BCI MINERALS LIMITED

Preston Consulting

MARDIE PROJECT

BENTHIC COMMUNITIES AND HABITAT MONITORING AND MANAGEMENT PLAN

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1 CONTEXT, SCOPE AND RATIONALE

This Benthic Communities and Habitat Monitoring and Management Plan (BCHMMP) describes the monitoring and management measures to be implemented by Mardie Minerals Pty Ltd (Mardie Minerals) during the construction and operation of the Mardie Project (the Proposal) to ensure that residual impacts to benthic communities and habitat (BCH) (including *Tecticornia* spp. shrubland vegetation) are minimised.

1.1 THE PROPOSAL

The Proposal is a greenfields high quality salt and sulphate of potash (SoP) project and an associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of Western Australia (WA) (Figure 1).

The Proposal is an evaporative solar project that utilises seawater to produce raw salts as a feedstock for dedicated processing facilities that will produce high purity salt, fertiliser grade SoP product, and other commercial by-products. Production rates of 4.4 million tonnes per annum (Mtpa) of salt (NaCl), 120 kilotonnes per annum (ktpa) of SoP, and up to 300 ktpa of other salt products are being targeted, sourced from a 150 gigalitures per annum (GLpa) seawater intake. To meet this production, the following infrastructure will be developed:

- Primary seawater intake pump station;
- Concentrator ponds;
- Processing facilities and stockpiles;
- Causeway, trestle jetty and transhipment berth / channel;
- Bitterns disposal pipeline and diffuser;
- Drainage channels and flood protection;
- Administration buildings;
- Accommodation village;
- Access / haul roads;
- Desalination plant and seawater intake for fresh water production;
- Boat launching facility and port stockyard; and
- Associated infrastructure including: power supply, communications, workshop, laydown, landfill facility, sewage treatment plant.

The Development Envelopes and indicative layout of the Proposal are shown in Figure 2 and Figure 3.

Proposal elements that are specifically relevant to this BCHMMP are further detailed in the sections below.

