APPENDIX D

Water Quality Management Plan and additional survey and assessments for Marcoola Drain

APPENDIX D

MARCOOLA DRAIN
WATER QUALITY (SALINITY) MANAGEMENT PLAN

1 BACKGROUND

1.1 Tailwater Design and Methodology

This management plan has been prepared as part of the Additional Environmental Impact Statement (AEIS) to mitigate and monitor potential salinity impacts from the release of dredge tailwater into the Marcoola Drain and Maroochy River during the construction phase of the Sunshine Coast Airport Expansion Project (AEP).

The construction methodology for the AEP will involve the hydraulic placement of clean sand from Moreton Bay onto the Sunshine Coast Airport site. The sand will be transported from the hopper of the dredge vessel onto the site via an enclosed pipeline using fluidisation water sourced from the pumpout area offshore of Marcoola Beach. Seawater will be used for fluidisation water.

The fluidisation water (also called dredge tailwater) will be gradually drained from the reclamation site through a series of bunded reclamation cells and into a settlement polishing pond at the northwest terminus of the runway reclamation footprtint. This pond will be connected to the proposed new Northern Perimeter Drain via a weir box structure so as to control flow out of the tailwater off the site. Dredge tailwater quality will be tested in the settlement pond prior to release off the site for key water quality parameters including turbidity, pH and dissolved oxygen.

The tailwater will mix with any fresh or brackish water that is present in the Northern Perimeter drain before leaving the site via the Marcoola Drain. The Marcoola Drain was originally a cane drain that has been converted into an artificial waterway to drain the golf course and associated development at Marcoola. The open cut drain is tidal with flows partially constricted by a culvert under Finland Road (Figure 1). Upstream of the culvert is the northern section of the Mount Coolum National Park.

Figure 1 Marcoola Drain Culvert under Finland Road

Salinity in the Upper Maroochy River and Marcoola Drain is highly variable, and is controlled by freshwater inputs and tidal advection. Salinity within Marcoola drain ranges from 0 ppt (freshwater) to 35 ppt (seawater), varying over time and along the length of the drain.

The Northern Perimeter drain outlet to the Marcoola Drain is located on Airport land at the downstream end of the drain, close to the Maroochy River. The location for the outlet is approximately:

- 450 meters upstream of the Maroochy River
- 650 metres downstream of the culvert under Finland Road and Mount Coolum National Park

A diagram showing the proposed tailwater polishing pond, Northern Perimeter Drain, Marcoola Drain, Finland Road culvert and the Mount Coolum National Park is shown in Figure 2.

Figure 2 Locality Plan

The tailwater discharge system has been designed as follows:

- Average discharge rate from the pond into the northern perimeter drain = 0.3 – 0.7 m^3/s
- Retention volume of approximately 100,000 m^3 to 150,000 m^3 for the tailwater pond (noting larger volumes of fluidisation water can be kept on the broader site in the reclamation cells)
- This provides 1 – 2 days of retention in addition to the broader reclamation site and will be mixed with any stormwater collected on the site during construction

A range of dredge plant could be used to carry out the construction works. The EIS outlined how different size dredges would impact on the construction duration and programme (see Table 1). The most likely dredge plant that would be used for the project is 10,000 to 12,500 m^3 capacity which would see the dredging (and associated tailwater discharge from the reclamation site) completed in 9.5 to 12.5 weeks (less than three months). This contrasts with the much longer (and hence greater impact) duration assumed during preparation of the EIS of 33 weeks.

Table 1 Hopper Capacity of Different Dredge Plant and Effect on Dredging Duration

		Hopper Capacity (m³)				
Assessment Criteria		2,900 (e.g. The Brisbane dredger)	8,000-10,000	10,000-12,500	12,500-17,500	17,500-25,000
Draft (m)			8.0 – 9.1	8.5 – 10.0	9.8 – 12.1	10.4 – 11.9
Dredging duration – 1.1 M m³ (no prior dredging)	weeks	Up to 33	10.5-14	9.5-12.5	7.5-10	7-9

1.2 Environmental Values and Impact Predictions

As outlined in the section above, the key environmental values that may be affected by the tailwater discharge into the Marcoola Drain are as follows:

- The instream aquatic ecology (flora and fauna) values of the lower Marcoola Drain
- The instream aquatic ecology (flora and fauna) values of the upper Marcoola Drain (upstream of the culvert) including riparian areas of the National Park
- The downstream aquatic ecology (flora and fauna) values of the Maroochy River which is a Fish Habitat Area

To assess the potential impacts from salinity on the Marcoola Drain and Maroochy River from the tailwater discharge, a conservative 33 weeks was modelled (using the small TSHD *Brisbane* as the design dredge) as a 'worst' case.

Numerical modelling undertaken as part of the EIS and subsequent modelling assessment undertaken for the AEIS, indicate that primary risk of impacts to these environmental values is from elevated salinity levels during tailwater release which is the focus of this management plan.

Based on modelling it is predicted that median salinity would increase from 3.5 ppt to 26 ppt over the course of the year (note that average seawater salinity is approximately 35 ppt). The largest changes to salinity are predicted to occur downstream of the Finland Road culvert, with smaller changes predicted to occur upstream of the Finland Road culvert.

In the Maroochy River, it is predicted that tailwater discharge would result in very minor increases in salinity compared to existing conditions, and negligible increases in the lower estuary. These changes are well within the natural variations observed at each site.

Findings of the marine ecology chapter of the EIS relevant to these increased salinities in the Marcoola Drain were as follows:

- While Marcoola Drain is a highly modified waterway, it provides various habitats for estuarine flora and fauna, and will continue to do so during construction.
- While tolerant to natural variability in salinity, temporary and minor effects to benthos and fish community structure are predicted, favouring brackish/euryhaline over freshwater (salt-sensitive) species.
- Freshwater macrophytes and emergent vegetation susceptible if increased salinities persist, but will likely resume this patchy downstream distribution on completion of the works, given the ongoing supply of propagules from upstream.
- No major impacts to mangroves are expected given the short duration of works, and salt tolerance of species present.

- The local benthic fauna community is expected to be temporarily dominated by the species that are tolerant of marine salinity conditions. This would represent a temporary impact, and benthic fauna community would be expected to revert to a euryhaline-dominated (e.g. brackish) community shortly after the completion of construction works.
- Estuarine fish species are typically highly mobile and tolerant of a wide salinity range.

In addition to salinity, the tailwater will also be monitored (at the point of discharge in the settlement pond) for other key water quality parameters including: turbidity/total suspended solids, pH, dissolved oxygen and for selected water chemistry parameters (Al, Fe and other dissolved metals).

These monitoring regimes are outlined in the ASS Framework Management Plan and Water Quality component of the EMP. Discharge standards for these parameters are expected to be confirmed as part of relevant permits to be obtained for the works subsequent to a decision on the EIS.

As discussed elsewhere in the Appendix D (refer Technical Memoranda by BMT WBM and Core Consultants), increased salinity associated with the tailwater discharge is not expected to impact off-stream terrestrial environments on the basis that:

- Additional modelling and interrogation of surveys have confirmed that the volumetric capacity of the Marcoola Drain is sufficient that there is no additional risk of bank overtopping during the tailwater phase; with only minor increases in drain water level at low tide on the order of an addition 0.1m; and
- There is a net flow of groundwater toward the drain most of the time and any ingress of drain water into the surrounding groundwater would be limited by its short duration and low hydraulic gradient and would be flushed by effluent fresh groundwater during intervening low drain water levels.

2 MANAGEMENT PLAN

The following management plan (Table 2) has been prepared to provide additional mitigation and monitoring of potential impacts on environmental values in and adjacent to the Marcoola Drain and to validate the findings of the EIS during construction.

Table 2 Water Quality (Salinity) Management Plan for Marcoola Drain

Issues	The management plan has been developed to address potential salinity impacts for the discharge of tailwater from the Northern Perimeter Drain of the Airport into the Marcoola Drain and Maroochy River. This plan applies during the construction phase of the project when dredge tailwater is being pumped to the airport site.
Management Objectives	The objective of this plan is to protect environmental values in the following locations: • The instream aquatic ecology (flora and fauna) values of the lower Marcoola Drain which is a predominantly estuarine environment • The instream aquatic ecology (flora and fauna) value of the upper Marcoola Drain (upstream of the culvert) including riparian areas of the National Park which are generally brackish to freshwater in nature • The downstream aquatic ecology (flora and fauna) values of the Maroochy River which is a Fish Habitat Area.

