainage system or additional augmentation systems (if required) may be constrained due to:

- the flat nature of terrain
- long length of existing pipes to discharge locations
- limited cover.

These factors may result in drainage lines that:

- have grades flatter than desirable
- have reduced cover, which requires protective works (e.g. concrete pavement and pipe encasement)
- may require the pumping of stormwater in extreme cases where the longitudinal grade cannot be achieved.

Climate change potential impacts

The Queensland Government's Department of Infrastructure and Planning is due to publish guidelines on this subject during 2009 and these should be referenced when available. The latest advice from the International Panel on Climate Change (IPCC) is that sea levels are rising faster than previously predicted, and may rise by 1 metre by the year 2100 (IPCC 2009). This advice post-dates current CSIRO advice, which has previously endorsed the IPCC's position.

The majority of the corridor drains to watercourses that are influenced by oceanic water levels, and which may be affected by global sea level rise. A brief summary of tidal levels, storm surge and climate change impacts is shown in Table 12-1 for comparative purposes.

Table 12-1: Tidal levels, storm surge and climate change impacts adapted from IPCC (2009)

Tidal plane	Elevation (RL m AHD)
Current mean high water springs (MHWS)	0.61
Current highest astronomical tide (HAT)	1.14
Allowance for climate change – year 2100 *	Up to + 1.0 m
Allowance for storm surge	+ 0.5 m
Potential MHWS in 2100	1.6
Potential MHWS plus storm surge in 2100	2.1

* Previous predictions by CSIRO (2007) estimated sea level rise of approximately 0.8–0.9 metres by the year 2100.

Conventionally, design conditions relate to mean high water springs. Under predicted climate change scenarios, the combination of high tide, global sea level rise, and storm surge can result in the design sea levels rising to approximately RL 2.1 metres (AHD). Given that some sections of the road corridor are as low as approximately 1.4 metres AHD there is clearly the potential for it to be affected.

Rising global sea levels are expected to:

- compromise the operation of the stormwater drainage system by reducing its capacity
- compromise the treatment of stormwater quality by the intrusion of saltwater into stormwater quality improvement devices (SQIDs)
- compromise the structural integrity of the pavement
- result in more frequent road closures.

The long-term climate change highest astronomical tidal (HAT) level is currently estimated to be up to approximately RL 2.1 metres, and this would result in flooding up to 700 millimetres deep in some areas if the current road elevation prevails. To mitigate these effects, consideration should be given to raising road levels or providing an elevated carriageway if a high level of flood immunity needs to be maintained for the public transport corridor. Alternative routes to avoid or minimise the impacts of rising sea levels could also be considered. The raising of the carriageway may interfere with overland flow paths, which could adversely affect flooding in neighbouring properties.

Mitigation measures to minimise climate change impacts are likely to come out of a regional approach covering widespread areas. It is considered that mitigation strategies associated with the climate change impacts are beyond the current scope of this project. Mitigation measures could have major implications for surrounding waterways, adjoining roads, existing overland flow paths, the hydraulics of existing canal systems and existing land use.

Climate change impact on rainfall intensity

Climate change has also been identified to have a possible impact on rainfall intensity, and this may also reduce flood immunity and have an impact on road flow widths and depths. IPCC (2009) states that peak rainfall intensities could rise by up to 30 % approximately. Further assessment and subsequent hydrological calculations would be required to prepare a ‘climate change’ smart design for the proposed corridor.

Typical mitigation measures

The mitigation works described below only apply to local drainage in areas affected by the corridor upgrades and they are identified to achieve ‘no worsening’ of the current situation. Climate change impacts are potentially greater, and mitigation measures for these impacts are likely to be part of regional strategies that have not been investigated by local and state authorities at this time.

Mitigation works to compensate for the potential impacts on surface drainage will generally be limited as follows:

- where the existing drainage infrastructure must be replaced, a new pipe configuration will be provided whose capacity will either match the existing system or accommodate an increase in flows
- inlet capacity provided will equal or better the existing capacity

- where run-off is significantly increased, an upgraded drainage system will be provided to accommodate increased flows
- the design of any alterations to the road carriageway (widening or reconstruction) will not have finished surface levels lower than those that currently exist as this would reduce the capacity of the drainage system.

The design of the new and/or realigned drainage should consider the additional impervious areas that will result from the proposed corridor upgrading to counter any negative effect that the CoastConnect — Caloundra to Maroochydore project may have on the current flood immunity with respect to local flooding issues.

The use of retention storages to attenuate increases in peak flows is not recommended for the following reasons:

- the limited area available to fit these within the corridor
- possible tidal inundation of storages
- high construction and maintenance cost
- potential harbour for vermin and source of other health risks.

However, their use may be investigated on a case-by-case basis during the detailed design. The investigation of retention storages may be warranted in the following situations:

- where upgrading drainage pipes downstream of the area affected by works is cost-prohibitive or has unacceptable impacts on the local community
- where flow increases occur in sensitive areas (e.g. areas with existing deficient drainage capacities).