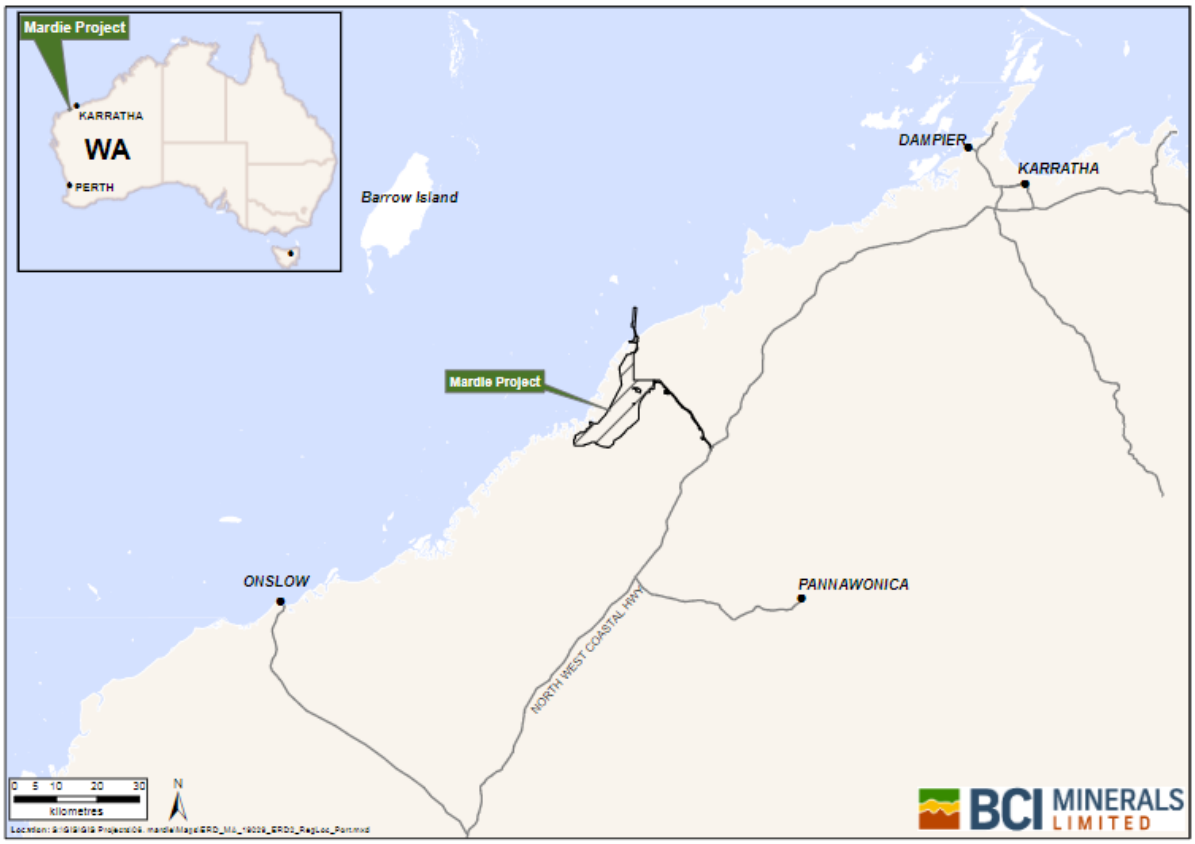


Figure 1: Regional Location of the Proposal

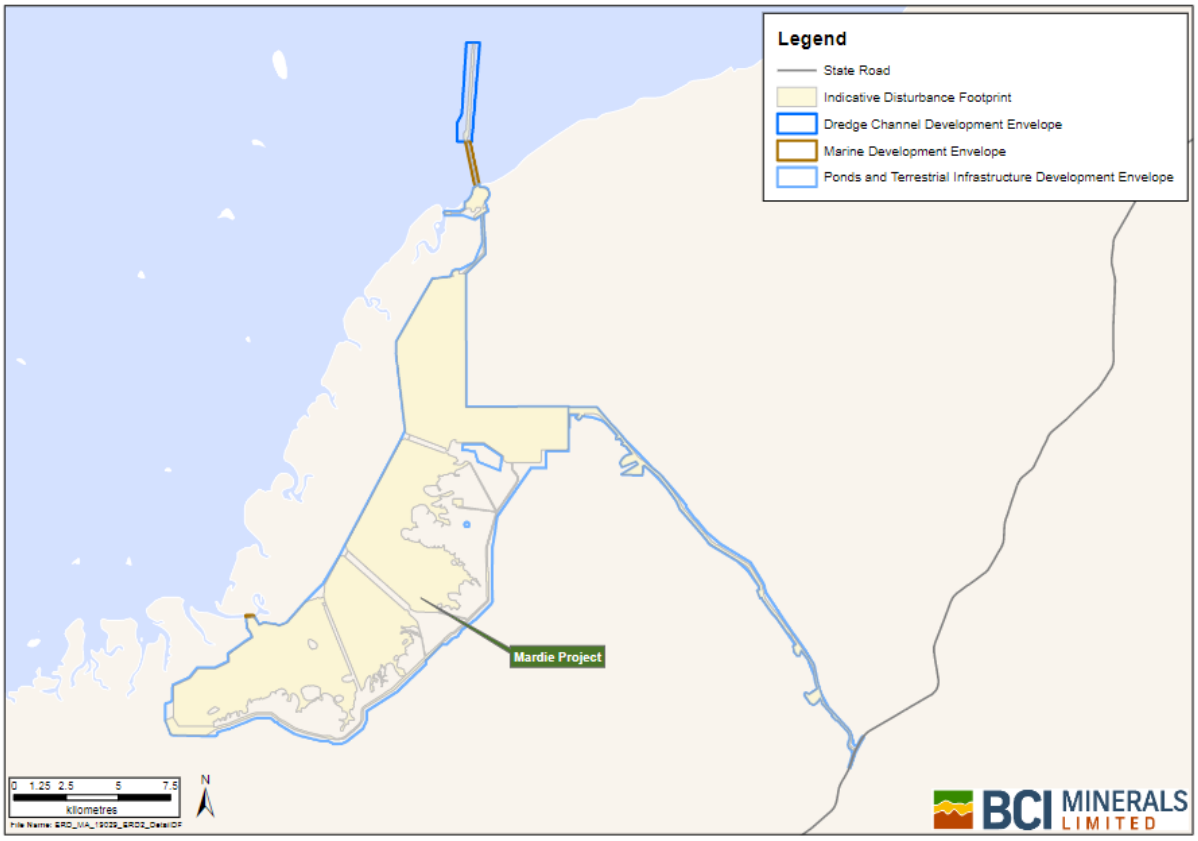


Figure 2: Proposal Development Envelopes and Indicative Disturbance Footprint

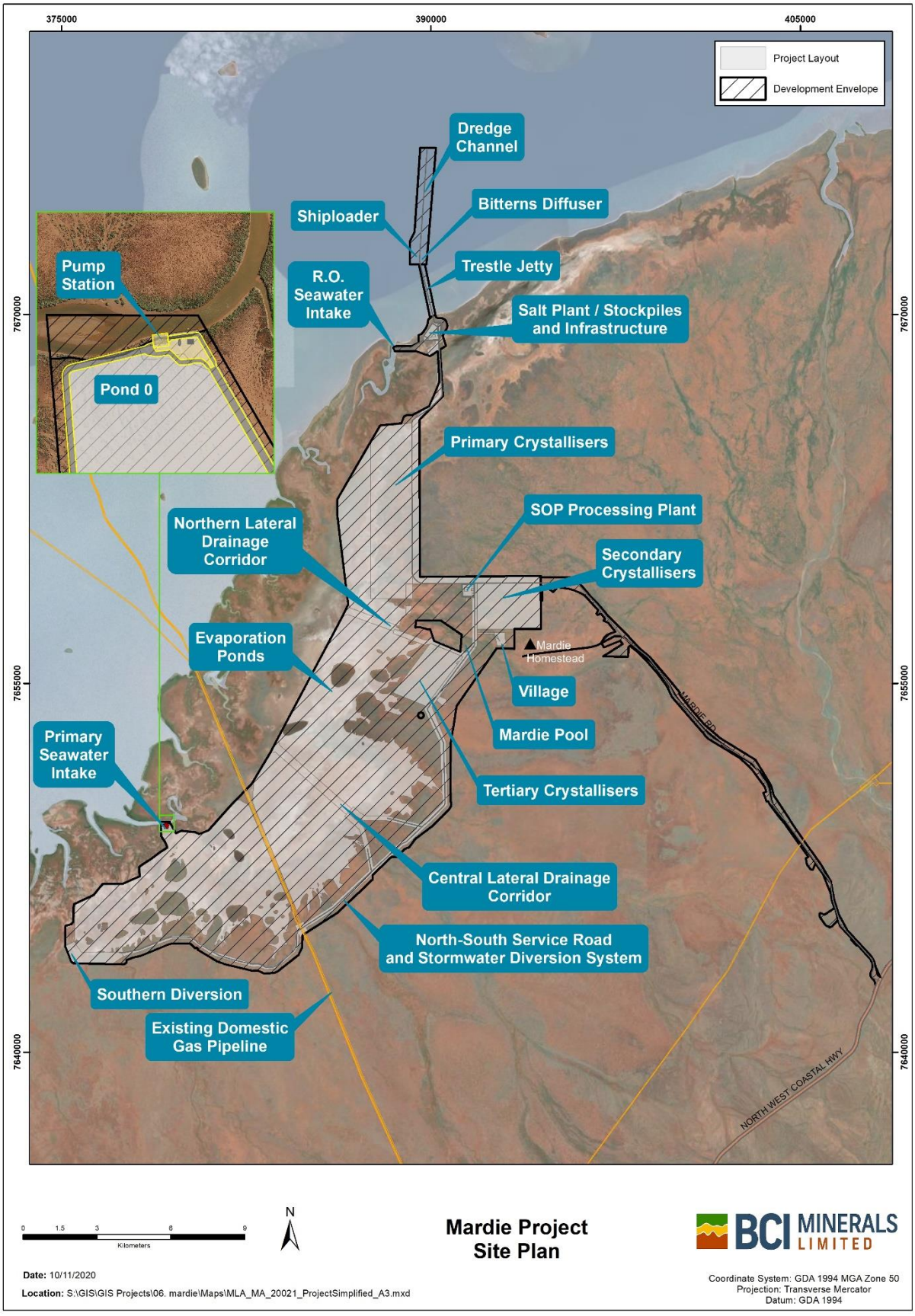


Figure 3: Indicative location of ponds and infrastructure

1.2 KEY ENVIRONMENTAL FACTORS

The key environmental factors relevant to this BCHMMP are BCH and Flora and Vegetation (*Tecticornia* spp. shrubland vegetation only). Flora and vegetation was included as samphires are considered under both the BCH and Flora and Vegetation factors. The activities that may affect these factors are described in Table 1.

