**Additional Information**

**What is the Site Like?**

**Physical Components**

**4.4.3– Soil**

The landforms of the Shoalwater Bay and Broome Head sections are low mountains and hills, low hills and rises, alluvial plains and fans, mudflats and beaches and coastal sand dunes. Geological units show igneous, sedimentary and metamorphic geologic processes have occurred on the site. Accordingly, surface geological materials are diverse but principally relate to either weathered in-situ rock or material that has been transported and deposited elsewhere in the landscape through wind, wave and other coastal processes.

The Ramsar site includes excellent and rare examples of unmodified, relict, cliff-top parabolic dunes dating from the Pleistocene age represented at Townsend Island, Mount Gibraltar-Pearl Bay region, Freshwater Bay and the Dismal Swamp sector seaward south to Byfield National Park. Most of the dunes are elongate at a maximum length as much as four kilometres. These dunes contain mostly well sorted fine to medium sands and quantities of other materials (e.g. rock fragments, heavy minerals, clay). The parabolic and parallel sand dune formations in the Ramsar site are highly significant in a national context and considered to be of ‘outstanding universal value’ for the purpose of the Great Barrier Reef World Heritage listing (Geoscience Australia 2013).

Numerous sinkholes of various sizes occur in the eastern sand dunes of the site. They are conical with sandy surfaces sloping up to 20 degrees, up to 30 m deep and 20 m across. The sinkholes are likely to be depressions caused by the collapse of iron-rich units within the weathered soil profile. The larger sinkholes have permanent freshwater springs emanating from their floors and support rainforest communities. Sinkholes with significant infilling of sand, like those in elevated dune terrain of site, appear to be rare features worldwide (DoD 2009).

Terrestrial soils in the Shoalwater Bay and Broome Head sections are mostly infertile and unstructured with clay sub-soils that are often saline and impervious to water. The large particle size, poor structure of surface soils and vegetated nature of the site limits natural soil erosion processes, but the subsoils are erodible especially due to their high salinity content. Soils in the eastern areas are wetter due to higher rainfall and have both sandy loams over heavy clays and podzols on the older sand dunes. Sand dune areas are an exception to this, with podzols unable to form because of active re-working. The sand dunes also contain numerous freshwater wetlands on soils that vary from sand with high organic matter to peat layers over one metre thick.

Shoalwater and Corio Bays are in a region that experiences the highest tidal range on the eastern Australian coastal margin, with up to 5–6 metres observed in Port Clinton. This is a result of several factors including an offshore break in the Great Barrier Reef, which reduces its normal sheltering effect, the convergence of regional tidal systems, and the broad continental shelf of the region that accentuates the effects of bottom interference.

The effect of the large tidal range produces alternating conditions of strong currents that transport sand and slack water, thereby enabling the deposition of finer muds. The tidal processes also repeatedly flood and expose large areas of coastline leading to the formation of an extensive intertidal zone, which is characterised by a succession of ecosystems controlled by the frequency and length of tidal inundation and other related factors such as the degree of exposure and protection from wave action.

Freshwater flows into Shoalwater Bay, Port Clinton and Corio Bay are highly variable over seasonal and inter-annual time scales in response to highly variable rainfall patterns. The Ramsar site is characterised by three main catchment sub-basins. The Shoalwater catchment consists of short streams and creeks that drain directly to Shoalwater Bay from the higher ranges across tidal flats and mangroves. In the Water Park Creek catchment the northern area within the SWBTA flows west to the Dismal Swamp and the southern area flows west and south to Corio Bay via Sandy Creek and Water Park Creek. The eastern of this catchment includes the narrow estuary and coastal plains associated with the Island Head Creek system, Port Clinton, and the eastern beach systems of the SWBTA from Cape Manifold to Five Rocks that drains directly to the coast without flowing in a major recognised waterway catchment. A small area in the south of the Dismal Swamp sector flows into the Fitzroy River catchment that drains into sea south of Rockhampton.