Construction impacts can be mitigated by use of best on-site practise, by remedial works and by ensuring adequate communication with affected land owners and the public in general before construction works commence.

Sections 1 and 2 — Caloundra to Currimundi

Potential benefits

The benefits associated with this section of the corridor are as follows:

- isolated widening of the roadway for bus stops that may result in the removal and replacement of ageing kerb and channel which may be approaching the end of its economic design life
- additional inlets to reduce road flow widths that may improve trafficability for road users during rainfall events.

Potential impacts

The potential impacts associated with this section of the corridor are as follows:

- construction works impacting on existing carriageway and footpaths, including possible clashes with existing services
- connection of new drain lines into existing structures, which may adversely affect the hydraulic performance of the structure.

Typical mitigation measures

The corridor-wide mitigation measures (see Section 1.5.2) apply.

The specific mitigation measures associated with this section of the corridor are:

- ensuring the new pipes do not enter existing structures at adverse angles when connecting new drainage lines
- improving the hydraulic efficiency of the pit to minimise structure losses when connecting new drainage lines (i.e. application of benching).

Section 3 — Nicklin Way

This section of the corridor involves road widening at approximately eight intersections. It is common for drainage inlets to be close to intersections to limit surface flow widths, and therefore the widening at intersections will require the relocation of a large number of drainage structures and their associated drain lines.

Potential impacts

The potential impacts associated with this section of the corridor are:

- a relatively small increase in peak run-off rates
- redirection of existing connections to the new infrastructure (e.g. roofwater drain lines from commercial buildings which may connect to existing manholes).

Typical mitigation measures

The corridor-wide mitigation measures (see Section 1.5.2) apply.

Section 4 — Kawana Town Centre

Since this section of the corridor is the most recently constructed, it is expected to meet current design standards. Possible options/components for this section are:

- new roadway corridors
- widening existing roads (Kawana Way, Main Drive and Lake Kawana Boulevard)
- new roads linking to the Multi Modal Transport Corridor (MMTC)
- new road parallel to the MMTC behind Kawana Town Centre
- realignment of the Sportsmans Parade/Main Drive intersection.

Potential impacts

The potential impacts associated with this section of the corridor are:

- a relatively small increase in peak run-off rates
- the realignment of Sportsmans Parade, which will necessitate the relocation of an existing drainage system; this system will need to be redesigned to suit the CoastConnect — Caloundra to Maroochydore project.

Typical mitigation measures

The corridor-wide mitigation measures (see Section 1.5.2) apply.

Section 5 — Mooloolaba

Planning and delivery of this section is being lead by the Sunshine Coast Regional Council.

Section 6 — Alexandra Headland

Potential impacts

The potential impacts associated with this section of the corridor are generally associated with a slight increase in peak run-off rates.

Typical mitigation measures

The corridor-wide mitigation measures (see Section 1.5.2) apply.

Section 7 — Maroochydore

Potential benefits

This section of the corridor only involves widening works between the Kingsford Smith Parade intersection and Sunshine Plaza; a distance of some 800 metres. This is likely to require reconstruction of at least part of the existing drainage system in the area. The replacement of existing drainage infrastructure will provide an extended economic design life for the new drainage system over that which presently exists.

Potential impacts

The potential impacts associated with this section of the corridor are:

- a relatively small increase in peak run-off rates
- redirection of existing connections to the new infrastructure (e.g. roofwater drain lines from commercial buildings which may connect to existing manholes)
- potential impact on Cornmeal Creek ecosystems during construction (it is located approximately 350 metres from the proposed corridor).

As noted above, the impacts listed here relate to local drainage. The low-lying section of Horton Parade and Aerodrome Road is vulnerable to potential climate change impacts.

Typical mitigation measures

The corridor-wide mitigation measures (see Section 1.5.2) apply.

The specific mitigation measure associated with this section of the corridor is as follows:

- Design of the new and/or realigned drainage should include consideration of the additional impervious areas that will result from upgrading the proposed corridor. This will negate any effect that the CoastConnect — Caloundra to Maroochydore project may have on current flood immunity.

12.5 Preliminary analysis — water quality

12.5.1 Environmental Values and Water Quality Objectives

The Environmental Protection (Water) Policy 1997 (EPP Water) is subordinate legislation under the *Environmental Protection Act 1994* that refines and defines the Act's broad environmental protection measures to ensure protection of water.

The EPP Water states legally binding standards for water quality. Environmental Values (EVs) and Water Quality Objectives (WQOs) have been established under Schedule 1 of the EPP Water for surface water. EVs are qualities of waterways that need to be protected, while WQOs are measures of particular indicators of water quality.