	This is to be achieved through: • Implementation actions to mitigate the potential impacts; • Implementation of a reactive monitoring programme for salinity with corrective actions to be undertaken by the contractor if set trigger points are exceeded • Implementation of other monitoring requirements
Statutory Requirements	The discharge of tailwater into the Marcoola Drain is not an environmentally relevant activity under the *Environmental Protection Act 1994*, but must address relevant requirements of the EPP Water as it relates to the discharge of contaminants to water. There are no surface water quality objectives for salinity set for the Maroochy River or Marcoola Drain under the EPP Water, but noting that the waters in the adjacent National Park (groundwater) are High Ecological Value and are required to maintain salinity based on 20^{th}, 50^{th} and 80^{th} percentile values. The waters of the Maroochy River are included within a Fish Habitat Area under the *Fisheries Act 1994.* The tailwater discharge is not expected to affect any matters of National Environmental Significance under the EPBC Act including downstream water mouse habitat along the Maroochy River. The Marcoola Drain and riparian areas do not provide known habitat for any species of NES including wallum sedgefrog or freshwater fish of conservation significance.
Performance Indicators	• Carrying out baseline water quality monitoring programme • No long term change or impacts occur to the environmental values of the Marcoola Drain, National Park and Maroochy River • Short term, temporary impacts from tailwater discharge are avoided, minimised or otherwise mitigated in accordance with this Plan
Implementation Activities	The following actions will be implemented as part of the tailwater construction phase – (a) Installation of a tidal gate (or similar structure)[1] on the Marcoola Drain culverts under Finland Road. This device will be operated as follows: 1) During the initial tailwater discharge period (~ 4 weeks) while monitoring data is being collected, the gate will be closed during and immediately following tailwater discharge periods to protect the upstream drain 2) The gate will be opened when tailwater is not being discharged (to allow normal fish movement to the extent such movement is occurring through the

[1] It is noted that this structure or apparatus is likely to require approval as a waterway barrier pursuant to the *Fisheries Act 1994*

	culvert at present) 3) The gate will be designed to allow freshwater flood flows through the culvert at all times (and not cause or contribute to any upstream flooding) 4) If it can be demonstrated through monitoring during the initial discharge period (~ 4 weeks) that there is no issue with increased salinity (due to tailwater discharge) upstream of the culvert, then the gate can remain open at all times - unless trigger values are exceeded during the reactive monitoring programme (b) Implementation of a reactive monitoring programme (as outlined below) with the instigation of corrective actions if trigger levels set as part of the reactive monitoring programme are exceeded.
Monitoring Activities	This section includes details about: (a) baseline water quality monitoring; and (b) a proposed reactive monitoring plan **(a) Baseline Monitoring** Baseline (*in situ*) continuous salinity (temperature and depth) monitoring is to be undertaken for a period of at least six months prior to construction at the following locations (refer to Figure 3): • In the Maroochy River near the confluence with Marcoola Drain • At the outlet of the Northern Perimeter Drain with the Marcoola Drain (downstream end) • At the culvert under Finland Road in the Marcoola Drain (which is the approximate downstream boundary of the Mount Coolum National Park). • At one site upstream of the culvert in the Marcoola Drain adjacent to the National Park (where possible coincident with the extent of normal tidal influence in the drain)

Figure 3 Indicative Monitoring Points (represented by blue triangles)

The data collected as part of the baseline monitoring campaign will be used to better define the natural variability of the system (in terms of salinity) and to determine the relevant water quality statistics for salinity (i.e. 20th, 50th, and 80th percentile values). These values will be used as management response triggers during construction.

As outlined in the Framework ASS Management Plan, groundwater wells will be established at two locations along the Drain (one on airport land and one in the Mount Coolum National Park). These wells will be monitored during construction following a baseline data collection campaign to ensure any increased salinity in the drain is not having an effect on groundwater resources in adjacent terrestrial areas.

(b) Reactive Monitoring Programme

Salinity monitoring will continue during the construction phase at the same locations as the baseline monitoring programme. Trigger values for in-stream salinity set as part of the baseline monitoring programme above will be used to trigger corrective actions where the above mitigation is not effective to maintain salinity at acceptable levels in the upstream section of the drain (upstream of the Finland Road culvert).

Management response triggers (for corrective actions) will be defined using the baseline data under the following response framework –

- Exceedance of the 50th percentile (median) of salinity upstream of the Finland Road culvert for a period of 48 hours – trigger investigation of the likely cause of exceedance. Continue monitoring.
- Exceedance of the 80th percentile of salinity upstream of the Finland Road culvert for a period of 48 hours – instigate corrective actions.

	Following confirmation of the cause of the exceedance, the key corrective actions will include one or more of the following: • Discharging of tailwater on ebbing tide only (which will maximise mixing of the tailwater with the River) • Imposing additional periods where the tidal gate is closed (e.g. following discharge periods or during larger than average high tide events) in order to limit the ingress of saline water into the upper drain • Halting or suspending discharge from the site until water quality conditions are more conducive to accepting the discharge (e.g. following tidal flushing or rain events). The key corrective actions listed above will also be triggered for investigation if any of the following visual monitors are observed during the tailwater discharge period: • The occurrence or detection of flooding from the tailwater discharge (over bank within the Marcoola drain or Northern Perimeter Drain) • The occurrence of fish kills in the Marcoola Drain or Maroochy River • The occurrence of any dieback of riparian vegetation upstream of the culverts or in the Maroochy River
Review and Reporting	The water quality monitoring equipment will be automated to provide *in situ* continuous measurements during the construction period. These will be automated through telemetry to provide results to the contractor and the site environmental supervisor (see below) A weekly compliance report will be provided from the contractor to the site supervisor including details of any exceedances and the implementation of corrective actions Exceedances of statutory requirements (exceedance of performance targets set by the conditions of approval) will be notified in accordance with permit conditions. An overall compliance report detailing the implementation of the water quality monitoring programme will be prepared and provided to the relevant regulatory agency (DEHP) at the conclusion of the construction period.

3 ROLES AND RESPONSIBILITIES

The following entities will be involved in the implementation of this Plan:

Dredge Contractor

The Dredge Contractor will manage the tailwater discharge out of the settlement pond and will likely install and maintain all water quality monitoring equipment to be used in the pond and in the Marcoola Drain.

All monitoring of water quality shall be carried out by a suitably qualified person, using appropriate calibrated equipment to collect samples that are representative of the discharge or background conditions.

The Contractor will also likely be responsible for the design and installation of the tidal flap structure on the Finland Road culverts and its operation during the construction period.

The dredge contractor will prepare an operational plan that addresses the requirements of this plan and any other statutory requirements related to tailwater quality associated with the AEP.

The contractor will provide weekly updates and report to the Environment Site Supervisor (ESS) with respect to the implementation of this plan.

Environment Site Supervisor (ESS)

The ESS will be appointed by the Sunshine Coast Airport to oversee the construction works. The ESS will be responsible for the collection of the baseline data collection, setting the triggers for corrective actions and ensuring compliance with all permits and permissions that arise from the project.

The ESS will oversee the Dredge Contractor during the works, including:

- Monitoring the in-situ water quality data collected in the drain
- Overseeing the investigation of exceedances and the implementation of any corrective actions
- Visual monitoring of the additional matters identified in the Plan (e.g. flooding, dieback and fish kills)
- Carrying out at periodic audits of the Contractor
- Undertaking required reporting as outlined in the management plan

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Technical Memorandum

To:	SCA	From:	Dr Michael Barry
Attention:	Simon Kinchington	Date:	22nd April 2015
Subject:	**Marcoola Drain**		

BMT WBM was requested to investigate the impact of a proposed tailwater discharge to Marcoola Drain from reclamation works on:

(1) Overtopping potential from the drain

(2) Salinity changes in the upper portion of the drain

This memo responds to this request.

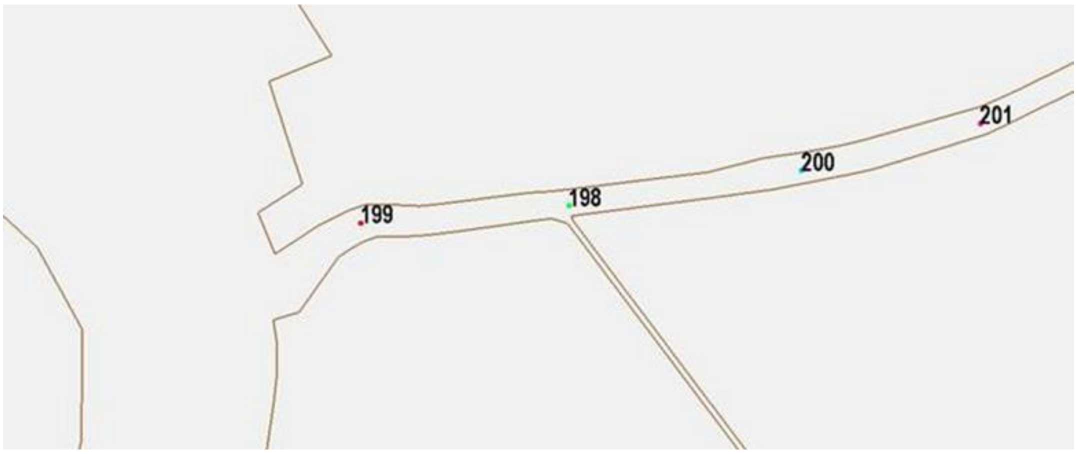
1 Overtopping potential

Two simulations were set up and executed to investigate this matter. They were:

- Base case (pre works)
  - No tailwater discharge
- As presented in the EIS
  - Continuous tailwater discharge over 33 week period within the simulation

Results are presented below as:

- Timeseries of the water levels in the drain at points presented below labelled 198 to 201 inclusive.