Table 1: Proposal activites that may affect BCH

Key Environmental Factor: BCH	

Proposal activities that may affect factor	• Direct disturbance of up to 8,282 ha of BCH, including:
	  ○ 17 ha of mangrove habitat
	  ○ 880 ha of algal mat habitat
	  ○ 954 ha of samphire mudflat habitat
	  ○ 19 ha of vegetated sub-tidal habitat
	• BCH may be indirectly impacted by:
	  ○ The introduction of marine pests
	  ○ Increased sedimentation resulting in settlement and smothering of habitat
	  ○ Alteration to surface water regimes
	  ○ Changes to the dynamics of nutrient flows and budgets
	  ○ Leaks or spills of hydrocarbons or chemicals
	  ○ Leaks or spillages of hypersaline brine
	  ○ Potential movement of hypersaline groundwater as a result of hydrostatic pressure of the brine in the salt ponds
	  ○ Bitterns disposal (salinity) at discharge locations
	  ○ Restriction of inland movement of zone due to sea level rise

Environmental values that may be affected	• General intertidal BCH • Mangrove communities • Algal mat habitat • Samphire / samphire mudflat habitat; and • Sub-tidal BCH
Ecosystem health condition / sensitive component of the key environmental factor	The BCH in the area is noted to be of high quality with no current impacts to health or condition.
Existing and/or potential uses	Limited clearing for pastoral use and gas pipelines.
Key Environmental Factor: Flora and Vegetation (*Tecticornia* spp. shrubland vegetation only)	

Proposal activities that may affect factor	• Direct disturbance of up to 1,108 ha of *Tecticornia* spp. shrubland vegetation, including up to 2.6 ha of the significant TtSvTc vegetation type.
	• *Tecticornia* species may be impacted by changes to salinity and hydrological regimes. Indirect impacts may result from the following or a combination of the following changes:
	  ○ Unintentional spillage or seepage of brine from concentrator and crystalliser ponds or pipelines
	  ○ Alteration of hydrological regimes
	  ○ Reduced rehabilitation success due to high salinity

Environmental values that may be affected	• Unidentified and potentially undescribed *Tecticornia* species • *Tecticornia* spp. shrubland vegetation including significant vegetation type TtSvTc (significant due to the presence of unidentified and undescribed *Tecticornia* species).
Ecosystem health condition / sensitive component of the key environmental factor	The *Tecticornia* spp. shrubland on the tidal mudflats has been subject to little or no disturbance apart from 43 ha of disturbance associated with two gas pipelines.
Existing and/or potential uses	Limited clearing for pastoral use and gas pipelines.

1.3 Scope and Association with Other Management Plans

This BCHMMP is designed to align with other Proposal management plans and avoid repetition. To that extent, this BCHMMMP provides monitoring and management actions for BCH and *Tecticornia* spp. shrubland vegetation impacts, with the exception of monitoring and management actions associated with:

- Dredging activities, which are covered in the Dredge Management Plan;
- Bitterns disposal, which are covered in the Marine Environmental Quality Monitoring and Management Plan (MEQMMP).

The Groundwater Monitoring and Management Plan provides monitoring and management actions related to groundwater seepage and mounding, which will trigger some of the BCH monitoring actions presented in this BCHMMP.

The actions in this BCHMMP may trigger additional monitoring measures in the Long-term Migratory Shorebird Survey Program.

The management of marine pests will be in accordance with Department of Primary Industries and Development requirements and therefore has not been included in this BCHMMP.

The management of leaks or spills of hydrocarbons, chemicals or hypersaline brine will be managed under the *Mining Act 1978* and Part V of the *Environmental Protection Act 1986* and therefore has not been included in this BCHMMP.

1.4 Condition Requirement

The Ministerial Statement for the Proposal has not yet been issued, therefore this section will be completed once the conditions are released.

1.5 Rationale and Approach

1.5.1 Management Objectives

The management objectives of this BCHMMP are:

1. Limit the direct disturbance of BCH and *Tecticornia* spp. shrubland vegetation to that specified in the ERD;
2. Ensure that indirect impacts to BCH from changes to hydrological regimes are minimised;
3. Ensure that indirect impacts to BCH from sedimentation are minimised during construction; and
4. Quantify any changes in BCH boundaries, cover and composition over time.

1.5.2 Survey and Study Findings

Survey Effort

A number of surveys and studies have been undertaken to for BCH and *Tecticornia* communities within the Proposal study areas, including:

- A regional intertidal BCH assessment of mangal (mangroves) and algal mat communities undertaken by Stantec consisting of a desktop (literature) review, preliminary hydrological modelling, and reconnaissance and targeted field surveys;
- Intertidal BCH assessments undertaken by O2 Marine, including a comprehensive desktop review of the intertidal BCH in vicinity to the Proposal and two field surveys (March 2018, December 2018) to collect information to fill any data gaps identified in the desktop review;
- A series of five surveys conducted from March 2018 to March 2019 by O2 Marine to characterise, map and describe the functional ecological value and regional significance of the subtidal BCH within Local Assessment Unit (LAU) 7;
- A detailed flora and vegetation survey by Phoenix Environmental Sciences (Phoenix), including extensive reconnaissance and detailed field surveys to verify and build on desktop reviews compiled using existing information of the Project and its surroundings. Survey effort included two helicopter reconnaissance surveys (August 2017, September 2017), a first phase detailed flora survey (May 2018), a second phase detailed flora survey (August 2018) and an additional survey of extended survey areas (September 2019). These surveys included *Tecticornia* spp. shrubland vegetation within the vicinity of the Proposal. An additional targeted conservation significant flora survey was conducted in March 2020, with the results incorporated into a revised Phoenix (2020a) Flora and Vegetation Survey Report. The survey included a targeted survey for *Minuria tridens* (P1) and unidentified *Tecticornia* species; and
- Actis Environmental Services conducted a review of the survey effort within samphire communities: 'Survey Adequacy of Tecticornia Communities at the Proposed Mardie Salt Field'.

These survey reports are included in the Proposal Environmental Review Document and Response to Submissions document available on the EPA website. The results of the surveys as relevant to this BCHMMP are summarised in the sections below.

Local Area Assessment Units

Seven LAUs were established across the O2 Marine Study Area, to provide a regional context for characterisation, mapping and assessment of impacts to BCH (Figure 4). LAUs were determined through consideration of the following key factors:

- BCH type, condition, extent and distribution;
- Management boundaries (i.e. Regionally significant mangrove areas);
- Bathymetry; and
- Coastal geomorphology.

Additional information related to the LAUs is provided in the Mardie Project ERD (Preston Consulting, 2020) and the BCH Cumulative Loss Assessment Report (O2 Marine, 2020XX), which are available on the EPA's website.