Released in March of 2007, the *Mooloolah River: environmental values and water quality objectives: Basin No. 141 (part): including all tributaries of the Mooloolah River* outlines EVs and WQOs for the waterways associated with the project area.

The Department of the Environment and Resource Management (DERM) (formerly Environmental Protection Agency) report has now been listed under Schedule 1 of the EPP Water. Scheduling means that local governments *must* consider the EVs and WQOs contained in the report when assessing developments — that is, the EVs and WQOs have the force of law. Therefore, the WQOs set by DERM have been adopted for the waterways associated with this project.

Figure 12-3 shows the area recognised by DERM as the Mooloolah River catchment area, with which all EVs and WQOs relevant to the project are associated.

12.5.2 EVs for Mooloolah River catchment

The EVs of waters to be enhanced or protected under the EPP Water are:

- biological integrity of a modified aquatic ecosystem
- suitability for recreational use
- suitability for minimal treatment before supply as drinking water
- suitability for agricultural use
- suitability for industrial use.

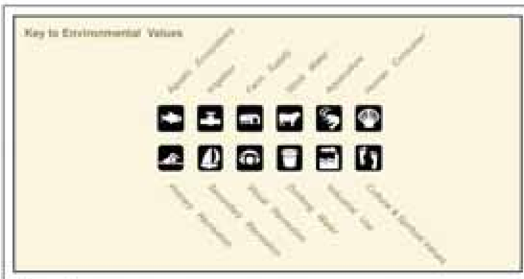
DERM describes EVs as ‘qualities of waterways that need to be protected from the effects of pollution, waste discharges and deposits to ensure healthy aquatic ecosystems and waterways that are safe and suitable for community use’.

Table 12-2 has been reproduced from EPA (2007) and shows DERM’s EVs for the Mooloolah River catchment.

MOOLOOLAH RIVER, INCLUDING ALL TRIBUTARIES OF THE RIVER

Part of Basin 141

Key to Environmental Values



Legend

- River / creek
- Coastline
- Sub-catchment boundary
- Boundary of waters covered by the scheduling document
- Local government boundary

Management Intent for Waters

- High ecological value freshwaters (maintain)
- High ecological value marine / estuarine waters (maintain)

Water Types

Marine / estuarine waters

- Open coastal waters
- Enclosed coastal / lower estuary
- Middle estuary
- Upper estuary
- Tidal canals / constructed estuaries / marinas / boat harbours

Freshwaters

- Lowland freshwaters
- Wallum / tannin freshwaters
- Coastal freshwaters
- Upland freshwaters
- Lakes / reservoirs

Note for users: Areas of the catchment that are not shown on this map as having a management intent of high ecological values, slightly disturbed or highly disturbed, have a **management intent of moderately disturbed.**

Environmental Protection (Water) Policy 2009
South-east Queensland Map Series
PLAN WQ1412

Publication date: July 2010

This plan forms part of the Mooloolah River Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the *Environmental Protection (Water) Policy 2009*.

Queensland Government

N

Projection: Map Grid of Australia (MGA) Zone 56

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

0 2 4 6 8 10

Kilometres

Scale of 1:60,000 when printed @ A1

Location Map

Table 12-2: Environmental values for the Mooloolah River catchment reproduced from DERM (EPA 2007, pp. 7–8)

Environmental value		Lower Mooloolah River Estuary	Currimundi Lake
Aquatic ecosystems	High conservation/ecological value systems (HCV)		
	Slightly to moderately disturbed systems (SMD)	✓	✓
	Highly disturbed systems (HD)		
Primary industries	Water for irrigating crops		
	Water for general farm use, such as fruit packing or milking sheds		
	Stock watering		
	Water for aquaculture		
	Human consumption of wild or stocked fish and crustaceans	✓	✓
Recreation and aesthetics	Primary recreation with direct water contact, such as swimming	✓	✓
	Secondary recreation with limited water contact, such as boating	✓	✓
	Visual appreciation without direct water contact, such as picnicking	✓	✓
Drinking water	Raw water supply for human consumption		
Industrial use	Water for purposes such as power supply and manufacturing plants	✓	
Cultural and spiritual	Cultural values of traditional owners and the general community	✓	✓
Seagrass	Maintenance or rehabilitation of seagrass habitat	✓	✓
Oystering	Health of humans consuming oysters from natural waterways and commercial ventures	✓	

12.5.3 WQOs for Mooloolah River catchment

WQOs are defined in the Environmental Protection (Water) Policy 1997 for the Mooloolah River catchment as long-term goals for water quality management.

They are numerical concentration levels or narrative statements of indicators established for receiving water, to support and protect the designated EVs for those waters. They are based on scientific criteria or water quality guidelines, but may be modified by other (social, cultural, economic) inputs. Table 12-3 shows the WQOs to protect aquatic ecosystem environmental values for the waterways associated with the CoastConnect — Caloundra to Maroochydore project.