  These timeseries also include the known drain bank height as a solid red line. The bank height was advised to be 1.3-1.7m AHD by AECOM via email.

- Percentile distributions of these water levels data is presented over.

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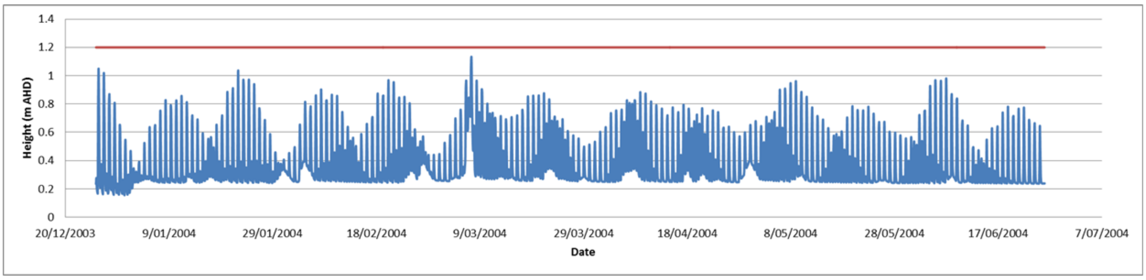
A part of BMT in Energy and Environment

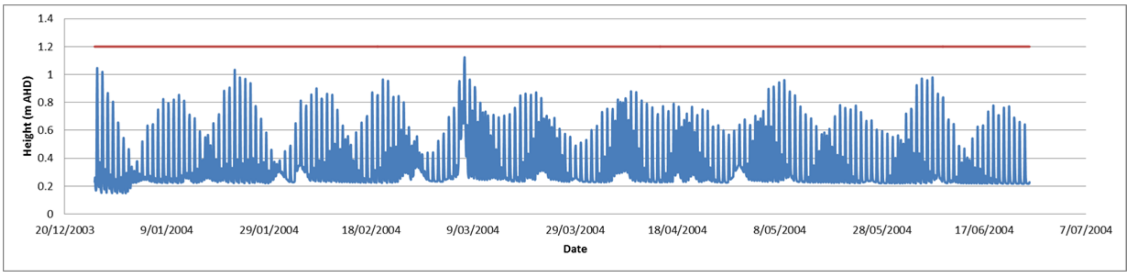
Timeseries

Blue and red lines are model predicted water level and bank height, respectively.

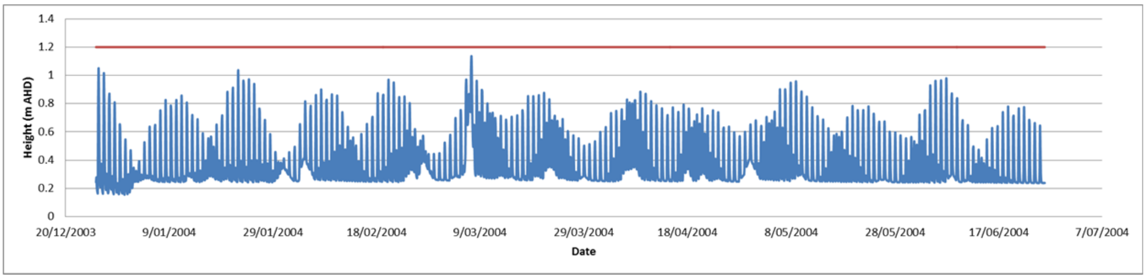
Point 198



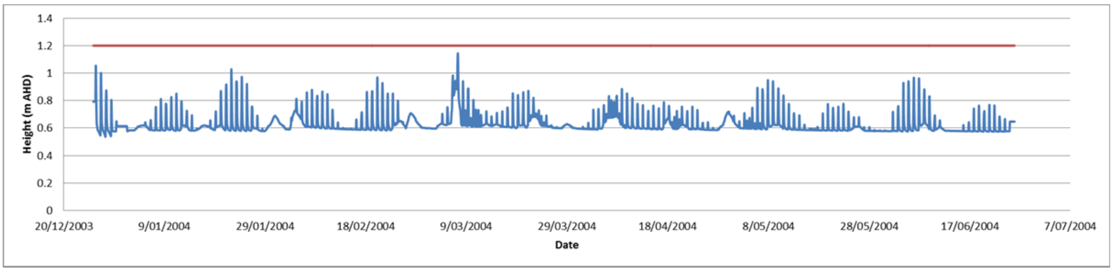
Point 199



Point 200



Point 201



The water level spike event March 2004 is due to catchment inflows, and appears in the Base Case as well as the tailwater scenarios. The spike is not related to the tailwater.

A zoomed in figure of several tidal cycles is shown below. Dark and light blue lines are modeled baseline and tailwater scenarios, respectively.

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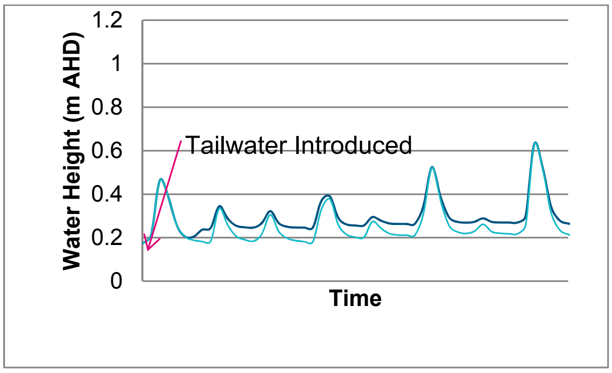
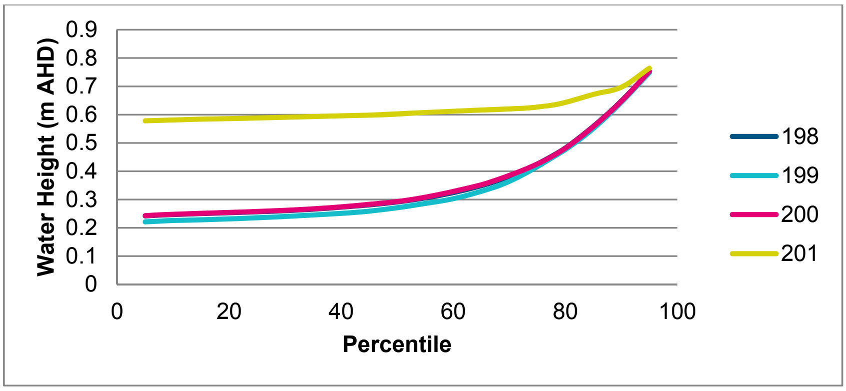


Percentile distributions



1.1 Key findings

The above show that there will be:

- Some minor increases in drain water level at low tide, and will be in the order of 0.1 m as a *maximum*
- No observed increases in water level at high tide
- Water levels do not reach the drain bank levels under any circumstances other than during a major rainfall (and hence inflow) event of 100 mm in one day in March 2004, where overflows (or close to it) are also predicted in the base case simulation.

In summary, the simulations predict there to be no additional risk of bank overtopping due to the tailwater discharge.

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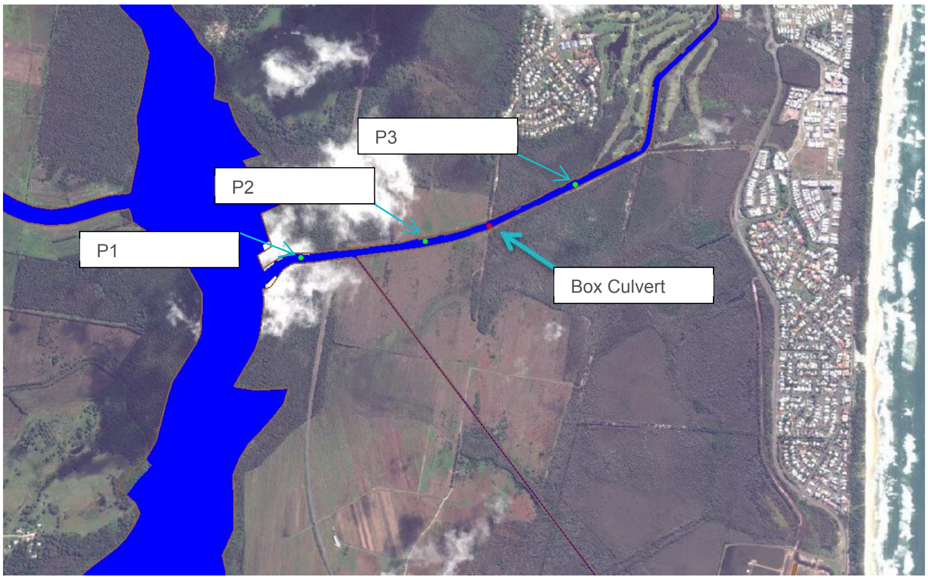
2 Upper Marcoola drain salinity

Three 6 month simulations were set up and executed to investigate this matter. They were:

- Base case (pre works)
  - No tailwater discharge
- As presented in the EIS
  - Continuous tailwater discharge over 33 week period within the simulation
- As presented in the EIS, but with alteration of the tailwater discharge
  - Tailwater discharge over 33 week period within the simulation
  - Discharge only on ebbing tides, at double the flow rate of the EIS (to conserve volume)

Results are presented below as:

- Timeseries extracted from 3 locations in Marcoola drain (as below) for all three simulations. These locations were chosen to represent regions: upstream of the Finland Road culvert; between the culvert and the perimeter/Marcoola drain confluence; and downstream of the perimeter/Marcoola drain confluence.