Most freshwater creeks in the Shoalwater Bay and Broome Head sections of the site are ephemeral, with flows occurring during the summer wet season from December to March. Sandy Creek and Water Park Creek maintain high levels of base flow throughout the year due to flow from Dismal Swamp and groundwater input from associated sand dunes. Freshwater inflow into the Corio Bay area is thought to be present through most years.

The movement of groundwater through the landscape is a critical process that sustains the wetlands of the Ramsar site. The groundwater resources of the Ramsar site are characterised by a mixture of fractured rock and primary porosity aquifers with flows that closely follow topography within the Shoalwater, Water Park Creek and Fitzroy River catchments.

The natural percolation of groundwater through the dune system provides a year-round supply of groundwater for the larger swamps that are fed by groundwater springs (such as Freshwater Swamp and the larger sinkholes) and higher elevation swamps such as Dismal Swamp, which are maintained by an impervious sand layer, rainfall and local runoff.

There is a general absence of estuarine or marine water quality data for the site’s major waterbodies (e.g. Shoalwater Bay and Port Clinton estuaries). A comparison of the water quality data collected from several sites across the SWBTA since 2002 with the water quality objectives of the Queensland Water Quality Guidelines (2009) found that the various water quality parameters were within the bounds of natural variability (DoD 2009).

The water quality of estuarine and marine features, based on the predominantly natural catchments that flow into them, the level of usage and ecosystem condition of key indicator habitats (e.g. seagrass), are indicative of excellent water quality. Corio Bay water quality displays features of a “typical Australian estuary”, with salinity increasing seaward, that is a pattern arising from freshwater input from surface water flows of Water Park Creek. There is a lack of information regarding the water quality of the site’s freshwater swamps.

**4.4.4 – Water Regime**

Environmental Values (EV) and Water Quality Objectives (WQO) for Shoalwater Creek and Water Park Creek Basins have been published under Schedule 1, of the Queensland Environmental Protection (Water) Policy 2009 (EPP Water), Capricorn Curtis coastal waters plan (WQ1272) and groundwater zones plan (WQ1273).

**4.4.5 – Sediment Regime**

In the Shoalwater Bay and Broome Head sections, beach sediments along the eastern seaboard are influenced by coastal sediment transport processes, with rivers supplying almost no sediment to the coastline. These beaches have medium to fine sand that is subject to minor erosion and local blow outs. The beaches are typically of Holocene age, backed by a foredune formed by vegetation trapping sand that is eroded by wind from the exposed beach. A notable exception to this is the Clinton Lowland area within Port Clinton, which represents an older Pleistocene age beach complex formed from prograding barrier ridges.

Marine sediments found offshore within the Shoalwater Bay and Broome Head sections include very fine sand nearshore and poorly sorted muddy sand further out. Coastal processes form ridges of fine to medium sand that can be up to 10 meters higher than the surrounding sea floor. These ridges can extend 1 kilometre wide by 20 kilometres in length, forming long channels oriented northwest-southeast that are filled with thick, muddy waters on the ebb tide.

A subtidal delta occupies the mouth of Port Clinton, with the seaward part an asymmetric sand bar that is prograding seawards. The delta is composed of fine to medium sand that is migrating from the southern coastal sand dune systems. The sediments within Port Clinton form extensive flat banks to the west and south, which are incised by deep channels.

Corio Bay is a shallow estuarine inlet forming the efflux of the streams flowing east from the Coast Range and south from Shoalwater Bay. The Corio Bay area has mixed lithology. Unconsolidated sediments of the subtidal areas of the bay are surrounded by intertidal Holocene marine deposits stabilised by mangroves and other halophytic vegetation. Most sediment in Corio Bay is comprised of fine-medium sands and can include coarse sand and gravel areas. Extensive aeolian dunes of Pleistocene to Holocene age abut the intertidal deposits. To the south of the bay and to some extent the west and north, the area surrounding the intertidal zone abuts extensive, low lying areas of Pleistocene sand, gravel, soil and arkose that form coastal swamps.