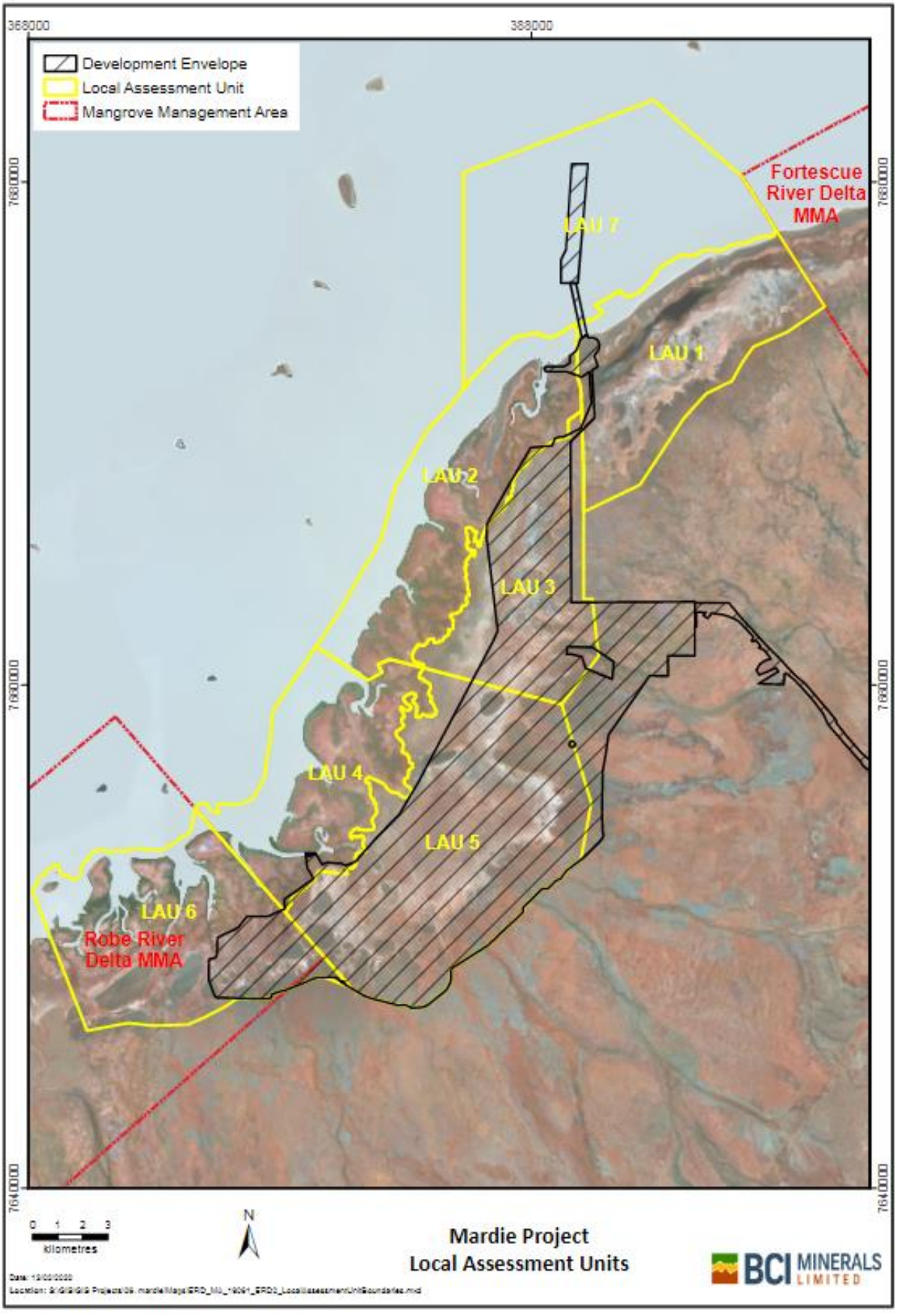
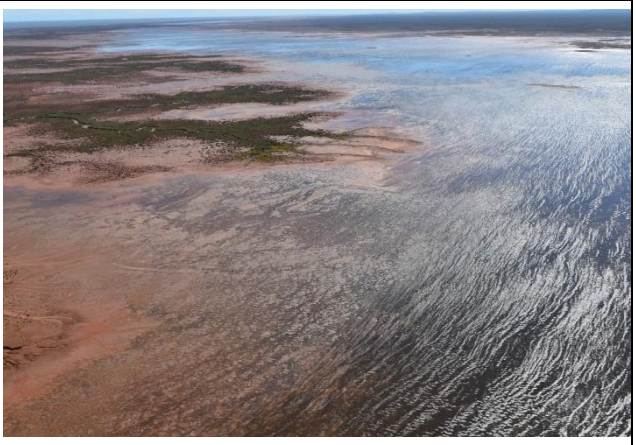


Figure 4: Boundaries of LAUs

Intertidal Benthic Communities and Habitat Summary

Eight broad intertidal BCH classes were identified and mapped within the Study Area, as shown in Figure 5 and detailed in Table 2.

Table 2: Description of broad intertidal BCH classes mapped within the Study Area.

Habitat Class	Example Image
Algal Mat Algal mats are typically green to grey or black, and either contiguous or fragmented. 11 species were identified with filamentous cyanobacteria *Microcoleus* sp. and *Lyngbya* sp. the dominant species. Algal mat communities extend over 3,400 ha and comprise 10% of the total mapped intertidal BCH area. They predominantly occur in two major communities within the central and northern sections of the Study Area. They occur within a relatively nominal elevation of 1.1 – 1.3 m AHD which is lower than the adjacent seaward BCH where they form vast shallow lakes at high tides (>1.2m).	
Foreshore Mudflat/Tidal Creek A variety of benthic habitat types from flat fine to coarse sands, flat mud, sparse to high macroalgae, and low to moderate seagrasses were identified occurring within Foreshore Mudflats/Tidal Creeks. Foreshore Mudflats/Tidal Creeks occur over 5,000 ha and comprise 14% of the total mapped intertidal BCH area. Tidal creeks are typically well established within the southern LAUs (Robe River Delta) and become sparser in the northern LAUs. Foreshore mudflats extend over a wider area through the central LAUs with subtidal area much closer to the coastline in the northern and southern LAUs.	
CC Mangroves CC mangroves comprise the greater structural complexity, typically higher seaward mangrove associations. *Avicennia marina* dominate the species with *Rhizophora stylosa* the sub dominant species. CC mangrove communities extend over 1,280 ha and comprise 4% of the total mapped intertidal BCH area. They are very well established within LAU 6, with over 46% of their total area represented. CC mangroves occur as ribbons along the coastline and fringing tidal creeks, with more vast forest occurring within the southern LAU, particularly LAU 6 within the boundary of the Robe River Delta Mangrove Management Area.	

Habitat Class	Example Image
SC Mangroves SC mangroves comprise the least structural complexity, typically lower landward mangrove associations. *Avicennia marina* dominate the species with *Ceriops australis* also observed. SC mangrove communities occur over 2,300 ha and comprise 7% of the total mapped BCH area. SC mangroves are the most extensive mangrove functional groups representing over 64%. They are typically located on the landward extents extending over wide intertidal mudflat areas with the largest areas occurring in LAU 2, LAU 4 and LAU 6.	
Rocky Shoreline Rocky shorelines within the Study Area were typically low relief rock platforms generally with little to low associated flora and fauna. Macroalgae were identified as the dominant communities with minimal juvenile hard corals, oyster stacks and some soft corals also present. Rocky shorelines occur over 59 ha comprising <1% of the total mapped BCH area. They are only located within LAU 2 and LAU 6.	Not available.
Samphire/Samphire Mudflat Samphire/Samphire Mudflats are distributed over more than 5,900 ha, comprising approximately 17% of the mapped intertidal BCH. They are typically located on the landward extent of mangroves, whilst through the centre of the Study Area are on the seaward extent of algal mats, with a smaller communities in LAU 1 and LAU 3 seaward of terrestrial vegetation. By area they are the greatest in LAU 2 and lowest in LAU 1.	
Mudflat/Saltflat Mudflat/Saltflats are extremely low in biodiversity and support little to no associated fauna or flora due to their characteristic high salinities. Mudflat/Saltflats are the dominant intertidal BCH extending over 10,500 ha and comprising 29% of the total mapped BCH area. They are most dominant through the supratidal LAUs (3 & 5) representing over 83% of their total distribution. They typically occur on the higher intertidal gradients on the landward extent of Samphire's or Algal Mats.	