Table 12-3: WQOs to protect aquatic ecosystem EV (refer Plan WQ1412 for location of waters, Figure 1-3)

Water area/type (refer Fig 12-3)	**Level of protection**	**Water quality objectives to protect aquatic ecosystem EV**
Marine and estuarine waters		
Estuary (mid-estuary)	Aquatic ecosystem — slightly to moderately disturbed (Level 2)	▪ turbidity*: 3.0 – 5.0 NTU ▪ suspended solids*: 4.0 – 13.0 mg/L ▪ chlorophyll a*: 0.7 – 2.9 µg/L ▪ total nitrogen (N)*: 300 µg/L ▪ oxidised N*: 2.0 – 10.0 µg/L ▪ ammonia NH_4*: 10.0 – 27.0 µg/L ▪ organic N*: 50.0 – 240.0 µg/L ▪ total phosphorus*: 10.0 – 20.0 µg/L ▪ dissolved reactive phosphorus (DRP)*: 2.0 – 6.0 µg/L ▪ dissolved oxygen (DO)*: 85 – 96% saturation ▪ pH: 8.06 – 8.44 ▪ secchi depth*: 0.4 – 0.9 m ▪ temperature: 19.6 – 27.2 °C ▪ conductivity: 37.40 – 52.70 mS/cm ▪ microbiological: median < 150 faecal coliforms or < 35 enterococci organisms/100mL
All marine and estuarine waters within this table	Aquatic ecosystem — slightly to moderately disturbed (Level 2)	Release of sewage from vessels to be controlled in accordance with requirements of the *Transport Operations (Marine Pollution) Act and Regulation 1995* Comply with Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC. Toxicants in sediment and biota as per Caloundra City Council (2007):

Water area/type (refer Fig 12-3)	Level of protection	Water quality objectives to protect aquatic ecosystem EV
		Metal toxicants in sediments: ▪ Cadmium (Cd): 0.5 – 1.5 mg/kg ▪ Chromium (Cr): 30.0 – 95.0 mg/kg ▪ Copper (Cu): 5.0 – 23.0% ▪ Nickel (Ni): 5.0 – 23.0 mg/kg ▪ Lead (Pb): 5.0 – 13.0 mg/kg ▪ Zinc (Zn): 37.0 – 110.0 mg/kg **Metal toxicants in biota (Hairy Mussel):** ▪ Aluminium (Al): 29.0 – 52.0% (Median = 37.0%) ▪ Arsenic (As): 14.0 – 25.0 (Median = 19.0) mg/kg ▪ Cadmium (Ca): 730.0 – 1570.0 (Median = 1020.0) mg/kg ▪ Chromium (Cr): 1.7 – 16.4 (Median = 3) mg/kg ▪ Cobalt (Co): 780 – 1710 (Median = 1040.0) ▪ Copper (Cu): 6.6 – 9.0% (Median = 7.7%) ▪ Iron (Fe): 270.0 – 680.0 (Median = 400) mg/kg ▪ Mercury (Hg): 22.0 – 36.0 (Median = 29) µg/L ▪ Manganese (Mg): 13.0 – 20.0 (Median 16.0) mg/kg ▪ Molybdenum (Mo): 700.0 – 1910.0 (Median = 1080.0) µg/L ▪ Nickel (Ni): 3.6 – 11.3 (Median = 6.6) mg/kg
Marine/ estuarine waters with seagrass EV chosen	Aquatic ecosystem — slightly to moderately disturbed (Level 2)	The minimum WQOs needed to restore seagrass to areas where it has been lost are: ▪ median total suspended solids: <10 mg/L; ▪ median secchi depth: >1.7 m ▪ light attenuation coefficient: >0.9. However, in areas where seagrass is intact, it is more important to maintain existing water quality. Therefore the WQOs are: ▪ local total suspended solids, turbidity, secchi and light attenuation is maintained ▪ local seagrass distribution and composition is maintained, as measured by: ‣ extent of seagrass ‣ species diversity ‣ seagrass depth limit.
Marine/ estuarine riparian areas	Aquatic ecosystem — slightly to moderately disturbed (Level 2)	Protect or restore riparian areas — riparian area water quality objectives.

Notes:

*For these parameters, compliance shall be determined by comparing the median value of monthly samples over a running 6-month period.

1. Oxidised N = NO_2 + NO_3. Units for nitrogen indicators are micrograms per litre (µg/L) N.

2. Units for phosphorus indicators are micrograms per litre (µg/L) P.

3. n/d = no data, n/a = not applicable for this indicator and water type.

4. DO objectives apply to daytime conditions. Lower values may occur at night but these should not be more than 10%–15% less than daytime values. DO values as low as 40% may occur in estuaries for short periods following material inflow events after rainfall. DO values <50% are likely to significantly impact on the ongoing ability of fish to persist in a water body. DO values <30% saturation are toxic to some fish species. These DO values should be applied as the absolute lower limit objectives for DO – see also section 4.2 of the QWQG. Very high DO (supersaturation) values can be toxic to some fish as they cause gas bubble disease.