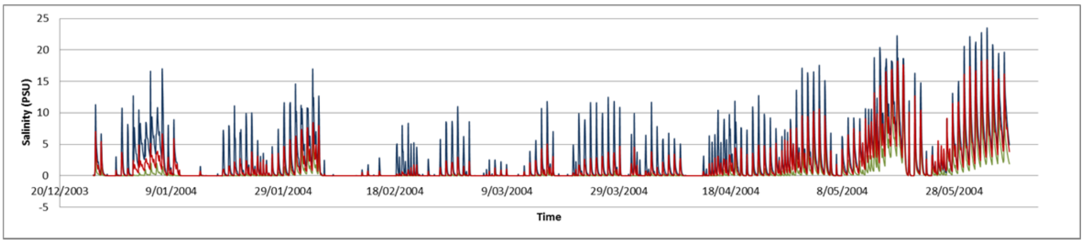
- Percentile distributions of these timeseries
- Spatial colour contour maps of average salinity over the entire simulation period (all have been presented on the same colour scale to allow easy comparison)

Data are presented over.

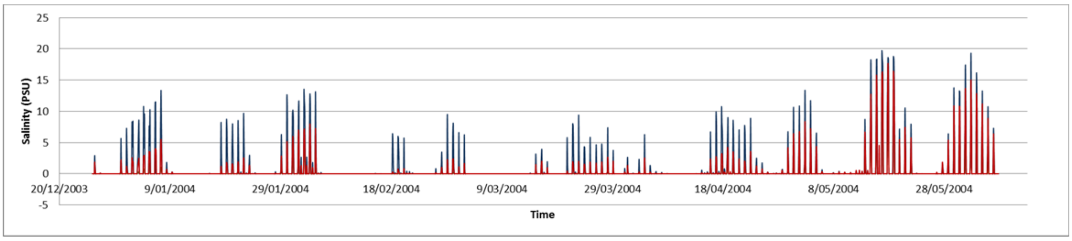
Timeseries

Green, blue and red lines are model predicted scenarios for baseline, constant tailwater discharge and ebb water discharge, respectively.

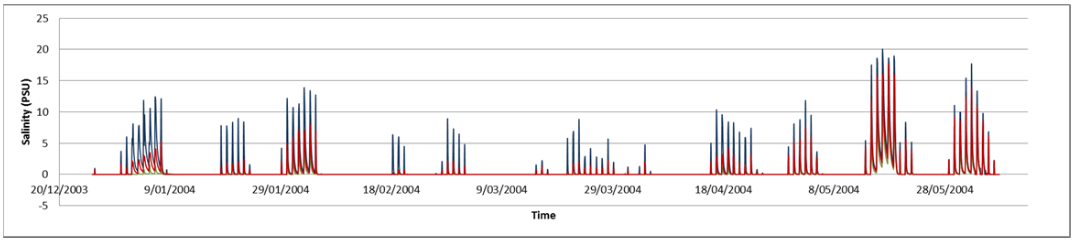
Point 1



Point 2



Point 3



Data was extracted from each model and mean, median and maximum values for the three scenarios at all three points are displayed below.

		Point 1	Point 2	Point 3
Baseline	Mean	0.960	1.318	0.537
	Median	0.070	0.091	0.011
	Max	17.085	16.183	15.950
EIS	Mean	2.792	3.407	1.209
	Median	0.759	0.602	0.015
	Max	23.098	19.624	19.912
Ebb	Mean	1.735	1.992	0.780
	Median	0.361	0.351	0.014
	Max	18.229	17.627	17.475

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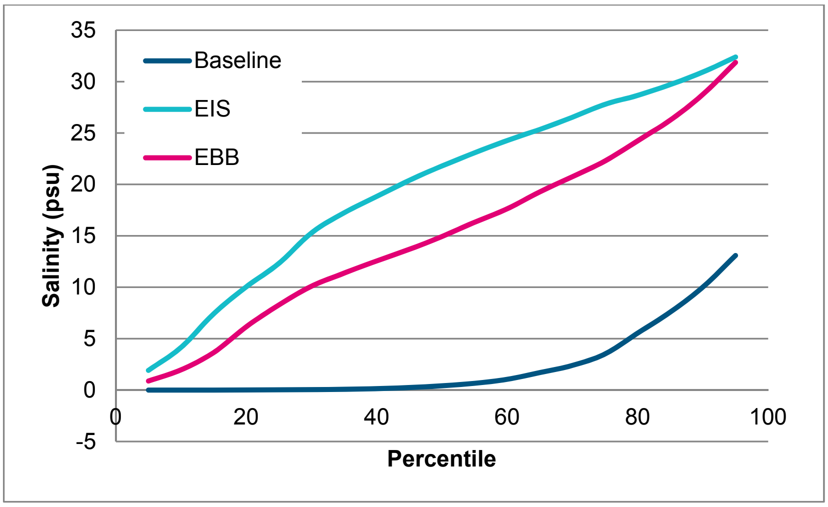
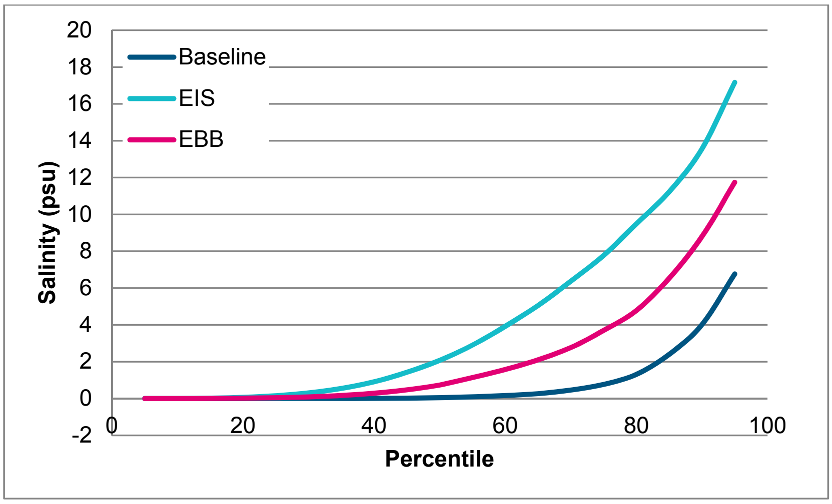
Percentile distributions

Note: Scales for salinity are not the same for each of the three points, for clarity of presentation.

Point 1



Point 2



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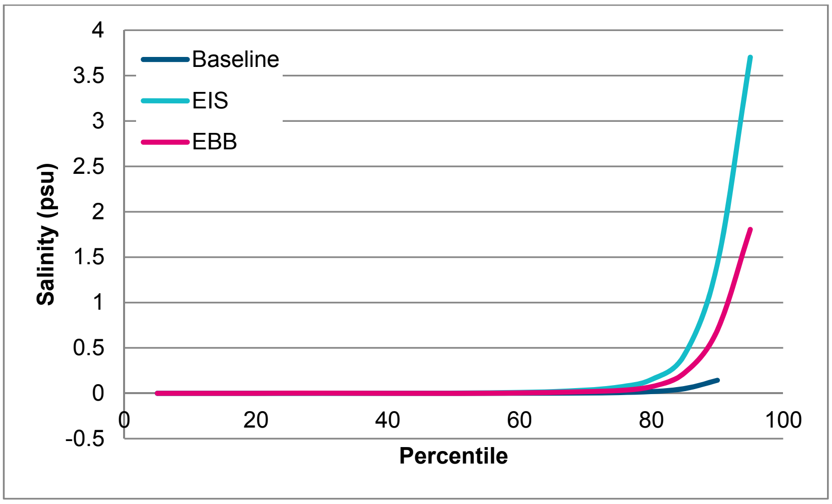
Point 3