The entrances of all creeks flowing into Corio Bay are marked by a series of sand banks and the predominant estuarine sediment is sandy material with low organic content excepting the mudflats within the well-defined wetland vegetation communities.

**4.4.8 – Dissolved or Suspended Nutrients in Water**

A brief comparison of water quality data sampled within the SWBTA against the regional Queensland Water Quality Guidelines (QWQG) found:

* Dissolved Oxygen – Dissolved oxygen levels (% saturation) range from 8.6% to 98.1%. The median and 80th percentile values are less than the lower guideline value of 85% saturation.
* Total Nitrogen – Total nitrogen concentrations range from <0.1 mg/L to 2.3 mg/L. The median, 20th and 80th percentile concentrations all exceed the QWQG guideline value of 0.50 mg/L.
* Total Phosphorous – The median and maximum total phosphorous concentrations range exceed the QWQG guideline value of 0.05 mg/L.
* Chlorophyll-a – Chlorophyll-a concentrations range from 0.001 µg/L to 12 µg/L. The 80th percentile and maximum concentrations exceed the guideline value or 5 µg/L.

While some exceedances of QWQG values for nutrients have been recorded in the above, these are considered to be well within the bounds of natural variability with natural high levels of organic nitrogen and phosphorus derived from the breakdown of plant material in streams and lagoons.

Water quality data has also been collected in Water Park Creek including in the downstream reaches of the creek near Corio Bay found:

* Dissolved Oxygen – Median dissolved oxygen levels (% saturation) are within the recommended guideline range of 85-110% saturation. The maximum recorded level is greater than the 110% saturation upper value.
* Total Nitrogen – Concentrations of total nitrogen are all less than the QWQG of 0.5 mg/L. The median total nitrogen concentration is 0.15 mg/L.
* Total Phosphorous – Total phosphorous concentrations within Corio Bay range from 0.003 mg/L to 0.038 mg/L. The median concentration is 0.011 mg/L. All recorded concentrations are compliant with the QWQG value of 0.05 mg/L.

Chlorophyll-a – The maximum recorded concentration of chlorophyll-a exceeds the QWQG value of 5 µg/L. The median value of 1.3µg/L is compliant with this value.

**Part 3.2 Ecological Processes**

**Primary Production**

The main primary producers within the site include phytoplankton, benthic microalgae (microphytobenthos), seagrass, mangroves, saltmarshes, and transitional habitats such as *Melaleuca* forest. The relative contribution of each of these components to total primary productivity will vary from place to place and across a range of spatial (and possibly temporal) scales.

**Nutrient Cycling**

As vegetative and animal matter begins to senesce and die, microbes invade the tissues and transform the organic material into more bio-available forms of carbon and other nutrients. While microalgae, mangroves and seagrasses are mainly responsible for primary productivity within estuarine and marine waters of the site, microbial breakdown is a key pathway for plant material entering the food-web in these ecosystems (Alongi 1990). This is especially true for marine, estuarine and freshwater macrophytes (seagrass, mangroves, saltmarshes, freshwater marshes), which with few notable exceptions (e.g. some invertebrates, fish and birds) are generally not directly grazed, but instead enter food-webs following microbial conversion of organic matter (Day *et al.* 1989).

Grazing of phytoplankton by zooplankton is likely to represent an important link in the chain of nutrient flux and energy flow in the marine and estuarine waters of the site. Furthermore, the planktonic phase forms part of the life-cycle of most benthic and marine demersal fauna (meroplankton), including most species of direct fisheries significance. Little is known about the relationships between nutrient levels, phytoplankton dynamics and zooplankton composition, grazing and production within the wetland.

The direct consumption of macrophytes by grazers also represents a pathway for energy flow through the ecosystem. Macrophytes generally form a direct food source for only a limited number of species, including sea urchins, some amphipods, gastropod snails, some fish species (e.g. garfish, luderick and leatherjackets), together with black swan, ducks and geese. From an energy flow perspective, perhaps the most important linkage between macrophytes and higher trophic levels is through the decomposition of dead plant material by bacteria and fungi. This is likely to be particularly the case in detritus-based foodwebs that characterise saltmarsh and freshwater wetland systems.