5. DO values for freshwaters should only be applied to flowing waters. Stagnant pools in intermittent streams naturally experience values of DO below 50% saturation.

6. Wallum/tannin-stained waters contain naturally high levels of humic acids (and have a characteristic brown ti-tree stain). In these types of waters, natural pH values may range from 3.6 to 6.

7. During flood events or nil flow periods, pH values should not fall below 5.5 (except in wallum/tannin waters) or exceed 9.

8. Nutrient objectives do not apply during high-flow events. See *Queensland Water Quality Guidelines 2006 (*QWQG) (i.e. Section 4 and Appendix D) for more information on applying guidelines under high-flow conditions.

9. During periods of low flow and particularly in smaller creeks, build-up of organic matter derived from natural sources (e.g. leaf litter) can result in increased organic N levels (generally in the range of 400 to 800 µg/L). This may lead to total N values exceeding the WQOs. Provided that levels of inorganic N (i.e. NH_3 + oxidised N) remain low, then the elevated levels of organic N should not be seen as a breach of the WQOs, provided this is due to natural causes.

10. Conductivity. Under natural conditions, conductivity is highly dependent on local geology and soil types. The *Queensland Water Quality Guidelines 2006* (i.e. Appendix G) provides information on conductivity values in a set of 18 defined salinity zones throughout Queensland. For each zone, the *Queensland Water Quality Guidelines 2006* provide a range of percentile values based on data from all the sites within that zone. This provides a useful first estimate of background conductivity within a zone. However, even within zones there is a degree of variation between streams, and therefore the values for the zone would still need to be ground-truthed against local values.

11. Temperature varies both daily and seasonally; it is depth-dependent and is also highly site-specific. It is therefore not possible to provide simple generic water quality objectives (WQOs) for this indicator. The recommended approach is that local WQOs be developed. Thus, WQOs for potentially impacted streams should be based on measurements from nearby streams that have similar morphology and which are thought not to be impacted by anthropogenic thermal influences. From an ecological effects perspective, the most important aspects of temperature are the daily maximum temperature and the daily variation in temperature. Therefore, measurements of temperature should be designed to collect information on these indicators of temperature, and similarly, local WQOs should be expressed in terms of these indicators. Clearly, there will be an annual cycle in the values of these indicators, and therefore a full seasonal cycle of measurements is required to develop guideline values.

12.5.4 Existing situation

Water quality description based on the EHMP

Water quality description was based on the Ecosystem Health Monitoring Program (EHMP) run by the SEQ Healthy Waterways Partnership. The water quality stations assessed were located along the estuary of the Mooloolah River. It should be noted that the proposed project traverses the Mooloolah River catchment for only 35% of its length; however, data from this particular catchment is considered representative of catchments in the area. The stations themselves were chosen to give a general overview of the water quality for estuary waters in the Mooloolah River catchment.

The EHMP water quality program assesses ecosystem health for major catchments and river estuaries in SEQ. This program also highlights if the health of specific SEQ waterways is improving or regressing.

In addition, the EHMP water quality monitoring program in the vicinity of the study area in the Mooloolah River catchment has been operating since 2001. The EHMP measures and reports on waterway health using a range of biological, physical and chemical indicators of ecosystem health. EHMP also reports on nutrient levels for each catchment.

Figure 12-4 shows the EHMP Mooloolah River catchment and estuary water quality monitoring sites.

