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Australia

## **Review of Environmental Issues in the Catchment of the Coochiemudlo Island ‘Melaleuca Wetlands’**

**Client:** Coast Care Coochiemudlo Island  
C/- Vivienne Roberts-Thomson (President)  
Coochiemudlo Island, QLD. 4184

## Purpose of the Report

There have been two engineering reports commissioned by Council which consider Ground Water (GW) issues with respect to leachate from a retired landfill (unsupervised), and possibly from a previous borrow pit, up catchment from the RAMSAR designated Melaleuca Wetlands contiguous and which extend to the boundary of the Moreton Bay Marine Park in the Norfolk Beach environs. There is a waste transfer station on the balance area of this site active at present, but any environmental issues resultant from this activity are not considered in this review.

The focus of this review has two principal subject areas which are:

- With regard to GW issues, do the two engineering investigations commissioned by Council provide robust and comprehensive data to formulate environmental risk assessment, the suitability of which will suffice to protect the RAMSAR designated Melaleuca Wetlands; and
- Juxtaposition of the scientific database for the Wetlands with engineering recommendations for management of the site and whether these recommendations are sufficient to protect species of significance identified in this RAMSAR designated Melaleuca Wetland<sup>1</sup>.

The RCC engineering reports referenced here are:

- EGIS (2001) *Landfill Remediation Assessment Program* for Redlands Shire Council; and
- GHD (2017) Coochiemudlo Island Waste Disposal Facility Groundwater Monitoring Event<sup>2</sup>.

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<sup>1</sup> Refer **Appendix 1** – *Essential Habitat* mapping.

<sup>2</sup> *Letter Report*

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## Context

Coochiemudlo Island had an unsupervised landfill site operating at what was Lot 45 SL 8606 (43 – 99 Elizabeth Street) in the period 1972 – 1994. Since the landfill closed, the site has been capped with subsequent construction of a croquet lawn, tennis courts and a playing field. This means that a previous RSC borrow pit, and now retired landfill, are beneath these facilities.

Questions are now being raised about any persistent environmental health risks, in most part driven by increasing awareness of the significance of this RAMSAR designated Melaleuca Wetland down catchment from these facilities i.e. the level of scientific knowledge which has now been assembled post 1994 by groups such as Coast Care raising concerns about the conservation of this area.

The situation today is that the facilities described above, comprising the ‘Laurie Burns Recreational Reserve’, provide a significant community asset, while the ‘balance’ area is used as a waste transfer station, which is not under consideration in this review.

The primary purpose of this review is to juxtaposition the considerable scientific knowledge of the RAMSAR designated Melaleuca Wetland’s fauna with the environmental engineering investigations and consequent engineering approach to ongoing site management.

A fundamental principle to this review will be the recurrent theme of ‘what are we trying to protect/conservé’, not adherence to some ‘recognized’<sup>3</sup> guideline levels i.e. ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters (1992), or Environmental Quality Objectives in the Netherlands (1994), as designated by EGIS.

This means that the environmental risk assessment must be directly relevant to any significant flora and fauna resident in the RAMSAR designated Melaleuca Wetland and environs, so defined as a category for special conservation consideration under current legislation<sup>4</sup> e.g. ‘Vulnerable’ or ‘Endangered’.

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<sup>3</sup> EGIS (2001) *Landfill Remediation Assessment Program* for Redlands Shire Council; p10, 2.5 Landfill Monitoring Assessment, dot point 2.

<sup>4</sup> *Environmental Protection & Biodiversity Conservation Act* (1999) (Cth.)

## Environmental Reporting

The fundamental considerations determining onsite works is to determine if there is any export of environmental nuisance offsite, and what are the pathways for mobilization of such nuisance e.g. GW flows and landfill gas production. This involves the sampling of GW both up catchment and down catchment of the retired landfill/borrow pit and determination of concentrations of, for example, heavy metals, Organochlorine and Organophosphorous Pesticide residues, nutrients, and physico-chemical characteristics such as water 'hardness', alkalinity and acidity. The interaction between these contaminants being very complex with regard to permeability over biological membranes, and thus no 'recognised' guideline limit will suffice, rather a precautionary threshold or 'trigger values' level<sup>5 6 7</sup> determined at site level and protecting, for example, 'Vulnerable' or 'Endangered' fauna and flora.

This means that the species which are to be protected determine the 'trigger values' which are appropriate to conserve these species at a site level. Where there is insufficient knowledge of a species physiology to determine lethal and sub-lethal responses, and it is listed as a significant species e.g. 'Vulnerable', then the precautionary 'trigger value' should be initially set at background levels<sup>8</sup> where there is insufficient data i.e. any increase in concentrations above background<sup>9</sup> become the 'trigger value'. With this level of protection, the impacts on a species are then described as 'no observable effect concentration' (NOEC) and will protect 'Vulnerable' species, but bioaccumulation in ecosystems can become problematic at site level.