Habitat Class	Example Image
Sandy Beach Sandy beaches are typically flat, low energy, low profile beaches backed by gently rising dunes. Sandy beaches are only located within LAU1 and LAU 2 representing 32 ha in total and comprising <1% of mapped BCH. They are found extending from the northern extent of LAU 1 into the northern LAU 2 they continue along the coast for approximately 2.5 km west of the northernmost creek mouth.	

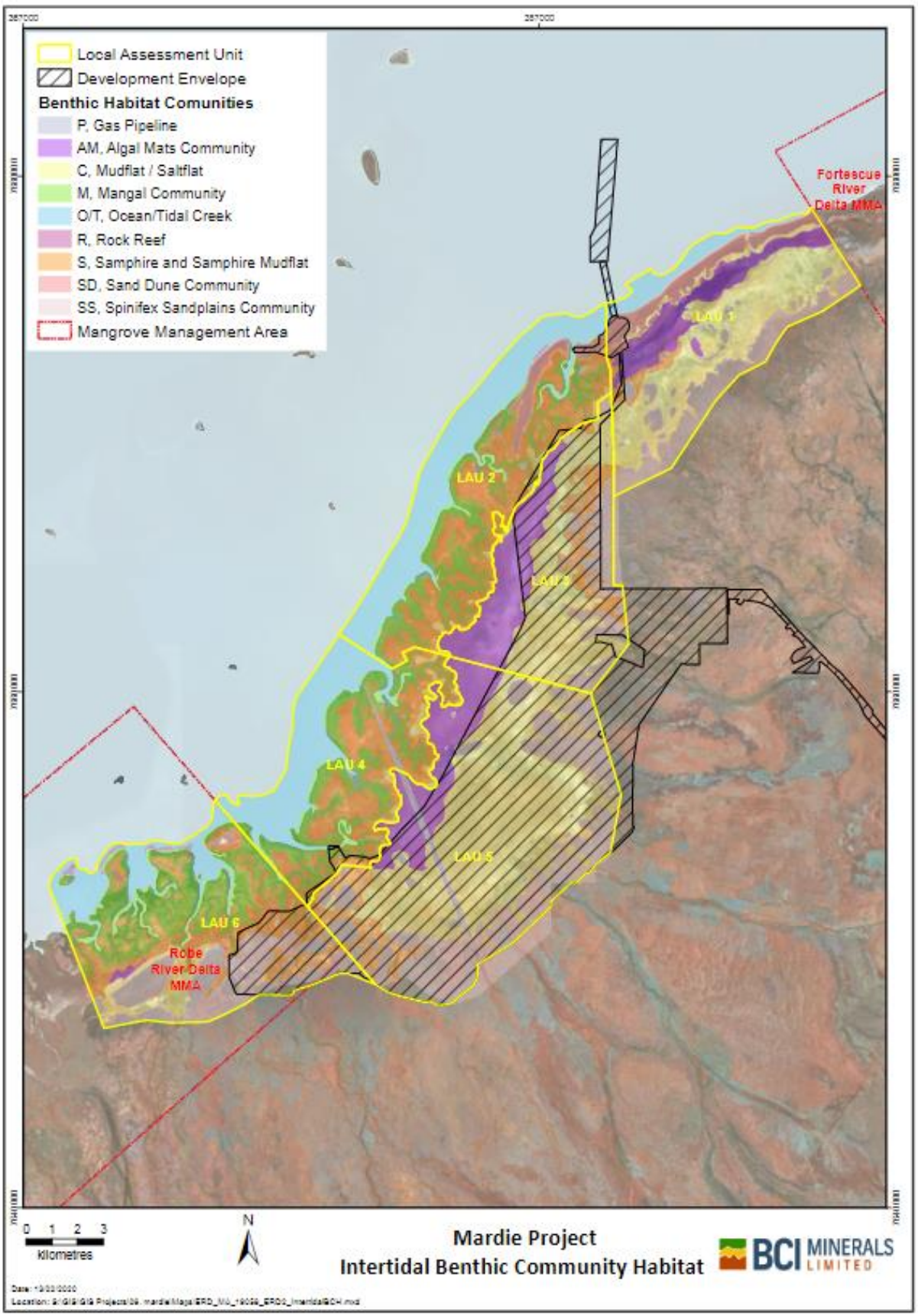


Figure 5: Intertidal benthic communities and habitat within the LAUs

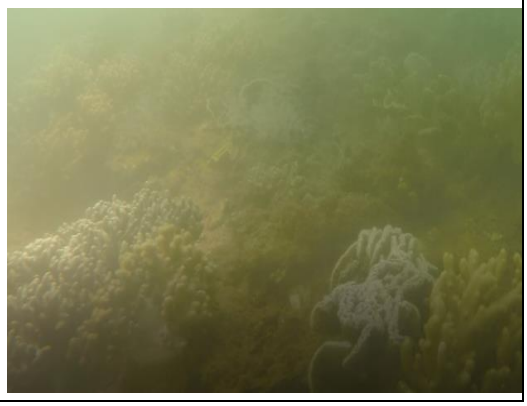
Subtidal Benthic Communities and Habitat Summary

Three broad subtidal BCH habitat classes were identified within LAU 7 (Bare sand, filter feeder/macroalgae/seagrasses and coral/macroalgae), with eight BCH subclasses distinguished based on varying levels of benthic cover and dominant taxa. These classes are described in Table 3 and mapped in Figure 6.

Table 3: Description of broad subtidal BCH classes mapped within LAU 7

BCH Class	Description	Example Image
Bare / bioturbated sand	**Bare Silt / Sand** Typically comprises of silt or sand with no or occasional very sparse macroalgae. Silt areas often comprised of bioturbation (burrows formed by living organisms). Sand areas often contain traces of shell grit. This habitat comprises 89% of the subtidal BCH within LAU 7 and is also widely dispersed across the region.	
	Sand / Sparse (<5%) Macroalgae Fine silt/sand and bioturbated bedform with a very patchy distribution of macroalgae and invertebrates. Macroalgae (*Phaeophyta*) was the dominant cover, but was very sparse, generally comprising <1% of the overall cover. Class was differentiated from the other macroalgal classes due to the very sparse nature of the cover and the much finer grained, and often bioturbated sediments. This habitat comprises 1% of the subtidal BCH within LAU 7. Outside LAU 7, it was also observed on the eastern fringing waters of Round Island, whilst the largest contiguous area was observed closer to the mainland in the shallow waters between Angle Island and the mainland.	
Filter feeder/ macroalgae / seagrass	**Sand / Sparse (<5%) Filter Feeders** Sparse filter feeder habitat occurs where the relief is flat and is associated with fine to coarse sands. Although only present in sparse densities (<5% cover), hydroids are most common where there is no bedform, whilst sponges occur where there is some bioturbation. This habitat comprises 2% of the subtidal BCH within LAU 7 and is widely dispersed throughout the region.	