**Notable Species Interactions**

Numerous studies have examined the roles of competition, predation, larval supply, food supply and disturbance in structure in soft-sediment benthic macroinvertebrate communities. Like estuarine fish communities, it is unlikely that any single factor controls patterns in community structure; rather the relative importance of density dependent and density-independent controls is expected to vary across a range of temporal and spatial scales (Seitz 1998).

While there is a large body of work examining population controls and processes for reef fish (Hixon 1998; Levin 1998), with few exceptions there is comparatively little information describing the ultimate population controls for estuarine and coastal fish species. It is likely that density-dependent controls (e.g. competition for food and space) and density independent factors (e.g. disturbance) both exert an influence of fish communities, with the relative importance of these processes varying across multiple spatial and temporal scales. These factors may operate both within and external to the Ramsar site.

The availability of food sources will affect the frequency and intensity of use of Shoalwater and Corio Bays as a feeding habitat by waterbirds, noting a broad range of feeding techniques are used by the array of waterbirds that use the site. These feeding adaptations range from shorebirds feeding on macroinvertebrates in the tidal and lake flats to pelagic fish feeders such as the little tern and raptors.

**Part 4.1 Summary of Critical Services, Components and Processes of the Shoalwater and Corio Bays Area Ramsar site**

| **Ecosystem services/benefits** | **Ecosystem components** | **Ecosystem processes** |
| --- | --- | --- |
| **1:** The site contains marine, estuarine and freshwater landscapes and ecosystems that are representative of the biogeographic region and are rare in the context of a large coastal system that remains in a near natural state  **2:** The site has wetland types (notably the peat swamps in the Dismal Sector and the Clinton Lowlands) that are rare, unusual and noteworthy for the biogeographic region and at greater spatial scales.  **3:** The site supports national and internationally threatened wetland species.  **4:** The habitat diversity present within the site supports outstanding biodiversity values including several notable vegetation communities.  **5:** The site supports substantial numbers of wetland species during a critical life stage (e.g. breeding, nesting, roosting, feeding, and/or refugia).  **6:** The site supports substantial numbers of resident and migratory waterbirds.  **7:** The site supports a high diversity of fish species reflecting the diversity of habitats of the site and a biogeographical overlap zone.  **8:** The site supports nursery habitat of critical importance to regional commercial and recreational fisheries.  **9:** The site supports a range of pristine/near natural wetland environments that are important for scientific research and assessing the future impacts of climate change.  **10:** The site provides a significant regional asset in terms of water supply to the Capricorn Coast and will provide a strategic reserve for freshwater in the future.  **11:** The site and its values are a major part of a broader ‘wilderness area’. . | **Wetland habitats,** including the following Ramsar types:  *Coastal/Marine*   * 9 Types   *Inland*   * 9 Types   **Populations of wetland-dependent fauna and flora species of national or international conservation significance**, including populations of:   * Aquatic animals (marine): Sea turtles and dugong * Aquatic animals (freshwater): honey blue eye * Wetland-dependent terrestrial fauna species: water mouse * Wetland-dependent flora: lesserswamp orchid   **Wetland vegetation communities** reliant on the site for conservation security  **Populations** of migratory and resident waterbirds  **Populations** of fish and invertebrates that are of recreational and commercial significance | **Physical coastal processes.** Hydrologic and hydrodynamic controls on habitats through tides, currents, waves, wind and associated erosion and accretion processes.  **Surface freshwater inflows**  Freshwater inflows from creeks and surface run-off most notably into Corio Bay and into Shoalwater Bay.  **Groundwater.** Groundwater dynamics and interaction with freshwater wetland systems.  **Water quality.** Water quality that provides aquatic ecosystem values within wetland habitats.  **Geomorphology**. Key geomorphologic/ topographic features of the site.  **Energy and nutrient dynamics.** Primary productivity and the natural functioning of carbon and nutrient cycling processes.  **Biological processes.** Important biological processes such as growth, reproduction, recruitment, migration and dispersal.  **Climate.** Patterns of temperature, rainfall, and evaporation. |