What is of paramount importance here is that until a species protection 'trigger level' is known, a protection level must be set to ensure their conservation until perhaps a less conservative 'trigger level' can be determined, but in some cases a precise value which is more restrictive can eventuate e.g. The 'acid' frog *Litoria longiburensis* (Wallum Sedgefrog) was considered to be protected in waters with pH <5.5 but specific studies<sup>10</sup> now show their optimal range for survival to be in the pH range 3.53 – 4.61.

*L. longiburensis* is mapped as having essential habitat across the RAMSAR designated Melaleuca Wetland (Refer **Figure 1**). Although not yet mapped by the Herbarium in the *Essential Habitat* mapping, the orchid *Phaius australis* is a confirmed 'Endangered' species [REDACTED] [REDACTED]<sup>11</sup> also.

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<sup>5</sup> ANZECC Water Quality Guidelines – Vol 1: pxii.

<sup>6</sup> Above n3: p1-2 *This document incorporates protocols and quite detailed advice to assist users in tailoring the WQ Guidelines to local conditions. Invariably the process of refining these guidelines – 'trigger values' will result in numbers for toxicants at least that are less conservative and hence less constraining on surrounding activities.*

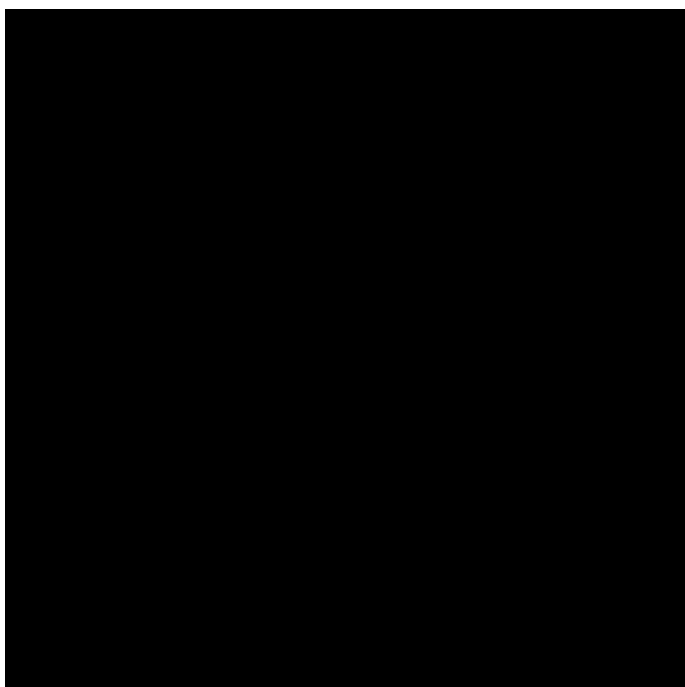
<sup>7</sup> Above n3: p1-2 *Methods for determining the physical and chemical WQ Guidelines for ecosystem management (now termed 'guideline trigger values') have also been updated in the light of an increased understanding of ecosystems, and improving technologies.*

<sup>8</sup> Above n3: Table 3.4.1 *Trigger level for toxicants at alternative levels of protection.*

<sup>9</sup> ANZECC Water Quality Guidelines – Vol 2: p8.3-45, Table 8.3.2 (Refer **Appendix 2**).

<sup>10</sup> Shuker, J.D., Simpkins, C.A. & Hero, J-M (2016) Determining environmental limits of threatened species: the example of the wallum sedgefrog *Litoria longiburensis* ECOSPHERE (2.1384).

<sup>11</sup> Confirmation of *Phaius australis* (Refer **Appendix 3**).



**Figure 1:** Regulated Vegetation Mapping showing *Essential Habitat* (green with crosshatch) for the wallum frog *Litoria olongburensis* reported from the Coochiemudlo Island Melaleuca Wetland *pers. comm.* Coast Care.

## Engineering Reporting

Neither of the engineering reports consider site conservation issues relevant to the RAMSAR designated Melaleuca Wetlands with ‘Vulnerable’ species e.g. *L. olongburensis*. Both reports failed to take a water sample in the RAMSAR designated Melaleuca Wetland to determine if there was an environmental risk from leachate, and GHD (2017) did not replicate the sampling of water from bores representing up catchment and down catchment of the retired landfill/borrow pit locations as determined by EGIS (2001).