BCH Class	Description	Example Image
Filter feeder/ macroalgae / seagrass	**Low (5-10%) Cover Macroalgae / Filter Feeders** Flat to low relief constituting either fine to coarse sands, including shell grit on occasions. Macroalgae, hydrozoan and sponge species are equally dispersed throughout this habitat although benthic cover is low (3-10%). Occasional very sparse (<1%) cover of *Halophila* sp. seagrass was also observed at some locations. This habitat comprises 6% of the subtidal BCH within LAU 7 and follows a patchy distribution throughout the region. Outside of LAU 7, this habitat was also observed in small patches fringing the shallow waters of Long Island, Mardie Island and close to the mainland.	
Coral/ macroalgae	**Low (5-10%) Cover Coral** Flat to low relief rock and rubble with coarse sand. Low (3 - 10%) cover of soft and hard corals, including *Faviidae, Dendrophyllidae, Mussidae and Octocroals*. Sparse macroalgae was also present. This habitat comprises 1% of the subtidal BCH within LAU 5. Outside of LAU 7 this habitat was also found fringing Mardie Island and in small isolated patches between Angle Island and the mainland. It was generally recorded in waters between 1-3 m depth.	
	Moderate (10-25%) Cover Coral / Macroalgae Low to moderate relief rock and rubble/coarse sand. Low to moderate cover (3 – 25%) of soft and hard corals with macroalgae. Corals largely consisted of *Faviidae, Poritidae, and Octocorals,* while *Phaeophyceae* dominated the macroalgae communities. This habitat class comprises only 1% of the subtidal BCH within LAU 7. However, outside of LAU 7, it was recorded in larger areas in fringing shallow waters south of Mardie Island and adjacent to the mainland coast.	
Coral/ macroalgae	**Dense (>25%) Cover Macroalgae / Coral / Filter Feeders** This habitat class occurs on low relief substrate with fine to coarse sands and areas of exposed limestone reef. Dense assemblages (>75%) of macroalgae and hydrozoan species predominately in waters at depths of 2.2 - 4.0 m. This habitat also supported sparse juvenile corals (*Faviidae, Dendrophyllidae, Mussidae)* with occasional larger coral (*Poritidae*) bommies (1 – 2 m diameter). This habitat class comprised <1% of the subtidal BCH in LAU 7. It was also identified outside of LAU 7 in the waters fringing the eastern outer edge of Long Island, Round Island and Sholl Island.	

BCH Class	Description	Example Image
	Dense (>25%) Cover Coral Dominated Low relief limestone reef and rubble substrate which supports high coral cover (25%-75%) of diverse coral species, including *Faviidae, Dendrophyllidae, Mussidae, Portitidae*, and *Octocoral* species. This habitat class was only recorded at one location in LAU 7 and, as such, comprises only <1% of the subtidal BCH within LAU 7. However, it was also recorded outside LAU 7, in a much larger area, fringing the northern edge of Mardie Island.	

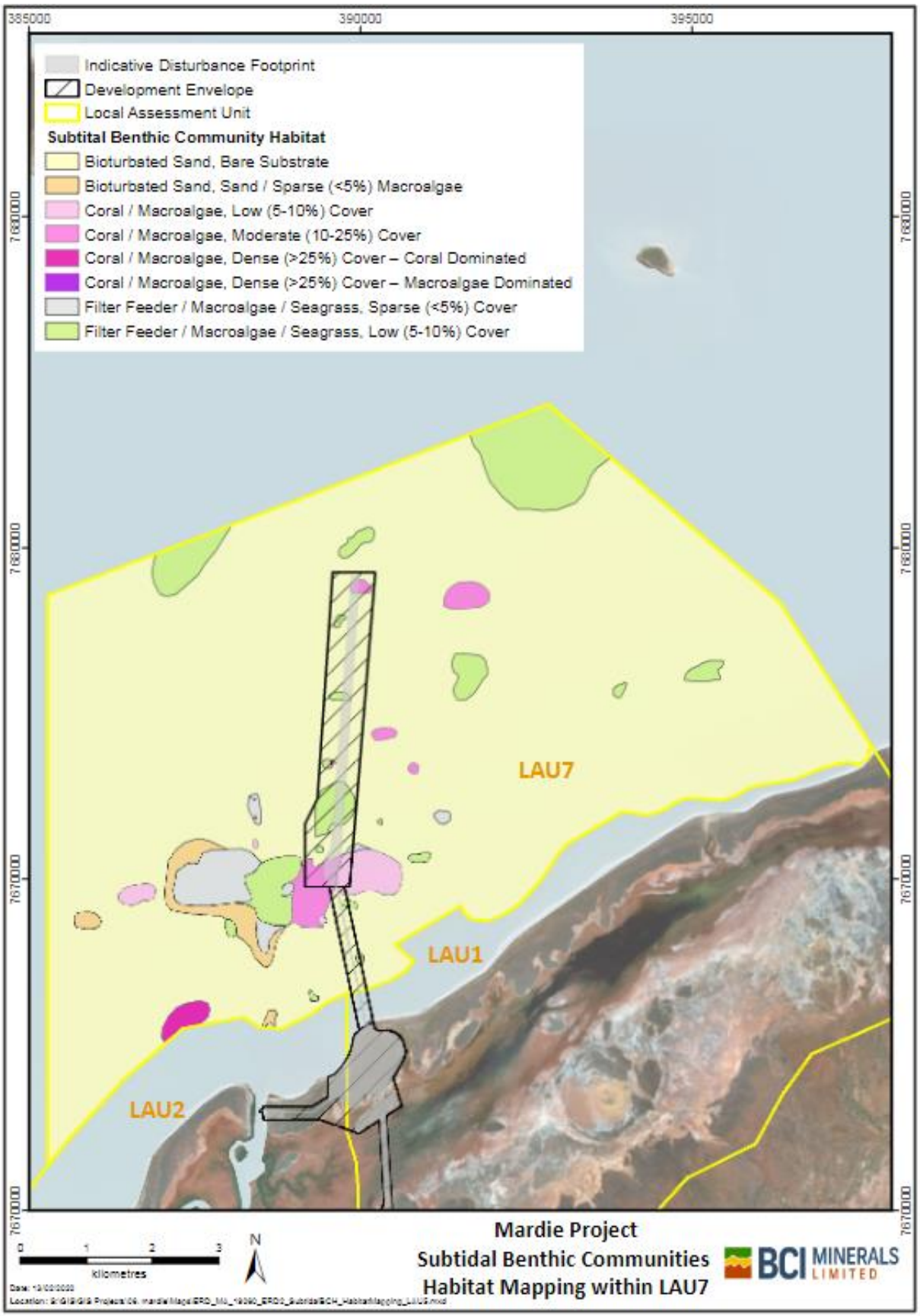


Figure 6: Subtidal BCH within LAU 7

Tecticornia spp. shrubland vegetation

Fourteen vegetation types were mapped within the Study Area (Figure 7), and two vegetation types containing *Tecticornia* spp are relevant to this BCHMMP:

- Tspp: low open *Tecticornia* spp. chenopod shrublands over low open mixed grasslands; and
- TtSvTc: Low shrubland over *Sporobolus virginicus* grassland.