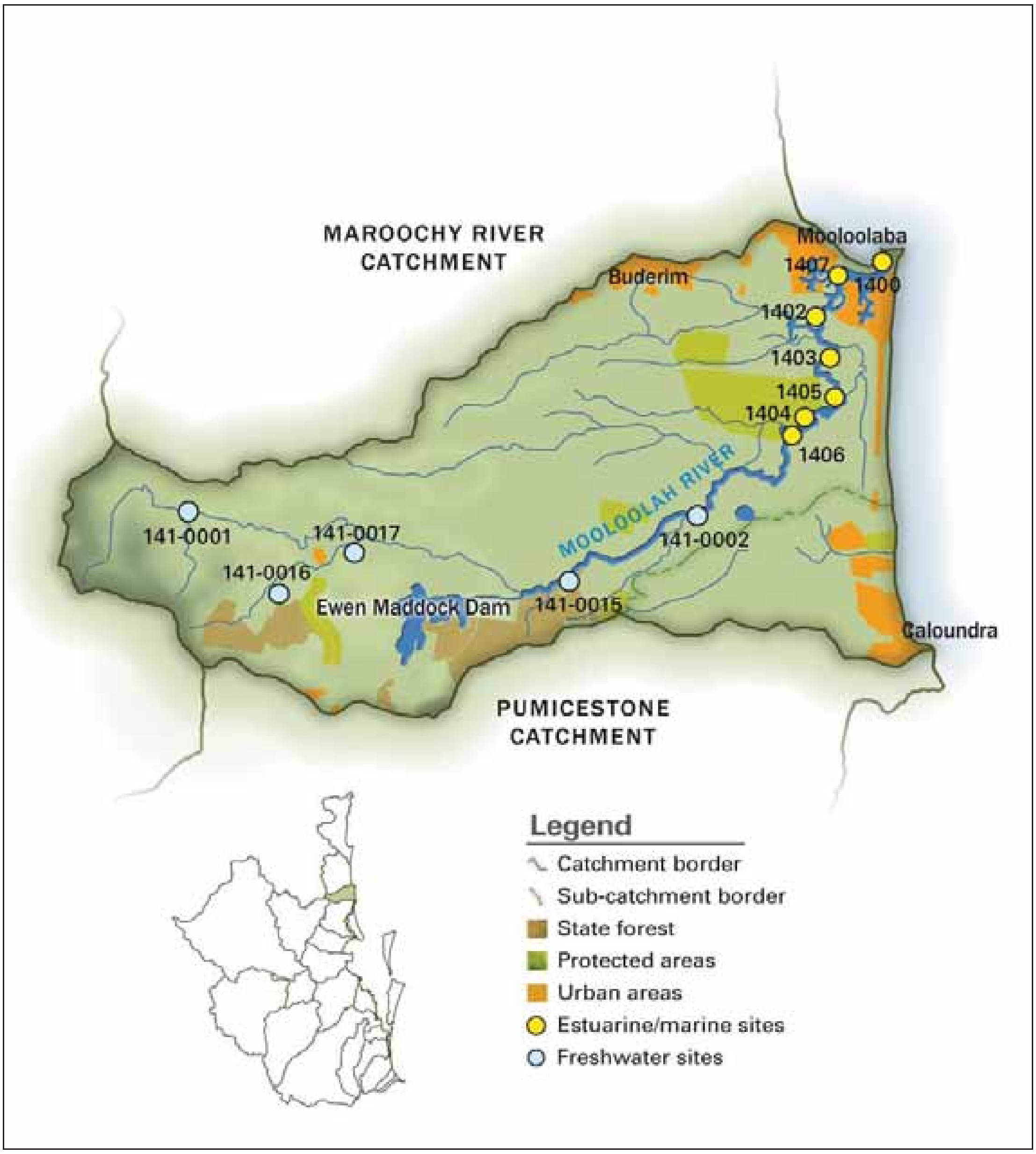


Figure 12-4: EHMP Mooloolah River catchment monitoring sites reproduced from the Healthy Waterways Partnership (2007)

Technical reports have been obtained from the Healthy Waterways Partnership website, which commenced in 2002. Results from monitoring since that time have been referenced. Healthy Waterways Partnership has a grading system that is briefly summarised in Table 12-4.

Table 12-4: Grading system

Grade	Classification
A – Excellent	All critical habitats in pristine condition
B – Good	Ecosystem health values: most critical habitats intact
C – Fair	Ecosystem health values: some critical habitats are impacted
D – Poor	Ecosystem health values: many critical habitats impacted
F – Fail	Most critical habitats severely impacted

Table 12-5 show the health scores achieved in the estuary section of Mooloolah River.

Table 12-5: Mooloolah River Healthy Waterways Partnership health scores

Year	Estuary health score
2002	B
2003	B-
2004	B-
2005	B
2006	B
2007	B
2008	B

Table 12-5 shows that the water quality in the Mooloolah River (estuary) has remained fairly constant since monitoring began in 2002. The ratings indicate that the performance of the estuarine water quality over the last couple of years was ‘good’.

The Mooloolah River (estuary) water quality profile reproduced from Healthy Waterways Partnership (2006) is shown in Figure 12-5.