GHD acknowledge the weakness in their field sampling and state:

*Assessment of whether groundwater is impacted by landfill leachate is also typically evaluated by comparing results from down gradient wells to up gradient wells as well as assessing concentration trends over time to determine any statistically significant increases. As the data is limited to only to (sic) the results from this monitoring and results from the EGIS monitoring conducted in 2001, these statistical analyses could not be facilitated for this investigation.*

The risk assessment for leachate from the retired landfill either focusses on the current usage as a sporting facility i.e. human health risk (EGIS 2001), or has selectively included ANZECC Guideline values for end uses including irrigation, stock watering and drinking water (GHD 2017), while the State freshwater guideline for protection of Wallum/Tannin (EPP - Water) in the GHD (2017) report gives a ‘target’ pH values range 6.5 – 8.

Clearly this environmental determination/limitation alone would cause the demise of the ‘Vulnerable’ species *L. olongburenensis* reported from this RAMSAR designated Melaleuca Wetland before any consideration of, for example, concentrations of heavy metals in the GW here.

In a study of anuran species richness and distribution in south-eastern Australia<sup>12</sup> it was reported that [heavy metal]<sup>13</sup> (pollution) correlated negatively with regard to Cu, Ni, Pb, Zn Cd and Hg. From the analytical analyses given in the GHD (2017) report, the [heavy metal] for these is now compared with the ANZECC Guidelines<sup>14</sup> - and Australian background levels used where available owing to the ‘Vulnerability’ of the anuran *L. olongburenensis* (Refer **Table 1**).

Note that the given units of measurement from the laboratory add a further level of complexity to interpretation as they report mg.L<sup>-1</sup> (ppm – parts per million) while the ANZECC Guidelines 2000 refer to µg.L<sup>-1</sup> (ppb – parts per billion).

**Table 1:** Selected comparison [heavy metal] between GHD (2017) GW monitoring results & ANZECC 2000 background limits. \* Note that the LOR is above the ANZECC background level and no meaningful interpretation can be made. The higher value for GW1 and GW3 is used here as the engineering reports agree that the rainfall runoff in this associated catchment is NE and there is a rapid recharge of bores i.e. any pollutant measured in wells GW1 – GW4 will migrate to the RAMSAR designated Melaleuca Wetlands.

|                | GW Samples GHD (2017) | ANZECC (2000) Table 8.3.2 – Background levels. |
|----------------|-----------------------|------------------------------------------------|
| [heavy metals] | µg.L <sup>-1</sup>    | µg.L <sup>-1</sup>                             |
| Copper (Cu)    | 2.0                   | 0.11                                           |
| Nickel (Ni)    | <1.0 (LOR) *          | 0.10                                           |
| Lead (Pb)      | <1.0 (LOR) *          | 0.01 (USA)                                     |
| Zinc (Zn)      | 14.0                  | 0.9                                            |
| Cadmium (Cd)   | <0.1 (LOR) *          | 0.001                                          |
| Mercury (Hg)   | <0.1 (LOR) *          | 0.01 (World)                                   |

<sup>12</sup> Ficken, K.L.G. & Byrne, P.G. (2012) *Heavy metal pollution negatively correlates with anuran species richness and distribution in south-eastern Australia*. *Austral Ecology* **38**, Issue 5.

<sup>13</sup> Square brackets in the text i.e. [heavy metal], reads as concentration of the ‘heavy metal’, or another substance.

<sup>14</sup> Above n8.

The toxicity of both copper and zinc is ameliorated by other factors such as pH, Dissolved Organic Matter (DOM) and the rate of inclusion in inorganic and organic complexes (ligands). The toxicity of zinc is an exponential inverse relationship with water hardness, and although it is suggested that the RAMSAR designated Melaleuca Wetland may be tidally pulsed<sup>15</sup> with consequent fluctuation in the REDOX, this would not be considered to directly affect toxicity owing to the high expected [DOM] in the Wetland.

The results show that:

- [Zn] exceeds the high reliability trigger value of 8 µg.L<sup>-1</sup> which affords 95% protection of FW species (with hardness of 30mg.L<sup>-1</sup> where GW1 i.e. down catchment, is reported as 121 mg.L<sup>-1</sup>).
- [Cu] exceeds the high reliability trigger value of 1.4 µg.L<sup>-1</sup> which affords 95% protection of FW species (with hardness of 30mg.L<sup>-1</sup> where GW1 i.e. down catchment, is reported as 121 mg.L<sup>-1</sup>).

Any further commentary on the reporting of a range of toxicants and their guideline limits as given in the engineering reports would be verbose as they bear no causal relationship to the species to be protected in the RAMSAR designated Melaleuca Wetland contiguous.