Tspp was identified as a significant vegetation type. Its significance was attributed to it providing habitat for one *Tecticornia* taxon considered representative of an undescribed species and a further four *Tecticornia* taxa that could not be described to species level and may potentially represent undescribed species. Additionally, the TtSvTc was also identified as habitat for the undescribed and potentially undescribed *Tecticornia* taxa mentioned above.

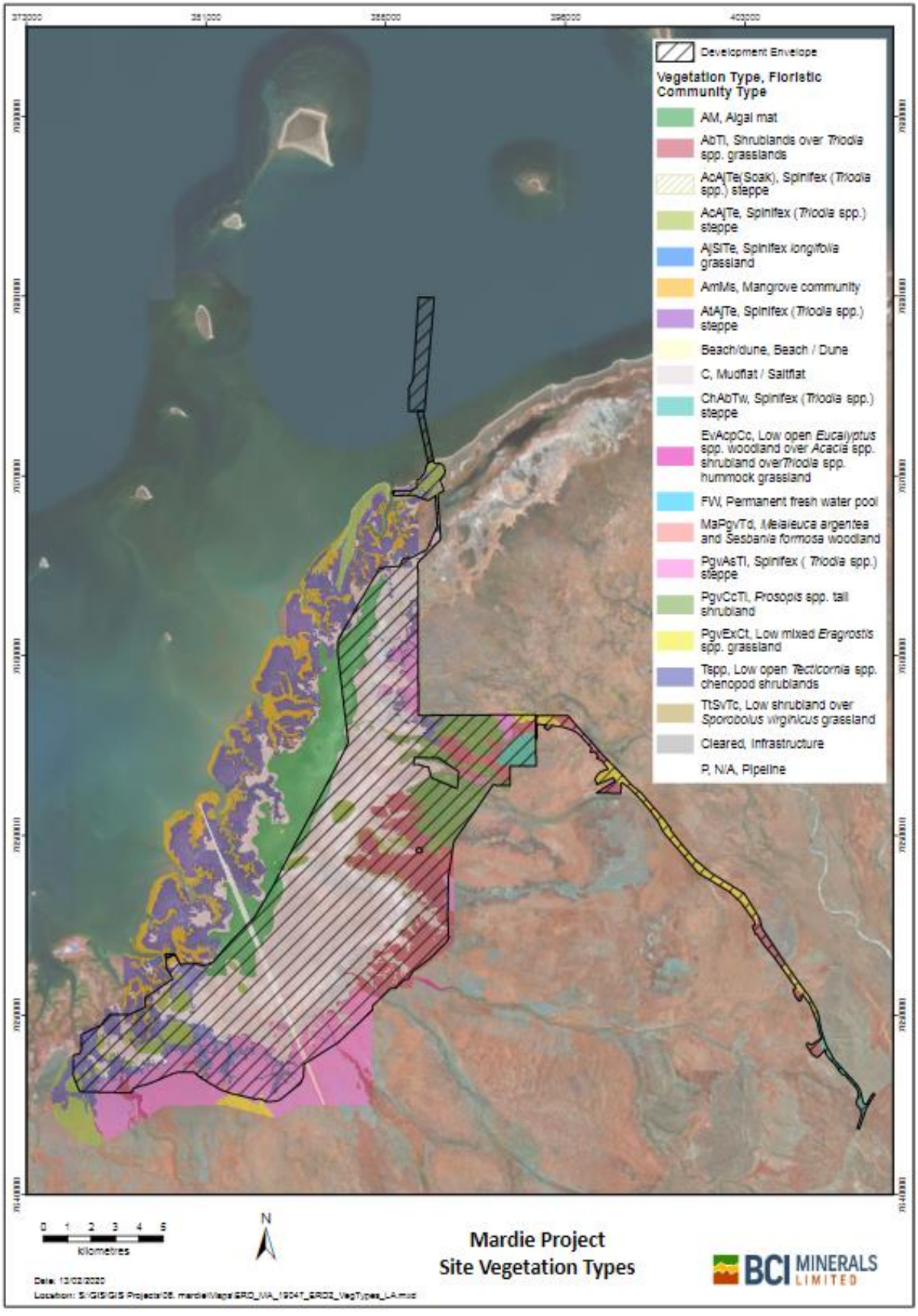


Figure 7: Vegetation Types

1.5.3 Relevant Environmental Values

The key environmental values relevant to this BCHMMP include:

- General intertidal BCH;
- Mangrove communities;
- Algal mat habitat;
- Samphire / samphire mudflat habitat;
- Sub-tidal BCH;
- Unidentfied and potentially undescribed *Tecticornia* species; and
- *Tecticornia* spp. shrubland vegetation (as defined by Phoenix (2020XX), 'Low open *Tecticornia* spp. Chenopod shrublands'), including locally significant vegetation type TvSvTc, due to the provision of habitat for one *Tecticornia* taxon considered representative of an undescribed species and/or the further four *Tecticornia* taxa that could not be described to species level and may potentially represent undescribed species.

1.5.4 Key Assumptions and Uncertainties

The indirect BCH impacts of the Proposal associated with hydrological changes are based on numerous models, all of which use a number of key assumptions to develop the models. These include:

- Soil permeability and seepage rates;
- Groundwater flow rates;
- Surface water runoff volumes and flow rates during rainfall events;
- Tidal inundation flow paths; and
- Sea level rise estimates.

This BCHMMP and other associated management plans include verification of these model assumptions and adaptive management if required based on updated information.

1.5.5 Rationale for Choice of Management Actions

The management actions presented in this BCHMMP have been designed according to the following rationale:

1. Model verification monitoring should be conducted as soon as possible to allow more accurate modelling to be conducted using real-time data. The revised model outputs should then be used to determine if there are any expected changes in the intensity, duration, magnitude or geographic footprint of any predicted impacts;
2. Early response indicators and criteria are used, based on the physical monitoring and management of impacting influences. For example the monitoring of hydrological changes should be trigger early management actions rather than relying on the results of BCH monitoring;
3. Management actions allow for expected changes to the environment (such as sea level rise) or possible effects of issues external to the Proposal; and
4. Mitigation measures are chosen that will have an appropriate timeframe for the mitigation to take effect.