Table 3‑3 **Critical services/benefits of the Shoalwater and Corio Bays Area Ramsar site**

| **Critical service/benefit** | **Aspect/attribute of the service** |
| --- | --- |
| 1: The Ramsar site contains marine, estuarine and freshwater landscapes and ecosystems that are representative of the biogeographic region and are rare in the context of a large coastal system that remains in a near natural state with relatively undisturbed catchments. | Habitat extent of representative wetland types |
| Habitat condition of representative wetland types |
| 2: The Ramsar site has wetland types (notably the peat swamps in the Dismal Sector and the Clinton Lowlands) that are rare, unusual and noteworthy for the biogeographic region and greater spatial scales. | Extent and condition of peat swamps |
| 3: The Ramsar site supports vulnerable/ endangered wetland species. | The population viability of those threatened species relevant to Criterion 2 |
| 4: The habitat diversity contained within the Ramsar site supports outstanding biodiversity values including several notable vegetation communities. | Diversity of wetland types  Habitat extent and condition  Abundance and diversity of wetland dependent species and populations |
| 5: The site supports several important wetland species during a critical life stage (e.g. breeding, nesting, roosting, feeding, migration and/or refugia). | Maintenance of critical life stage functions |
| 6: Supports substantial numbers of resident and migratory waterbirds | Abundance of migratory waterbirds |
| Maintenance of usage of the site by key migratory and resident shorebird species |
| 7: Supports a high diversity of fish species reflecting the diversity of habitats and a biogeographical overlap zone. | Diversity of fish species |
| 8: Supports critical nursery habitat for regional commercial and recreational fisheries. | Populations of key commercial and recreational fishery species |
| 9: Supports a range of pristine/near natural wetland environments that are important for scientific research and assessing the future impacts of climate change. | Relies on the above. |
| 10: The Ramsar site provides a significant regional asset in terms of water supply to the Capricorn Coast and will provide a strategic reserve for freshwater in the future. | Relies on the above. |
| 11:The Ramsar site and its values are part of a broader ‘wilderness area’. | Relies on the above. |