## Conclusions

GW monitoring and interpretation of results is fundamentally defined by the physiological tolerances for the species in the defined habitat/catchment that is to be conserved/protected. To 'conveniently' select guideline limits for end uses including irrigation, stock watering and drinking water does not protect the species which are, for example, 'Vulnerable'.

Any analytical analysis must not be limited by the capabilities of laboratory, nor by the budget set for a project. The laboratory analysis LOR must be lower than the ANZECC 2000 Freshwater Guideline Limits, and where a species is protected under Legislation e.g. *EPBC Act* (1999) (Cth.), and there is no known data for a species, then any concentration above accepted background limits should serve as a trigger value until more detailed studies produce, perhaps, a more conservative trigger level.

The [heavy metals] Copper and Zinc are at levels that would be toxic to anurans, and in particular *Litoria alongburensis*, and as stated by GHD '*... the current copper results are consistent with those observed previously*' and indicates that a highly probable chronic to sub-lethal impact has been prevailing over at least the past 16+ years.

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<sup>15</sup> EGIS (2001) *Landfill Remediation Assessment Program* for Redlands Shire Council; p16, 5.1 Water Quality – para 3.



For GHD (2017) to conclude that '*... the results are not indicative of landfill leachate*' ignores the history of the site, as an unsupervised landfill such as this is the only probable source of heavy metals in groundwater. The only other probable source being the fill material in the previous borrow pit.

But what is paramount is determination of the source of pollutants and determining its competent management to protect the declared RAMSAR designated Melaleuca Wetland which is contiguous with the Moreton Bay Marine Park.

## **Recommendations**

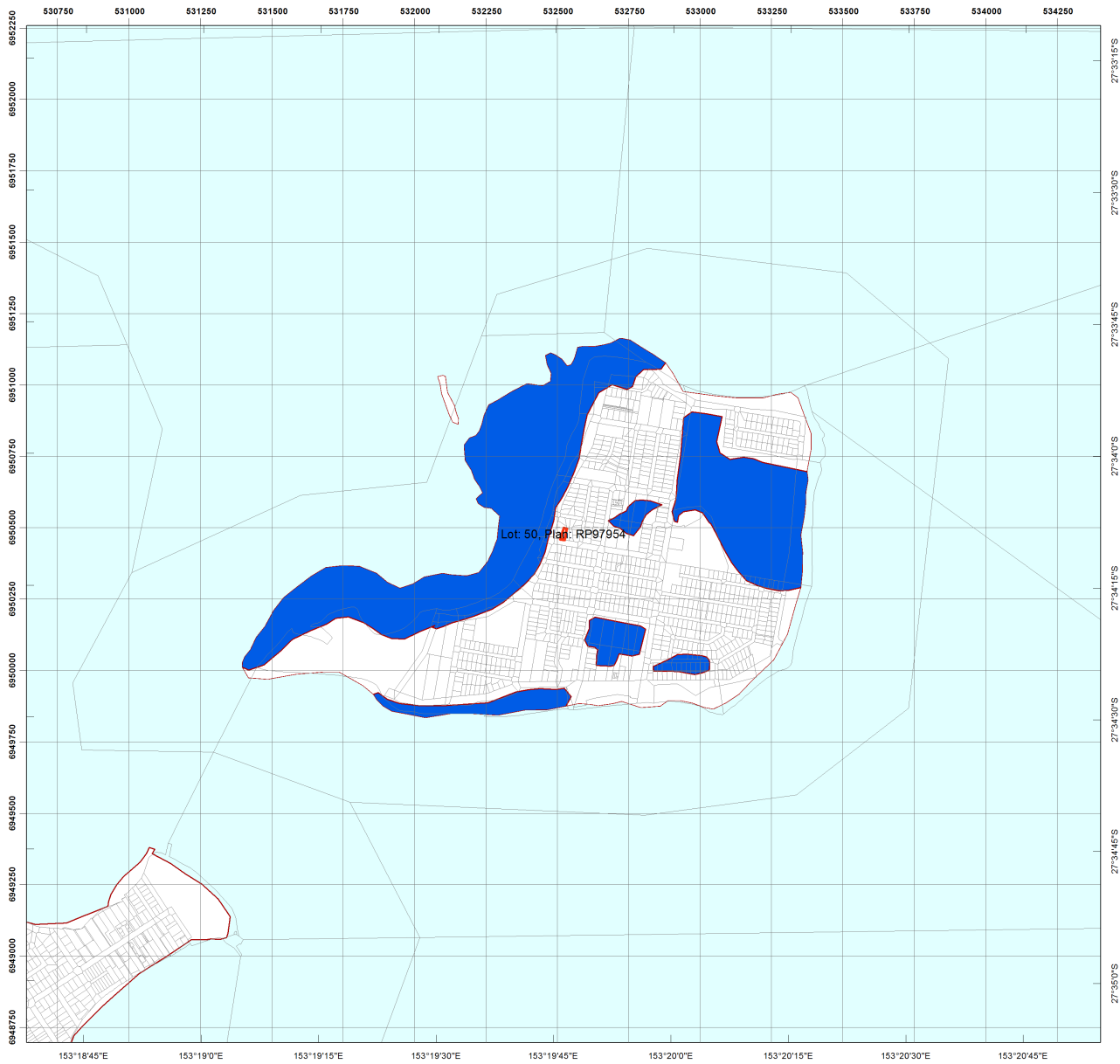
Future actions are best restated from the GHD (2017) report:

- Reinststate the GW monitoring onsite, and this would include replacing one monitoring well and redeveloping GW1 And GW2.

It is then an imperative that a competent study be performed which samples GW/surface water in the RAMSAR designated Melaleuca Wetland proper.











## **Appendix 1**

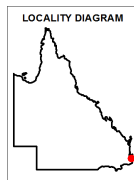
Vegetation Management Mapping – *Essential Habitat*



## Regulated Vegetation Management Map

### Legend

-  Lot and Plan
-  Category A area (Vegetation offsets/compliance notices/VDecs)
-  Category B area (Remnant vegetation)
-  Category C area (High-value regrowth vegetation)
-  Category R area (Reef regrowth watercourse vegetation)
-  Category X area (Exempt on Freehold, Indigenous and Leasehold land)
-  Water
-  Area not categorised
-  Cadastral line
-  Property boundaries shown are provided as a locational aid only



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Additional information required for the assessment of vegetation values is provided in the accompanying "Vegetation Management Supporting map". For further information go to the web site: [www.dnrm.qld.gov.au](http://www.dnrm.qld.gov.au) or contact the Department of Natural Resources and Mines.

Digital data for the regulated vegetation management map is available from the Queensland Spatial Portal at <http://www.information.qld.gov.au/>

This map is updated on a monthly basis to ensure new PMAVs are included as they are approved.



This product is projected into:  
GDA 1994 MGA Zone 56



/03/2017 14:25:38 Lot: 50 Plan: RP97954

## Vegetation Management Act 1999 - Extract from the essential habitat database

essential habitat is required for assessment under the: State Development Assessment Provisions - Module 8: Native vegetation clearing which sets the matters of interest to the state for development assessment under the *Sustainable Planning Act 2009*; and Self-assessable vegetation clearing rules made under the *Vegetation Management Act 1999*

essential habitat for one or more of the following species is found on and within 1.1 km of the identified subject lot/s or on and within 2.2 km of an identified coordinate on the accompanying essential habitat map. This report identifies essential habitat in Category A, B and Category C areas. The numeric labels on the essential habitat map can be cross referenced with the database below to determine which essential habitat factors might exist for particular species.

essential habitat is compiled from a combination of species habitat models and buffered species records. The Department of Natural Resources and Environment website (<http://www.dnrm.qld.gov.au>) has more information on how the layer is applied under the State Development Assessment Provisions - Module 8: Native vegetation clearing and the *Vegetation Management Act 1999*. Regional ecosystem is a mandatory essential habitat factor, unless otherwise stated. Essential habitat, for protected wildlife, means a category A area, a category B area or category C area shown on the regulated vegetation management map-

(a) that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for protected wildlife in the essential habitat database; or 2) (b) in which the protected wildlife, at any stage of its life cycle, is located.

essential habitat identifies endangered or vulnerable native wildlife prescribed under the *Nature Conservation Act 1994*.

### essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Species Information

results)

### essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Regional Ecosystems Information

results)