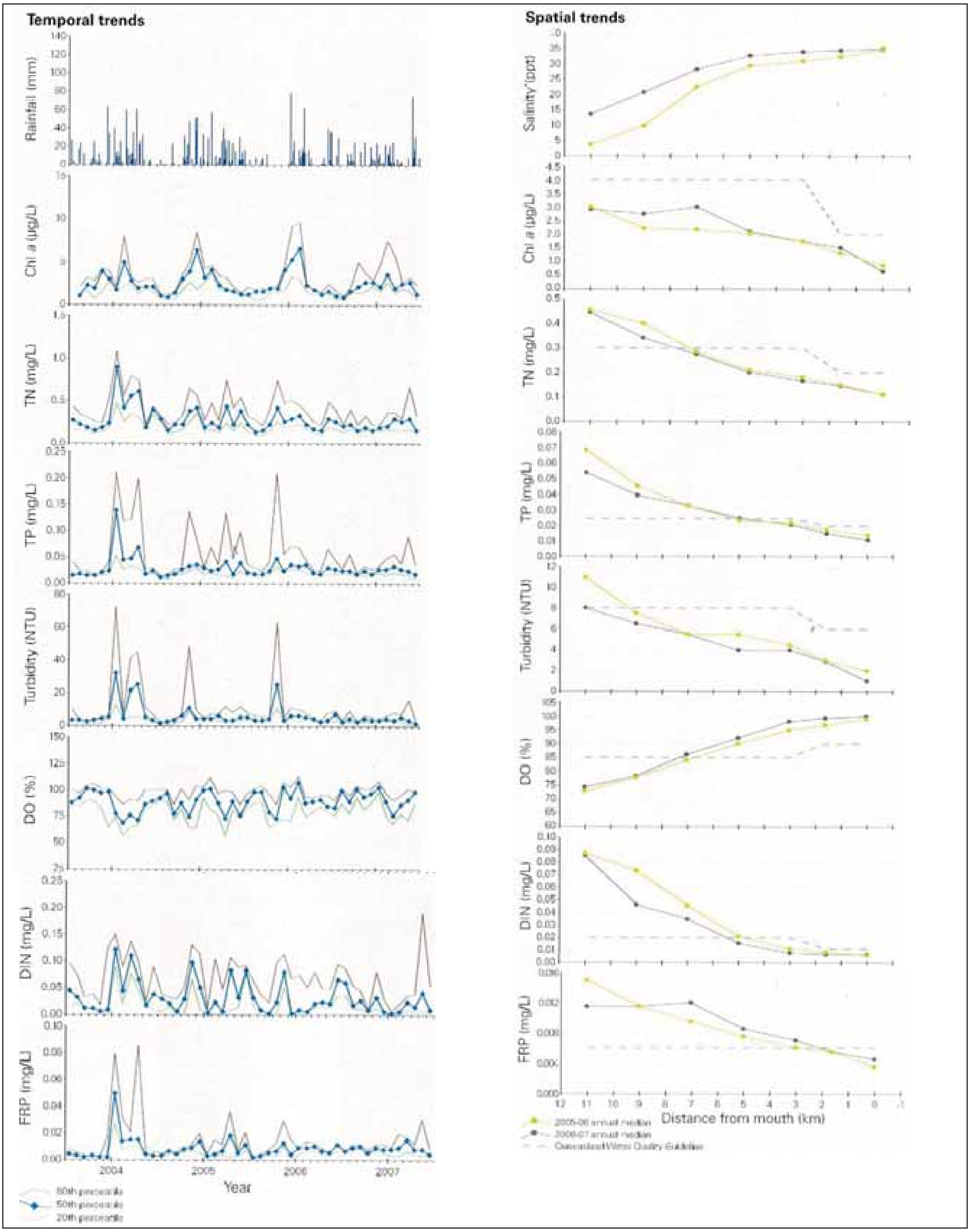


Figure 12-5: Mooloolah estuary water quality profile for 2006–2007 reproduced from Healthy Waterways Partnership (2007)

The water quality compliance against the WQOs to key chemical indicators within the estuary is summarised in Table 12-6.

Table 12-6: Maroochy River key indicator compliance

Key indicator	% Compliance (2007)
Total phosphorous (TP)	45
Total nitrogen (TN)	77
Chlorophyll a	100
Dissolved oxygen	70
Turbidity	100

There is insufficient data available to discuss the existing water quality in terms of seasonal variations or variations with flow.

12.5.5 Potential impacts and mitigation measures

Corridor-wide potential impacts

The corridor-wide potential impacts in relation to water quality issues are:

- soil erosion and sediment transportation and deposition that may have the following effects on the environment:
  - on-site effects: loss of top soil, buried vegetation and buffer zones, and increased flooding, silting and bank damage to trench works (on construction sites), increased downtime on construction sites after storm events, visual impact, siltation and loss of storage capacity (i.e. sedimentation dams)
  - off-site effects: siltation in some weirs, siltation of watercourses and aquatic habitats, introduction of exotic weed species, irregular and unstable land forms due to gully and bank erosion, increased pollution of streams, adverse ecological effects of de-silting of waterways, reduced ecological and aesthetic value of waterways and bushland.
- oil spills along the corridor
- surface water run-off from the corridor containing gross pollutants, suspended solids, nutrients, heavy metals and hydrocarbons
- local drainage infrastructure incapable of handling the volume of run-off from a catchment
- failure to divert waterways during the construction that will result in clogged drainage infrastructure and increased flooding, as well as silting and bank damage to trench works (on construction sites)
- disturbances to natural watercourses and riparian zones.