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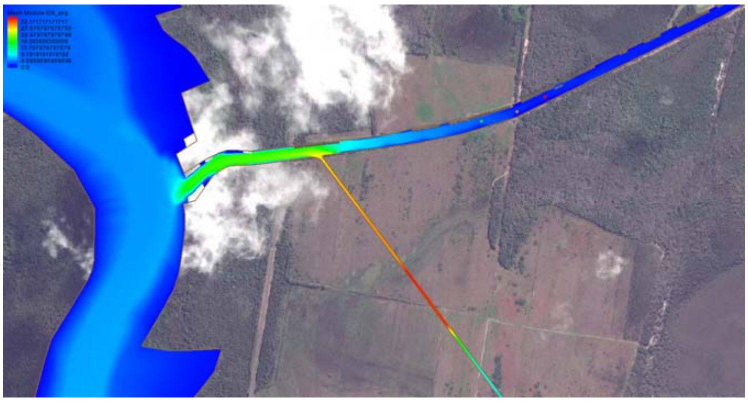
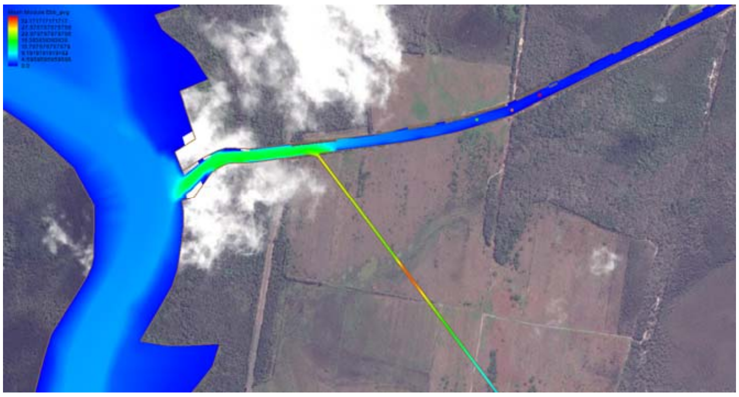
Colour contour maps

Scenario	Model Output
Base Average	
EIS Average	
Ebb Average	

2.1 Key findings

The above show that, as per Chapter B6 of the EIS:

- There are salinity increases upstream of the perimeter/Marcoola drain confluence and the Finland Road culvert
- These increases vary in time (depending on tidal state and inflow dynamics from other catchments) from zero to approximately 5 psu as a *maximum*. This variation is due to tidal flushing and

demonstrates that there will be no ongoing accumulation of salt upstream of the culvert as a result of the tailwater discharge.

- Mean and median salinity increases upstream of the culvert in both the EIS and ebb tide discharge case are approximately 0.5 psu and 0.002, respectively, over the simulation period.

In considering potential mitigation for their impacts, the simulation results show that an ebb tide discharge of the tailwater can result in a considerable reduction in salinity increases predicted above the culvert. For example, the instantaneous maximum salinity increases (over base case) observed at the upstream site are 3.96 and 1.53 psu for the EIS and Ebb tide mitigation measure simulations, respectively.

These findings support this mitigation measure as a feasible corrective action as outlined in the proposed water quality management plan for Marcoola drain, if required.

core consultants
clarity • commitment • passion

TECHNICAL MEMORANDUM

DATE 22 April 2015 **REFERENCE No.** J000030-002-TM-Rev0

TO Simon Kinchington (Simon.Kinchington@sunshinecoast.qld.gov.au)

CC Greg Fisk (Greg.Fisk@bmtwbm.com.au)

FROM Walter Mastenbroek (WMastenbroek@coreconsult.com.au)

GEO-ENVIRONMENTAL SERVICES, SUNSHINE COAST AIRPORT EXPANSION PROJECT GROUNDWATER IMPACTS – MARCOOLA DRAIN

Dear Simon,

This letter report presents results of an assessment of groundwater impacts from discharge of tail-water into the Marcoola drain, in response to queries from the Department of Environment and Heritage Protection on the Environmental Impact Statement for the above project.

1.0 EXISTING CONDITIONS

1.1 Previous investigations

Information provided by BMT WBM indicate that water depths in the drain range between about 0.2 m (0.1 m AHD; lowest low tide) up to about 1 m (0.9 m AHD; highest high tide).

Ground conditions in borehole BH1/13[1] approximately 50 m from the Marcoola drain comprise sand to a depth of about 1.8 m below ground level (-0.3 m AHD), underlain by a layer of very dense indurated sand ('coffee rock') of about 2 m thick, over sand and clayey sand to the investigation depth.

Groundwater quality monitoring undertaken as part of the EIS process shows that groundwater on the site is generally fresh (< 700 mg/L).

Groundwater levels in borehole BH1/13 recorded between August 2013 and April 2014 ranged between about 0.4 m and 1.1 m below ground (1.1 m and 0.4 m AHD). The groundwater level measurements indicate a significant response to rainfall and a smaller response to tidal variation in Marcoola drain.

Existing site conditions are shown as a conceptual diagram in Figure 1.

1.2 Discussion

Surface water in the Marcoola drain is subject to tidal influence from diurnal tidal variations via the Maroochy River. Groundwater adjacent to the Marcoola drain is considered to be in dynamic equilibrium with the surface water in the drain. Regional groundwater levels are predominantly influenced by the area's moderate to high rainfall, due to the permeable nature of the alluvial soils and relatively flat topography.

Based on the results of previous investigations, it is considered that under existing conditions there is a net flow of groundwater towards the drain most of the time, i.e. the potentiometric groundwater gradient is largely effluent at most times.

During some temporary short-term conditions, however, low groundwater levels may occur at the same time as high drain water levels. The potentiometric gradient under these temporary conditions would be influent (i.e. drain water level higher than groundwater level) to static (i.e. drain water level corresponding to groundwater level; no gradient).

Ingress of drain water into the surrounding groundwater during temporary influent conditions would be limited by the short duration (only at high tide, say for a few hours at a time) and low hydraulic gradient (maximum

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hydraulic gradient of about 0.6 m). Interaction of potentially saline drain water with fresh groundwater during periods of static gradients would be limited by short duration, and very low rates of diffusion (anticipated to be in the order of less than 10 millimetres per hour). Potential salinity impacts are likely also flushed by effluent fresh groundwater during intervening low drain water levels.

This is supported by the low groundwater salinity measurements recorded during the EIS site investigations.

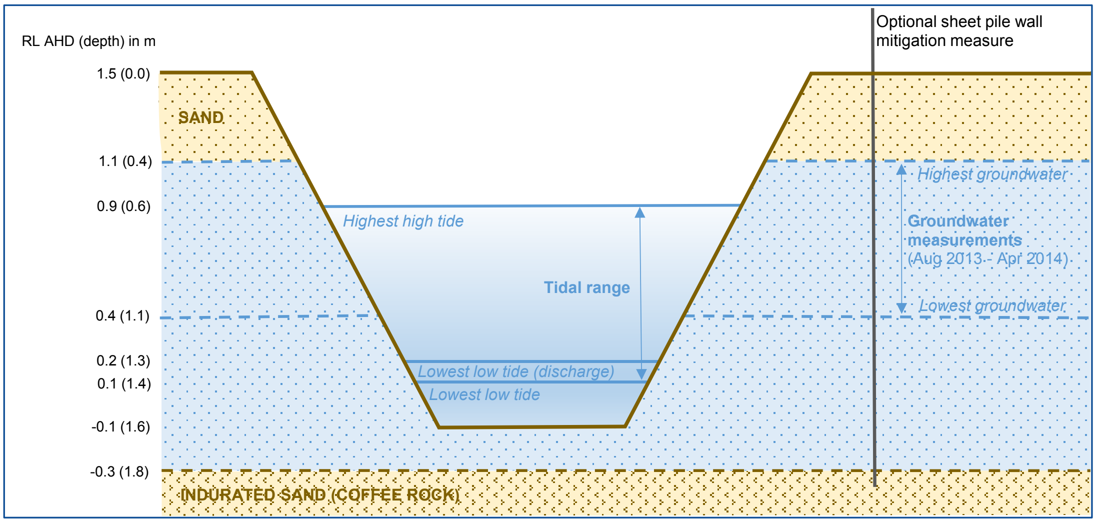

Figure 1: Conceptual diagram of subsurface conditions at Marcoola drain (not to scale)

2.0 PROPOSED CONSTRUCTION WORKS

2.1 Surface water modelling

BMT WBM have provided results of surface water modelling in the Marcoola drain (refer M B21223 001). Key findings from that modelling are the following:

- Discharge of tail-water (from hydraulic fill placement) into the Marcoola drain will only raise the overall water level in the drain at low tide (by 0.1 m as a maximum), with no significant difference at high tide. (This is defined as *Lowest low tide (discharge)* on Figure 1)
- There are salinity increases in Marcoola drain as a result of discharge of tail-water, which vary in time (depending on tidal state and inflow dynamics from other catchments) from zero to approximately 5 practical salinity units (psu) as a maximum

2.2 Groundwater risk assessment

An assessment of the risk of tail-water discharge into Marcoola drain impacting the salinity of surrounding groundwater was carried out in accordance with the assessment criteria provided in the Sunshine Coast Airport Expansion Project Environmental Impact Statement document[2].

The risk assessment is summarised in Table 1, and discussed below.

Impact	Likelihood	Significance	Risk
Drain water level increase impacting groundwater salinity	Highly Unlikely	Moderate	Low
Drain water salinity increase impacting groundwater salinity	Possible	Minor	Low

[1] Refer Chapter B3, Sunshine Coast Airport Expansion Project, Environmental Impact Statement
[2] Refer Table 3.6b, Sunshine Coast Airport Expansion Project, Environmental Impact Statement

Modelling shows little change in drain water levels as a result of discharge of tail-water (less than 0.1 m raise at low tide level only). The likelihood of a resulting impact on groundwater salinity is therefore considered *Highly Unlikely*, with *Moderate Significance*, resulting in ***Low*** assessed risk.