### essential habitat in Category A and B (Remnant vegetation) areas:1100m Species Information

| el | Scientific Name              | Common Name       | NCA Status | Vegetation Community                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Altitude           |
|----|------------------------------|-------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
|    | <i>Litoria freycineti</i>    | Wallum Rocketfrog | V          | Vegetation community is a mandatory essential habitat factor for this species. Freshwater acidic swamps/lagoons (permanent or temporary still water) dominated by sedges (e.g. <i>Baumea</i> and <i>Eleocharis</i> spp.) in heathland (e.g. <i>Banksia/Xanthorrhoea</i> ), wallum ( <i>Banksia aemula</i> shrubland/woodland) or Melaleuca open forest (e.g. <i>M. quinquenervia</i> ), and adjacent <i>Eucalyptus racemosa</i> forest, also found around acidic coastal lakes; on sand and sandstone; can be found well away from water during non-breeding season.                                             | Sea level to 200m. |
|    | <i>Crinia tinnula</i>        | Wallum Froglet    | V          | Vegetation community is a mandatory essential habitat factor for this species. Permanent to ephemeral acidic (pH 4.3 - 5.2), soft freshwater in Melaleuca (e.g. <i>M. quinquenervia</i> ) swamps, sedgeland, wet and dry heathland (e.g. <i>Banksia robur</i> , <i>Xanthorrhoea</i> ) and wallum ( <i>Banksia aemula</i> shrubland/woodland) areas coastal lowlands on sand or sandstone, occasionally in adjacent open forest/woodland (e.g. <i>Eucalyptus racemosa</i> , <i>Corymbia citriodora</i> ) with heathy understorey; known to persist in small remnants (<10ha); may be found well away from water.  | Sea level to 200m. |
|    | <i>Litoria olongburensis</i> | Wallum Sedgefrog  | V          | Vegetation community is a mandatory essential habitat factor for this species. Well vegetated permanent to ephemeral freshwater swamp, sedgeland, lake or creek, e.g. dense reed beds (including <i>Baumea</i> , <i>Restio</i> spp.) occasionally with Melaleuca <i>quinquenervia</i> or <i>Callistemon pachyphyllus</i> , acidic wallum swamps and wallum creeks on coastal sand masses; most abundant in wallum ( <i>Banksia aemula</i> ) swamps that seasonally flood where they are found year-round; recorded in adjacent wet heath, dry heath, <i>Gahnia</i> heath and Melaleuca swamp forest/open forest. | Sea level to 200m. |

### essential habitat in Category A and B (Remnant vegetation) areas:1100m Regional Ecosystems Information

### essential habitat in Category C (High value regrowth vegetation) areas:1100m Species Information

results)

### essential habitat in Category C (High value regrowth vegetation) areas:1100m Regional Ecosystems Information

results)

|    |                                                                                                                                                                                                                               |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| e1 | <b>Regional Ecosystem (this is a mandatory essential habitat factor, unless otherwise stated)</b>                                                                                                                             |
|    | 12.2.2, 12.2.5, 12.2.7, 12.2.12, 12.2.13, 12.2.15, 12.3.4, 12.3.5, 12.3.6, 12.3.12, 12.3.13, 12.5.4, 12.5.9, 12.9-10.10, 12.9-10.22. These regional ecosystems are not a mandatory essential habitat factor for this species. |
|    | 12.2.5, 12.2.7, 12.2.9, 12.2.10, 12.2.12, 12.2.15, 12.3.4, 12.3.5, 12.3.6, 12.3.12, 12.3.14, 12.5.10. These regional ecosystems are not a mandatory essential habitat factor for this species.                                |
|    | 12.2.5, 12.2.7, 12.2.12, 12.2.15. These regional ecosystems are not a mandatory essential habitat factor for this species.                                                                                                    |

e 3

## Appendix 2

ANZECC Water Quality Guidelines – Vol 2: p8.3-45, Table 8.3.2

**Table 8.3.2** Summary of background metal concentrations for Australian, New Zealand and Northern Hemisphere waters using 'clean' techniques. Adapted from Hickey and Pyle (2000)