Corridor-wide mitigation measures

The corridor-wide mitigation measures in relation to water quality issues are:

- early planning and construction of temporary drainage system to minimise erosion and avoid delays in initial earthworks
- plans for both temporary and permanent drainage, including design capacities, identification of all proposed temporary and final overland flow paths, and any proposed diversions of overland flow paths of watercourses
- diversion of upslope water to reduce on-site erosion, reduce total volume of contaminated run-off requiring treatment and reduce downtime following prolonged rain event
- development and application of erosion and sediment control plans (ESCPs) including:
  - clear definition of soil and water management problems — including existing site conditions, soil and climatic data, critically on-site erosion-prone areas, location of the nearest and other relevant environmentally sensitive areas
  - clear interpretation of proposed control measures, including the following actions — minimise disturbance; provide drainage, erosion and sediment control; implement effective revegetation; undertake effective implementation of an approved ESCP
  - provision of a locality plan identifying the development, staging of works and temporary erosion control measures (in event of unforseen construction delays)
  - development of recognised approval processes
  - maintenance and supervision of ESCP implementation, and undertaking scheduled inspections
  - monitoring the effectiveness of ESCP, including diary notes/logbook entries of control techniques used on-site, and water quality sampling (i.e. upstream and downstream. Downstream sampling should not be limited to the immediate downstream point, but should include full travel path of sediment-laden run-off
- implementation of a treatment train that includes a number of stormwater quality improvement devices (SQIDs). Ideally, this would include infiltration systems, longitudinal vegetated swales, bioretention devices, and gross pollutant traps. However, the lack of available space and the lack of hydraulic gradient within the stormwater drainage system may limit the types of SQID to gross pollutant traps and infiltration devices where space permits. The limited options may mean that water discharged from road surfaces may not meet conventional water quality objectives, but they would mitigate the adverse impacts of increasing the road surface area and increasing traffic volumes
- proper management of treatment train is required to ensure that the SQIDs continue to operate as intended
- construction and maintenance of in-line interceptors to capture potential oil spills
- implementation of the revegetation plan to establish a weed-free groundcover for disturbed areas that will be a self-regenerating and sustainable erosion control.

It is recommended that an erosion and sediment control plan (ESCP) be formulated for construction works in the corridor in recognition of the scale of the works and constraints within the corridor.

12.6 Future investigations

Future investigations, design work and liaison with other authorities will be required to progress the future stages of planning and design for the project.

12.6.1 Liaison with authorities

PB (2008) report nominates design criteria for flooding, water quality, and drainage issues. This currently recommends that the proposed corridor upgrade should result in a 'non-worsening' condition with localised improvements to improve flow widths and depths at bus stop locations.

The following is recommended to facilitate agreement on the nominated design criteria.

- liaison with SCRC and the Department of Transport and Main Roads regarding current design capacities and the design criteria approach
- data collection from SCRC and the department to obtain catchment extents, design flows, capacities of the existing drainage systems, and current road flows for the design event in the areas affected by the corridor proposals. This data may be difficult to obtain or unavailable, and the quality of data received cannot be adequately foreseen.

12.6.2 Water quality monitoring program

It is recommended that the surface water quality monitoring program be developed to assess the existing surface water quality (in relation to project area), to any changes during the construction and operation stages to be identified. This task will include:

- outlining associated catchments in terms of their drainage density, land cover, land use and slope
- assessing the project area to determine appropriate water quality sampling locations associated with the condition of the waterways and catchments for the ambient assessment
- outlining the sampling frequency
- developing a water quality monitoring schedule.

12.6.3 Future analysis and design

Analysis and design work of drainage systems is typically undertaken using the Rational Method and Hydraulic Grade Line (HGL) analysis of the piped system.

Dynamic modelling (e.g. using XP-Storm or equivalent) is also recommended for the areas of low elevation, and where:

- stormwater retention is likely to attenuate peak flow rates
- significant inundation of the area occurs (typically during rarer more severe events).

Future investigations, design work and liaison with other authorities will be required to progress the future stages of planning and design for the CoastConnect — Caloundra to Maroochydore project, including the following:

- liaise with relevant authorities
- confirm design criteria with relevant authorities
- determine the baseline water quality for the project area
- undertake MUSIC modelling to develop appropriate stormwater treatment design that meets the required WQOs
- collate and summarise available data in terms of current pipe capacity and overland flows within roadways for the relevant design event
- determine suitable discharge locations and alignments for any required additional drain lines
- undertake modelling (Rational Method & HGL) to determine the capacities of systems for which design data is not available or incomplete, and to determine the capacity of the altered drainage system resulting from the corridor upgrading
- should the capacity of downstream drainage infrastructure be compromised by the corridor upgrade, consider options for further relief drainage works
- apply results of analysis into detailed design of operational works.

Further consideration of climate change impacts should be made; this is particularly relevant for Section 7 (Maroochydore). Due to the widespread regional effects of the potential sea level rise, a regional cooperative approach involving other stakeholders may be beneficial. Confirmation is required concerning what allowances for climate change should be made in the design of the stormwater drainage system and stormwater quality treatment system.

12.7 References

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