In addition, it is considered *Possible* that the modelled temporary, short-term increase in average drain water salinity would impact surrounding groundwater salinity. The significance of such an impact is considered *Minor*, due to a combination of the net flow of groundwater towards the drain in most circumstances; short duration and low hydraulic gradient of influent conditions; very low rates of diffusion, and the flushing effect during effluent groundwater conditions. The resulting assessed risk is ***Low***.

3.0 RECOMMENDATIONS

It is recommended that monitoring of groundwater levels and salinity be undertaken from standpipes installed adjacent to the Marcoola drain during the discharge period, particularly at or close to the nearby national park.

Criteria for implementation of mitigation measures should be established based on assessments of groundwater-dependent fauna or flora to salinity impacts.

Such mitigation measures could comprise installation of a plastic (HDPE) sheet pile wall, which would significantly reduce the potential for lateral interaction between drain water and surrounding groundwater, and address potential salinity impacts in the national park. The sheet piles would have to be founded into coffee rock or be installed at greater depth if coffee rock is absent.

4.0 CONCLUSION

It is our opinion that there is a ***Low risk*** of tail-water discharge impacting surrounding groundwater salinity.

Groundwater monitoring is recommended during the discharge phase, with implementation of mitigation measures (i.e. sheet piles) if pre-established groundwater criteria are exceeded.

Your attention is drawn to the document *Limitations*, attached.

Yours faithfully,

CORE CONSULTANTS PTY LTD

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Attachments: Limitations

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Technical Memorandum

To:	Sunshine Coast Airport	From:	Paul Dubowski
Attention:	Simon Kinchington	Date:	17 April 2015
Subject:	Marcoola Drain Ecological Characterisation		

1 Marcoola Drain Environmental Assessment

1.1 Background

Marcoola Drain is an artificial waterway that drains the Mount Coolum Golf Club, surrounding urban areas and Sunshine Coast Airport. As outlined in the Sunshine Coast Airport Expansion EIS, it is proposed that saline tailwater from the runway construction site be released into Marcoola Drain, which ultimately reports to the Maroochy River.

The EIS notes that there is distinct spatial gradient in aquatic communities along the drain, reflecting spatial variations in the relative degree of influence of tidal and catchment processes on salinity and hydrology. The downstream reach of the drain had an estuarine ecological character with mangroves dominating the riparian zone, whereas areas upstream of Finland Road had vegetation communities that were more freshwater to slightly brackish in character.

The EIS predicts that the release of tailwaters would temporarily increase salinity within the drain, resulting in measurable effects to any species that are sensitive to elevated salinity. Regulatory agencies have raised concerns regarding the potential for saline tailwater (nominally at levels found in seawater) to effect ecological receptors within the drain and its riparian zone.

An environmental assessment was undertaken in April 2015 to further assess potential impacts on the ecological values of Marcoola Drain and adjacent ecosystems from tailwater discharges (construction) and stormwater runoff (construction/operational) from the airport site. This information is intended to inform the water quality monitoring program outlined in this AIES. The specific objectives of this assessment are to:

- Characterise spatial patterns in community structure of instream and riparian vegetation along the upper reaches of drain
- Provide a snap-shot assessment of spatial patterns in salinity along the drain.

A fauna survey did not form part of the scope of this assessment although it is noted that Gambusia holbrooki (plague minnow), were clearly evident throughout the drain (from David Low Way to the Finland Road culverts).

1.2 Methodology

1.2.1 Habitat Assessment

An assessment of vegetation in Marcoola Drain was undertaken by a qualified ecologist on Wednesday 8th April 2015. The survey area is shown in Figure 1. The assessment was limited to the drainage reserve which does not form part of either adjoining freehold lands or national park.

The extent of the drain which was inspected included:

- The eastern drain from David Low Way to the confluence with the northern drain
- The main branch of the drain upstream of Finland Road culverts.

The northern drain which flows through the Mt Coolum Golf Club was not inspected. The survey area focused on two distinct habitats namely:

- The aquatic habitat including up to the approximate high water mark, hereafter referred to as the aquatic habitat
- From the approximate high water mark to the top of the bank, hereafter referred to as the riparian habitat.

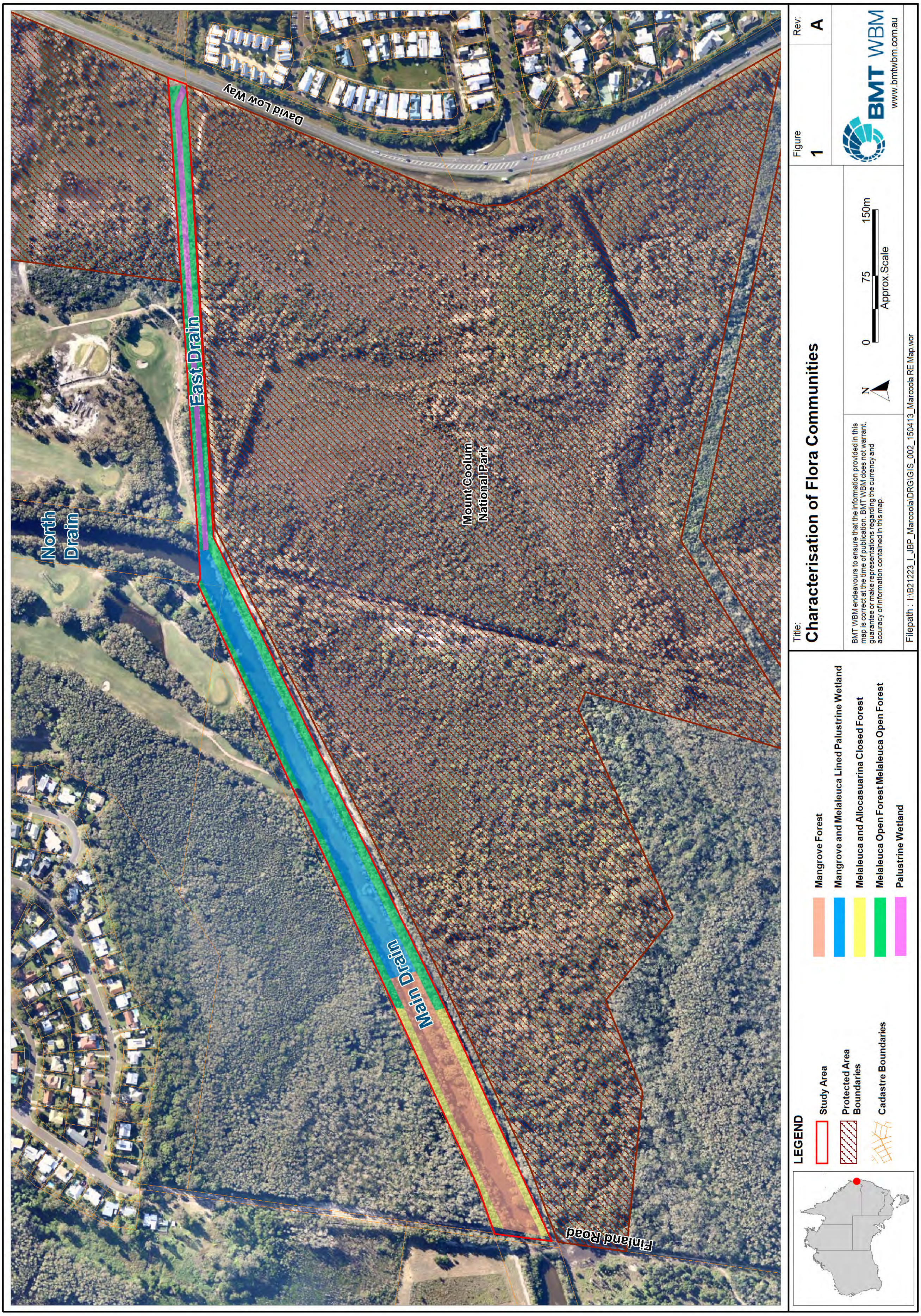
The status and condition of vegetation was verified using quaternary level site assessments (Neldner et al., 2012). Quaternary site assessments are used primarily as a record of field traverses and to verify RE/vegetation mapping. Dominant species were recorded for each strata present at sampling sites in order of dominance with their height and cover/abundance estimated.

1.2.2 Water Quality Measurements

An assessment of limited water quality parameters in Marcoola Drain were tested on Wednesday 8th April 2015. Water quality testing was undertaken using a calibrated Yeo-Cal water quality instrument. Five locations were sampled as shown in Figure 2.

Physical and chemical water quality parameter measurements were measured in situ using a calibrated Yeo-Cal multi-parameter sonde. The sonde house multiple probes that simultaneously measured temperature, electrical conductivity, dissolved oxygen (percent saturation), depth, pH and turbidity. Other parameters are not measured directly but calculated by the sonde, namely: salinity, which is calculated using specific conductivity and temperature; and dissolved oxygen which is calculated using temperature, salinity and dissolved oxygen percent saturation.