| <b>Metal</b>     | <b>Marine water<br/>(µg/L)</b> | <b>Estuarine water<br/>(µg/L)</b> | <b>Fresh water<br/>(µg/L)</b>                                  | <b>Country</b> |
|------------------|--------------------------------|-----------------------------------|----------------------------------------------------------------|----------------|
| <b>Arsenic</b>   | 1.0–1.6 <sup>a</sup>           | 1.0–3.3 <sup>m</sup>              | NI                                                             | Australia      |
| <b>Cadmium</b>   | 0.01–0.2 <sup>b</sup>          | NI                                | 0.002–0.08 <sup>b</sup>                                        | USA            |
|                  | 0.001–1.1 <sup>c</sup>         | NI                                | 0.01 <sup>d</sup> ; 0.002–0.1 <sup>e</sup> ; 0.08 <sup>k</sup> | World          |
|                  | 0.002–0.7 <sup>a,f</sup>       | 0.002–0.026 <sup>g,m</sup>        | 0.001 <sup>g</sup>                                             | Australia      |
|                  |                                | 0.51–1.2 <sup>h</sup>             |                                                                |                |
|                  | NI                             | NI                                | 0.008 <sup>l</sup>                                             | New Zealand    |
| <b>Copper</b>    | 0.1–3 <sup>b</sup>             | NI                                | 0.4–4 <sup>b</sup>                                             | USA            |
|                  | 0.003–0.37 <sup>i</sup>        | NI                                | 1.5 <sup>d</sup>                                               | World          |
|                  | 0.025–0.38 <sup>a</sup>        | 0.06–1.3 <sup>g,m</sup>           | 0.11 <sup>g</sup>                                              | Australia      |
|                  | 0.1–0.2 <sup>j</sup>           | NI                                | 0.15 <sup>l</sup>                                              | New Zealand    |
| <b>Chromium</b>  | 0.062–0.1 <sup>a</sup>         | 0.01–0.1 <sup>m</sup>             | NI                                                             | Australia      |
| <b>Iron</b>      | 0.006–0.14 <sup>c</sup>        | <0.04–13.7 <sup>m</sup>           | 40 <sup>d</sup>                                                | World          |
|                  | NI                             | 0.76–67 <sup>g,m</sup>            | NI                                                             | Australia      |
| <b>Lead</b>      | 0.01– 1 <sup>b</sup>           | NI                                | 0.01–0.19 <sup>b</sup>                                         | USA            |
|                  | <0.006–0.03 <sup>a</sup>       | 0.02–0.13 <sup>m</sup>            | NI                                                             | Australia      |
|                  | NI                             | NI                                | 0.02–0.03 <sup>l</sup>                                         | New Zealand    |
| <b>Manganese</b> | 0.003–0.38 <sup>c</sup>        | NI                                | 1.5 <sup>d</sup>                                               | World          |
|                  | NI                             | 0.55–3.1 <sup>g</sup>             | NI                                                             | Australia      |
| <b>Mercury</b>   | NI                             | 0.0007–0.003 <sup>m</sup>         | 0.01 <sup>k</sup>                                              | World          |
|                  | NI                             | 0.0017 <sup>m</sup>               | NI                                                             | Australia      |
| <b>Nickel</b>    | 0.3–5 <sup>b</sup>             | NI                                | 1–2 <sup>b</sup>                                               | USA            |
|                  | 0.12–0.7 <sup>c</sup>          | NI                                | 0.5 <sup>d</sup> ; 3.3 <sup>k</sup>                            | World          |
|                  | 0.13–0.5 <sup>a</sup>          | 0.14–1.10 <sup>g,m</sup>          | 0.10 <sup>g</sup>                                              | Australia      |
|                  | 0.33 <sup>j</sup>              | NI                                | 0.1–0.15 <sup>l</sup>                                          | New Zealand    |
| <b>Silver</b>    | 0.006–0.2 <sup>b</sup>         | NI                                | NI                                                             | USA            |
|                  | <0.0005 <sup>a</sup>           | NI                                | NI                                                             | Australia      |
| <b>Zinc</b>      | 0.1–15 <sup>b</sup>            |                                   | 0.03–5 <sup>b</sup>                                            | USA            |
|                  | 0.003–0.59 <sup>c</sup>        |                                   | 0.6 <sup>d</sup> ; 2.8 <sup>k</sup>                            | World          |
|                  | <0.022–0.1 <sup>a</sup>        | 0.39–3.8 <sup>g,m</sup>           | 0.9 <sup>g</sup>                                               | Australia      |
|                  |                                | 0.4–1.8 <sup>h</sup>              |                                                                |                |
|                  | 0.005–0.02 <sup>j</sup>        |                                   | 0.15–0.2 <sup>l</sup>                                          | New Zealand    |

Footnotes: NI = No information found. References: a = Apte et al. 1998; b = Prothro 1993; c = Bruland 1983; d = 'World average' Martin & Windom 1991; e = Canada: Stephenson & Mackie 1988; f = NW Shelf, Australia: Mackey 1984; g = Bathurst Harbour & Old River, Tasmania: Mackey et al. 1996; h = Higgins & Mackey 1987; i = Ahlers et al. 1991; j = Dickson & Hunter 1981; k = Geometric mean in The Netherlands: RIVM 1999; m = Port Phillip Bay: CSIRO 1996.



## Appendix 3

*Endangered Swamp Orchid Phaius australis*

# Extract from *Atlas of Living Australia*

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[Compare "original vs processed" values](#)

|                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dataset                                                                                                                                                                                                               |
| Event                                                                                                                                                                                                                 |
| Taxonomy                                                                                                                                                                                                              |
| Geospatial                                                                                                                                                                                                            |
| Additional properties                                                                                                                                                                                                 |
| Data quality tests (1 <span style="color:red">+</span> , 1 <span style="color:orange">!</span> , 42 <span style="color:green">✔</span> , 5 <span style="color:blue">?</span> , 37 <span style="color:grey">⊗</span> ) |
| Additional political boundaries information                                                                                                                                                                           |
| Environmental sampling for this location                                                                                                                                                                              |