Table 3‑4: **Critical components and processes of the Shoalwater and Corio Bays Area Ramsar site - Limits of Acceptable Change**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ramsar criteria** | **Critical components and processes** | **Baseline/Supporting Evidence** | **Limit of acceptable change** | **Confidence** |
| Criteria 1 | Wetland habitats (Marine) – Seagrass (Wetland Type A, B, F) | Mapped extent in 1995-1996 (post Ramsar listing) ~13,000 ± 800-890 ha (Lee Long *et al.* 1997). For late spring (seasonal maximum) monitoring, aerial extent is likely to be relatively stable. | Presence of habitat | Moderate |
| Wetland habitats (Marine) – Mangroves (Wetland Type F, G, H, I) | While broad-scale mapping of wetland and vegetation community types exists (e.g. RE mapping), there are no data describing the range of natural temporal variability in extent of different vegetation communities and the controls on these changes. | Presence of habitat | Moderate |
| Wetland habitats (Marine) – Saltmarsh (Wetland Type G, H, I) | See Wetland habitats (Marine) - Mangroves. | Presence of habitat | Moderate |
| Wetland habitats (Marine) – Rocky reef coral communities (Wetland Type C, D) | There is very coarse mapping available for rocky reefs in the site. Broad community structure and species is available but not at a site or community scale. This needs to be updated to form a baseline for the LAC. | Presence of habitat | Moderate |
| Wetland habitats (Marine) – Sandy shores (Wetland Type E, G) | Aerial photography could be used to establish a baseline extent for beach and dune features. Literature reviewed indicates that these habitats are fairly stable in the SWTBA area. There is likely a combination and natural and anthropogenic impacts on beaches at Sandy Point in Corio Bay. | Presence of habitat | Moderate |
| Wetland habitat (Freshwater) – marshes, Peat swamps (Wetland Type M, N, Tp, Ts, U, W, Xf, Y) | While broad-scale mapping of wetland and vegetation community types exists (e.g. RE mapping), there are no data describing the range of natural temporal variability in extent of different vegetation communities and the controls on these changes. It should be noted that a mapping layer specifically for the extent of peat swamps has not been derived. | Presence of habitats | Moderate |
| Hydrology – freshwater flows (e.g. Waterpark Creek, Peat swamps, saltmarsh) (Wetland Type M, N, Tp, Ts, U, W, Xf, Y) | Annual volumes (ML) at Water Park Creek gauging station (1957-1996):  Range = 24,278 to 429,030; Mean = 156,135.9; Median = 109,157; CoV = 73.6%.  There are no available baseline data to determine ranges of natural variability under different flow conditions. Until such time as site specific flow duration curves are developed for each wetland type, no LAC is proposed. Changes in LAC for wetland habitats could be used as surrogate measures for this process. | No direct LAC has been developed and instead the critical process will be assessed indirectly through changes in wetland habitats and threatened species. |  |
| Hydrology – groundwater dynamics (e.g. Freshwater wetlands, Peat swamps) (Wetland Type M, N, Tp, Ts, U, W, Xf, Y) | There are no available baseline data to determine ranges of natural variability under different flow conditions. Until such time as site specific flow duration curves are developed for each wetland type, no LAC is proposed. Changes in LAC for wetland habitats could be used as surrogate measures for this process. | No direct LAC has been developed and instead the critical process will be assessed indirectly through changes in wetland habitats and threatened species. |  |
| Criteria 2 | Threatened species – water mouse | There is insufficient site data for this species which is typically regarded as occurring in potentially low population densities and patchy occurrence. | Presence of water mouse in the site | Low |
| Threatened species – dugong | Population numbers outlined in GBRMPA (1997): 765 ± 161 S.E. in 1987; 406 ± 78 S.E. in 1994.  However, there is insufficient available information on the population dynamics and genetics of dugongs to develop a definitive LAC. | Information presently insufficient for proposing any LACs |  |
| Threatened species – flatback turtle | Wild Duck Island to the north of Shoalwater Bay is one of the two major flatback rookeries in eastern Australia, with several hundred females nesting annually.  Low density or sporadic nesting occurs on many other beaches and islands in the vicinity of Shoalwater Bay (Limpus *et al.* 2005). The area encompassing SWBTA south of the Percy Islands south to Stockyard Point and the Duke Island Group between Wild Duck Island and the Marble Group remains unsurveyed. It is expected that this unsurveyed area will contain *N. depressus* and *C. mydas* rookeries. | The loss or prolonged absence (>5 successive years) of flatback nesting within the beaches of the site | Moderate |