Measurements were taken around the morning high tide which occurred at 10:08 AM (1.47m AHD) on the day of sampling. At the completion of the survey, the instrument was thoroughly inspected and any significant damage was noted in order to compare with reported values. Raw data were saved in a Microsoft Excel data file.


David Low Way
East Drain
North Drain
Main Drain
Mount Coolum National Park
Finland Road
LEGEND
Study Area
Protected Area Boundaries
Cadastre Boundaries
Mangrove Forest
Mangrove and Melaleuca Lined Palustrine Wetland
Melaleuca and Allocasuarina Closed Forest
Melaleuca Open Forest Melaleuca Open Forest
Palustrine Wetland
Title:
Characterisation of Flora Communities
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
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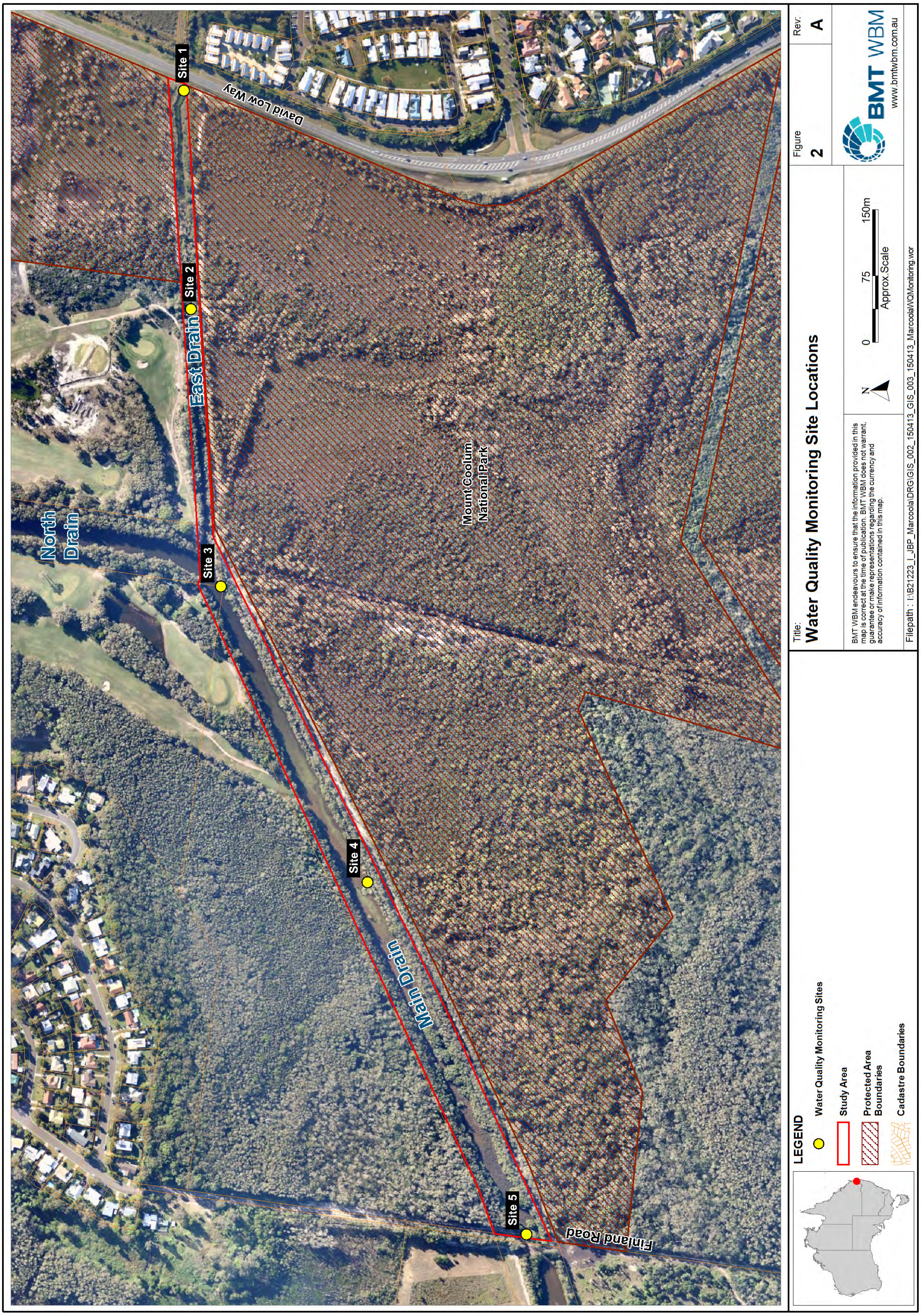
APPENDIX D

Water Quality Management Plan and additional survey and assessments for Marcoola Drain (continued)



1.3 Vegetation and Habitat Assessment Findings

Table 1 is a list of vegetation species recorded in the present study. The following describes structural characteristics of vegetation communities in the survey area, which are mapped in Figure 1.

1.3.1 Riparian Habitat Ecosystems

1.3.1.1 Melaleuca open forest

This vegetation type consisted of *Melaleuca quinquenervia* open forest, which is analogous with RE 12.2.7 (least concern). Other canopy species included *Allocasuarina littoralis, Acacia leiocalyx, Alphitonia excelsa* and *Melaleuca bracteata*. A dense shrub layer was present along the upper, narrow reach of the drain although no one species dominates. Shrubs included *Baeckea frutescens, Persoonia virgate, Hovea acutifolia, Banksia robur, Leptospermum liversidgei, Leucopogon pedicellatus, Hakea actites* and *Melastoma malabathricum* subsp. *malabathricum*. Along the lower reach of the drain, the same shrub layer was present albeit at much lower density and lower species richness. The shrub layer was almost completely absent

The ground layer along the banks of the upper drain included *Gleichenia dicarpa* and *Lygodium microphyllum,* which co-dominated to form dense thickets. Other ground layer species included *Gahnia sieberiana, Imperata cylindrical, Lycopodiella cernua, Drosera* sp. As with the shrub layer, the ground layer in the lower reach of the drain was less dense and generally had slightly lower species richness.

Figure 3 Examples of *Melaleuca* open forest

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Table 1 List of vegetation species recorded in the present study, and vegetation types where species were recorded

Species Name	Common Name	Melaleuca Open Forest	Melaleuca/ Allocasuarina closed forest	Mangrove forest	Mangrove/ Melaleuca + Palustrine Wetland	Palustrine wetland
Trees						
Acacia leiocalyx	Black wattle	X				
Allocasuarina littoralis	Black sheoak	X	X		X	
Allocasuarina glauca	Swamp oak		*X*		*X*	
Alphitonia excelsa	Red ash	X				
Avicennia marina	Grey mangrove			*X*	*X*	
Eucalyptus robusta	Swamp mahogany		X			
Melaleuca bracteata	Black tea tree	X				
Melaleuca quinquenervia	Broad-leaved paperbark	X	X			X
Shrubs						
Baeckea frutescens	Weeping baeckea	X				
Banksia robur	Swamp banksia	X	X			
Hakea actites	Wallum hakea	X	X			
Hovea acutifolia	Pointed-leaf hovea	X				
Leptospermum liversidgei	Swamp may	X	X			
Leucopogon pedicellatus	Wallum beard heath	X	X			
Melastoma malabathricum subsp. malabathricum	Blue tongue	X	X			
Persoonia virgate	Geebung	X	X			
Ferns						
Acrostichum speciosum	Mangrove fern			X	X	
Blechnum indicum	Bungwall	X	X			X
Gleichenia dicarpa	Pouched coral fern	X				
Lygodium microphyllum	Climbing maidenhair fern	X	X			
Lycopodiella cernua	Coral fern	X				
Other groundcovers						
Gahnia sieberiana	Red-fruit saw-sedge	X	X			
Imperata cylindrica	Blady grass	X				
Drosera sp.						X
Macrophytes and aquatics						
Baloskion pallens	Pale chord rush					X

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Species Name	Common Name	Melaleuca Open Forest	Melaleuca/ Allocasuarina closed forest	Mangrove forest	Mangrove/ Melaleuca + Palustrine Wetland	Palustrine wetland
Callitriche stagnalis	*Water starwort*				*X*	*X*
Ceratopteris thalictroides	*Water fern*					*X*
Charus sp.					X	X
Cyperus digitatus	*Red-root flatsedge*					*X*
Eleocharis equisetina	*Spikerush*				*X*	*X*
Eleocharis sp.						
Juncus kraussii	*Sea rush*				*X*	
Lepironia articulata	Grey sedge					X
Ludwigia sp.						
Nymphoides caerulea	Blue waterlilly				X	X
Nymphoides gigantean	*Giant waterlilly*				*X*	*X*
Nymphoides indica	*Water snowflake*				X	X
Persicaria attenuata	*White smartweed*					*X*
Philydrum lanuginosum	*Frogsmouth*					*X*
Phragmites australis	Common reed					X
*Pistia stratiotes**	*Water lettuce*				*X*	
*Salvinia molesta**	Giant salvinia				X	X
Schoenoplectus litoralis	*Mangrove clubrush*			*X*	*X*	*X*
Schoenoplectus mucronatus	*Star clubrush*					X
Sporadanthus interruptus						X
*Typha orientalis**	Cambungi					X

* Species introduced to Queensland

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This vegetation community type was recorded along the upper banks and landward areas immediately adjacent, along the middle and upper reach of the main drain (Figure 1). This vegetation type occurred landward of mangroves and Melaleuca lined palustrine wetland, and would not typically be tidally inundated. On this basis, it is not expected that tailwater releases into the drain would influence this community type.