## Dataset

|                                      |                                                                                                                                                                                                                                                                                                 |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Data provider</b>                 | Australia's Virtual Herbarium                                                                                                                                                                                                                                                                   |
| <b>Data resource</b>                 | Queensland Herbarium Records                                                                                                                                                                                                                                                                    |
| <b>Institution</b>                   | Department of Science, Information Technology and Innovation<br><i>Supplied institution code "BRI"</i>                                                                                                                                                                                          |
| <b>Collection</b>                    | Queensland Herbarium                                                                                                                                                                                                                                                                            |
| <b>Catalogue number</b>              | BRI AQ0890825                                                                                                                                                                                                                                                                                   |
| <b>Occurrence ID</b>                 | urn:catalog:BRI:Herbrecs:AQ0890825                                                                                                                                                                                                                                                              |
| <b>Basis of record</b>               | Preserved specimen                                                                                                                                                                                                                                                                              |
| <b>Preparations</b>                  | alcohol, photograph, sheet                                                                                                                                                                                                                                                                      |
| <b>Identified by</b>                 | Mathieson, M.T.                                                                                                                                                                                                                                                                                 |
| <b>Identified date</b>               | 2015-10                                                                                                                                                                                                                                                                                         |
| <b>Identifier role</b>               | det.                                                                                                                                                                                                                                                                                            |
| <b>Collector</b>                     | Mathieson, M.T.                                                                                                                                                                                                                                                                                 |
| <b>Collecting number</b>             | MTM2332                                                                                                                                                                                                                                                                                         |
| <b>Reproductive condition</b>        | flowers                                                                                                                                                                                                                                                                                         |
| <b>License</b>                       | CC BY                                                                                                                                                                                                                                                                                           |
| <b>Natural occurrence</b>            | native                                                                                                                                                                                                                                                                                          |
| <b>State conservation</b>            | Endangered wildlife, Endangered wildlife                                                                                                                                                                                                                                                        |
| <b>Data generalizations</b>          | Location in Queensland, Australia generalised to 0.1 degrees. Sensitive in QLD, Name: Queensland, Zone: STATE [Endangered, Qld DEHP]                                                                                                                                                            |
| <b>Establishment means</b>           | native                                                                                                                                                                                                                                                                                          |
| <b>Occurrence remarks</b>            | 'Melaleuca Wetlands', Coochiemudlo Island. Vegetated swamp dominated by Melaleuca quinquenervia. Terrestrial herb to c. 1 m high. Inflorescences to c. 1.3 m high. Flowers brown with purple labellum. c. 12 plants observed. Spirit material at BRI. Photo at BRI. Status (in Qld): Endangered |
| <b>Occurrence status</b>             | present                                                                                                                                                                                                                                                                                         |
| <b>Cultivated</b>                    | not cultivated                                                                                                                                                                                                                                                                                  |
| <b>Collection code</b>               | Herbrecs                                                                                                                                                                                                                                                                                        |
| <b>Abcd identification qualifier</b> | Not provided                                                                                                                                                                                                                                                                                    |
| <b>Date identified</b>               | 2015-10                                                                                                                                                                                                                                                                                         |
| <b>Verbatim date identified</b>      | 2015-10-00                                                                                                                                                                                                                                                                                      |
| <b>Identification id</b>             | 19883                                                                                                                                                                                                                                                                                           |

## Location of record



Date loaded: 2017-01-12

Date last processed: 2017-05-19

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**From:** Michael Mathieson <[michael.mathieson@dsiti.qld.gov.au](mailto:michael.mathieson@dsiti.qld.gov.au)>  
**Sent:** Tuesday, October 13, 2015 6:16 PM  
**To:** [REDACTED]  
**Cc:** [REDACTED]  
**Subject:** RE: Phaius Australis on Coochiemudlo Island

Hello [REDACTED]

As Boyd no doubt will have told you, we collected a specimen of the endangered Swamp Orchid *Phaius australis* flowering on October 7 [REDACTED]. This specimen has been dried and is currently in the freezer in preparation for mounting and incorporation in to the Queensland Herbarium database. The 12 or so plants observed on the day [REDACTED] and there is, as you know, incursion by weeds, notably Singapore Daisy, in the area. It would be good to keep on top of that to preserve this group of orchids. Time did not permit surveying beyond this group of plants; I have been assured there are more so perhaps a survey [REDACTED] next winter would be appropriate. If you have any questions, please call me.

Best wishes and thanks to [REDACTED] for coming out on the day.

Mike



**Dr Michael Mathieson**  
Queensland Herbarium  
Department of Science, Information Technology and Innovation

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**P 07 3896 9718**  
Brisbane Botanic Gardens – Mt Coot-tha, Mt Coot-tha Rd, TOOWONG QLD 4066

**Customers first | Ideas into action | Unleash potential | Be courageous | Empower people**