| Threatened species – green turtle | Specific feeding areas, prey types and prey densities required to support turtles unknown. Limpus *et al.* (2005) suggests that seagrass represents ~86% of turtle volume of turtle diet, followed by red algae (~10% by volume). Presently no data on red algae distribution and abundance.    Limpus *et al.* (2005) found over an 18 year monitoring period the following breeding rates: ♀ Mean = 0.119 ± 0.026 S.E.; ♂ Mean = 0.34 ± 0.072 S.E.  There is comparatively fewer pre-listing data (n = 7-11 years): ♀ Mean = 0.118 ± 0.032 S.E.; ♂ Mean = 0.39 ± 0.010 S.E.  Insufficient empirical data to derive definitive LACs. There is a need to develop baseline data describing variability in key turtle food resources within and adjacent to the site in order to develop empirical LACs. It is not possible at this stage to provide guidance on these limits as, to a large extent, these will be dependent on the adopted sampling methodology and levels of natural variability. There is also insufficient empirical data to derive empirical, threshold-based LACs that are meaningful in the context of maintaining turtle populations. | Information presently insufficient for proposing any LACs |  |
| Threatened species – Honey blue-eye | This species typically has low population densities hence empirical population estimated have not been determined. There is insufficient empirical data to derive definitive LAC. | Presence of Honey blue-eye | Moderate |
| Threatened species – lesser swamp orchid | There are no available data on water requirements of the lesser swamp orchid, nor are there suitable baseline data describing water regimes/water levels at particular locations supporting the threatened plant species. No information is available regarding the population sizes, dynamics and viability of the threatened plant species within the site.  Should an adequate baseline be established, such as watering requirements of each species, LACs could be calculated based on the range of variability at representative sites. It is not possible at this stage to provide guidance on these limits as, to a large extent, these will be dependent on the adopted sampling methodology and levels of natural variability, and will vary across locations. | Presence of lesser swamp orchid | Moderate |
| Criteria 3 | Biodiversity | The site supports 18 Ramsar wetland types (9 coastal/marine; 9 inland).  In terms of wetland dependent species, the site supports 22 frog species, 77 waterbird species and 32 shorebird species. Surveys have recorded 428 estuarine and marine fishes and 17 freshwater fishes, not including records of the Honey blue-eye.The Queensland State Government WildNet database records 909 species of native plants. Changes in LAC for wetland habitats and threatened species could be used as surrogate measures for this component. | No direct LAC has been developed and instead the critical component will be assessed indirectly through changes in wetland habitats and threatened species. See  LAC above. |  |
| Criteria 4 | Habitat for critical life stages | The site provides the following critical life stage processes:   * Feeding and roosting habitat for 77 waterbird species; * Non-breeding, feeding and roost habitat for 26 migratory shorebird species including 26 and 27 species protected under the JAMBA and CAMBA agreements respectively; * Habitat for 22 frog species; * Feeding and breeding habitat for wetland-dependent raptor species; * Habitat for honey blue-eye freshwater fish (entire life-cycle); and * Nesting habitat for flatback turtles.   While an ecological condition assessment was done by Wetlands International (refer Jaensch 2008a) for the SWBTA, there is no analogous ecological condition assessment across the site. Changes in LAC for wetland habitats and threatened species could be used as surrogate measures for this component.  The ecological condition assessment by Wetlands International (refer Jaensch 2008a) provides the baseline for assessment of this LAC at SWBTA. There is no analogous ecological condition assessment for Corio Bay. Changes in LAC for wetland habitats and threatened species could be used as surrogate measures for this component. | No direct LAC has been developed and instead the critical component will be assessed indirectly through changes in wetland habitats and threatened species. |  |
| Criteria 5 and Criteria 6 | Waterbirds – numbers of species | Key shorebird species include grey-tailed tattler, bar-tailed godwit, eastern curlew, whimbrel, terek sandpiper and Australian pied oystercatcher. There is insufficient time series sequence to assess natural population variability of resident shorebird breeding success (pied oystercatcher only).  Interpretation of changes in abundance for migratory species need to be assessed against potential external factors (potential variability in breeding success) and in particular, anthropogenic impacts to key sites within other parts of the flyway.  As a result there in insufficient empirical data to derive definitive LACs. There is a need to develop a sequence of population estimates and measures of breeding success within site in order to develop empirical LACs. | Information presently insufficient for proposing any LACs |  |
| Criteria 7 | Fish | There are currently no recent baseline data (collected using systematic sampling techniques) to determine patterns in fish assemblages at representative locations and habitats in the site. Until such time as these data become available, this LAC cannot be directly assessed.  Undertaking a marine and freshwater fish survey in similar locations and using a similar methodology to Trnski *et al.* (1993) may provide an adequate baseline from which to derive a LAC for this component. Refer survey by Trnski *et al.* (1993) as the baseline for fish diversity at the time of listing in 1996 which noted 428 marine species were present and 17 freshwater species. | Information presently insufficient for proposing any LACs |  |