1.3.1.2 Melaleuca and Allocasuarina closed forest

This vegetation community type consisted of *Melaleuca quinquenervia* open forest to woodland, which is analogous with RE 12.3.5a (least concern). Co-dominant species include *Melaleuca quinquenervia, Allocasuarina glauca* and *Allocasuarina littoralis* with occasional *Eucalyptus robusta*. The shrub layer and ground layer are mostly absent although species observed include *Blechnum indicum, Lygodium microphyllum* and *Gahnia sieberiana*.

Figure 4 Examples of *Melaleuca* and *Allocasuarina* closed forest

This vegetation community type was recorded along the upper banks, and areas immediately landward, along the lower reach of the main drain (Figure 1). This vegetation type occurred landward of mangrove forest, and would not typically be tidally inundated. On this basis, it is not expected that tailwater releases into the drain would influence this community type.

1.3.2 Aquatic Habitat Ecosystems

1.3.2.1 Mangrove forest

This vegetation community consisted of open low closed mangrove forest typically RE 12.1.1 (of concern). This vegetation type was dominated by grey mangrove *Avicennia marina* and mangrove fern *Acrostichum speciosum*, whereas the wider section of the channel also had a high cover of club rush *Schoenoplectus litoralis*.

Examples of ecosystem in narrow closed forest

Examples of ecosystem wider open section including drain

Figure 5 Mangrove forest vegetation types

This vegetation type was present in tidal waters in the downstream section of the main drain (Figure 1). This vegetation type was also the dominant instream vegetation type immediately downstream of the Finland Road culverts. The vegetation species present are typical of saline, tidally influenced wetland environments, and are tolerant of regular inundation.

1.3.2.2 Mangrove and Melaleuca lined Palustrine Wetland and Pools

This vegetation type consisted of palustrine wetland with canopy margins co-dominated by *Avicennia marina, Melaleuca quinquenervia* and to a lesser extent by *Allocasuarina littoralis* and *Allocasuarina glauca*. This ecosystem would also be analogous with RE 12.3.8 if not for the presence of mangrove species. Open water was co-dominated by *Nymphoides* and various *Charus* species. Sub-dominant species included *Schoenoplectus litoralis, Pistia stratiotes, Salvinia molesta, Callitriche stagnalis* and *Eleocharis* sp. A shrub layer was absent although *Acrostichum speciosum* and *Juncus kraussii* dominated the sparse ground cover along the drain margins.

This vegetation type was recorded in the middle and upstream sections of the main drain (Figure 1). This vegetation type represents an ecotone between the tidally influenced mangrove forest in the downstream section of the main drain, and freshwater palustrine wetland in upstream areas (i.e. the East Drain). The presence of mangroves indicates that this area was tidally affected, however the co-dominance of species typically found in brackish water and freshwater environments (*Melaleuca quinquenervia,* *Allocasuarina littoralis* and *Allocasuarina glauca)* suggests that this area would not regularly experience highly saline conditions.

1.3.2.3 Palustrine wetland

This palustrine wetland type had dense emergent macrophyte cover and limited open water sections, and was analogous to RE 12.3.8 (of concern). This ecosystem was dominated or co-dominated by *Eleocharis equisetina, Lepironia articulata, Typha orientalis* and *Blechnum indicum*, while in more open water areas, *Nymphoides* sp., *Charus* sp. and *Callitriche stagnalis* dominated. *Melaleuca quinquenervia* lined the margin of the drain with *Phragmites australis* dominating the disturbed margin in the upstream reach near the David Low Way culverts. Other less common species observed include *Schoenoplectus mucronatus, Cyperus digitatus, Persicaria attenuata, Baloskion pallens, Salvinia molesta, Philydrum lanuginosum, Ceratopteris thalictroides* and *Drosera* sp.

The palustrine wetland vegetation type was restricted to instream sections of the East Drain. While some species may tolerate brackish water conditions, this vegetation type can be broadly described as a freshwater wetland. An increase in salinity in this area would expect to result in the loss of salt sensitive species.

Examples of ecosystem along open water reaches

Examples of ecosystem along drain margins

Examples of ecosystem along drain margins to high water mark

Figure 6 Mangrove and Melaleuca lined palustrine wetland

Nymphoides sp and *Phragmites australis* dominant community

Blechnum indicum and *Typha orientalis* dominant community

Lepironia articulata dominant community

Eleocharis equisetina dominant community

Figure 7 Palustrine wetlands

1.4 Water Quality

Table 2 provides *in situ* water quality measurements. In summary, these measurements indicate:

- There was a salinity gradient along the length of the stream. All sites could be classified as 'freshwater' at the time of sampling, although site 5 in the lower reach of the study area was close to brackish (oligosaline, *sensu* Blackman et al. 1992).
- pH was slightly acidic at most sites (pH 6.5-6.8) except site 5 in the lower reach which was acidic (pH 5.5).
- Dissolved oxygen concentrations were highly variable throughout the study area. The two upstream sites (sites 1 and 2) had low dissolved oxygen concentrations (24-25% saturation), which were at levels unconducive for supporting most fish and many invertebrate species. Sites 3 and 4 had good dissolved oxygen concentrations (97% saturation), whereas the downstream site 5 had low dissolved oxygen (54%), which would cause stress to many fish and invertebrate species.

Table 2 Water quality measurements

Site	Time	Time Since High Tide (hh:mm)	Depth	Temp. (°C)	Cond. (mS/cm)	Cond. (µS/cm)	Salinity (ppt)	pH	DO (% sat)	DO (mg/L)
1	09:40 AM	-0:28	0.3	22.80	0.29	335	0.14	6.85	24.8	2.1
2	10:30 AM	0:22	0.2	22.14	0.29	332	0.14	6.67	25.2	2.2
3	11:25 AM	1:17	0.2	22.55	0.32	382	0.16	6.51	97.7	7.7
4	12:05 PM	1:57	0.2	27.45	0.38	439	0.19	6.51	97.9	7.9
5	12:40 PM	2:32	0.2	24.62	0.66	732	0.33	5.52	53.8	4.4

It is important to note that the water quality survey represents a one-off snap-shot that would not necessarily be representative of long term conditions. The survey was conducted during the wet season, and 106.8 mm of rain was recorded at Sunshine Coast Airport in the week prior to surveys (Figure 8). This high rainfall would have resulted in lowered salinities and pH values within the drain during sampling compared to 'typical' conditions, noting the presence of salt-tolerant mangrove and melaleuca vegetation communities in the middle and upstream areas of the main Drain (as discussed in section 1.3.2.3 above).

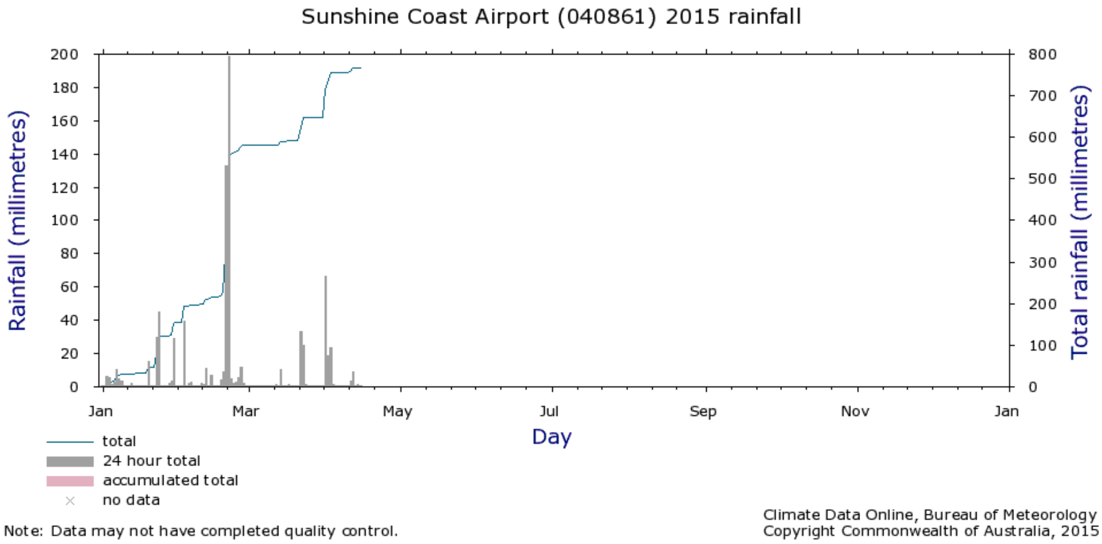

Figure 8 Rainfall at Sunshine Coast Airport (Bureau of Meteorology 040861)

1.5 References

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