2 COMPONENTS

2.1 INTEGRATED MONITORING PROGRAM

Mardie Minerals will implement an Integrated BCH Monitoring Program to achieve the management objectives outlined in Section 1.5.1 of this BCHMMP.

Each sub-program will be integrated into a set of nine transects, comprising control and impact areas, that commence at the seaward pond wall and will traverse generally in an east-west direction to the western margin of mangrove stands. The set also includes transects located each side of the proposed causeway; one on the west side and two on the east (upstream) side. The transects are shown in Figure 8.

Each sub-program will comprise both remote monitoring and on-ground measures:

- Multi-spectral satellite imagery (red, green, blue, NIR as a minimum) at ~50 cm resolution will be captured quarterly for mangrove stands, *Tecticornia* shrublands and algal mats at each transect, with the following measures/indices derived:
    - Spatial extent (m^2) determined and captured as vector data;
    - Raster dataset derived for Normalised Difference Vegetation Index (NDVI), Moisture index, other indices as appropriate;
- On-ground monitoring for *Tecticornia* health applied annually in an appropriate season (summer) (see specific methods for *Tecticornia* monitoring in Section 2.1.5), or following a trigger event such as a wall breach, spill or where quarterly remote sensing data suggests significant change has occurred by the afore-mentioned or due to a cyclone;
- On-ground monitoring for Mangrove health applied every five years in an appropriate season (summer) (see specific methods for Mangrove monitoring in Section 2.1.3), or following a trigger event such as a wall breach, spill or where quarterly remote sensing data suggests significant change as occurred by the afore-mentioned or due to a cyclone.
- Diver-based monitoring of subtidal BCH health applied biennially and monitoring of spatial extent of key subtidal habitat every five years (see specific methods for subtidal monitoring in Section 2.1.4) or following a trigger event such as a toxicant spill, reports of animals kills / disease / lesions, a large scale disturbance event, as directed by an exceedance of Environmental Quality Guidelines or post-cyclone if warranted; and
- Continuous inundation / sea level monitoring via a tide gauge to measure inundation at the Proposal.

In additional to the Integrated BCH Monitoring Program, a series of other monitoring and management plans will be implemented for the Proposal, including:

- Groundwater Monitoring and Management Plan;
- Long-term Migratory Shorebird Survey Program;
- Dredge Management Plan; and
- MEQMMP.

Findings from these monitoring programs may be used to inform the analysis of results from the BCHMMP monitoring and management actions or may trigger additional monitoring requirements under the BCHMMP.

Further detail on the various monitoring and management programs for BCH and *Tecticornia* spp. shrublands are outlined in Sections 0 - 2.1.5. Specific management actions for the BCHMMP are outlined in Section 2.2.

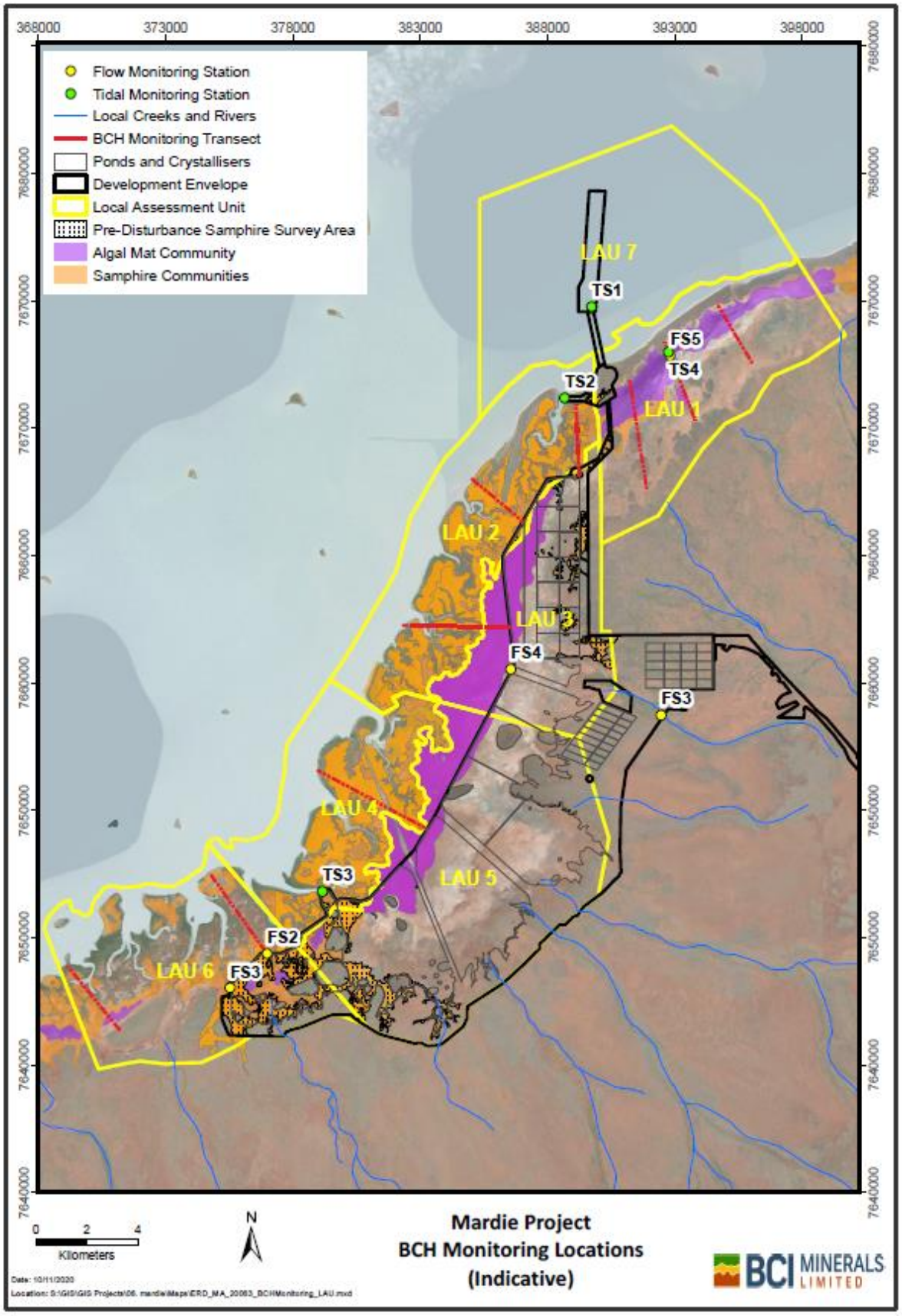


Figure 8: Location of monitoring transects

2.1.1 INUNDATION / SEA LEVEL MONITORING

Inundation / sea level monitoring will be undertaken at the Proposal to determine:

- Actual tidal inundation changes associated with Proposal (i.e. due to the presence of the causeway, pond walls or due to seawater abstraction;
- Actual freshwater inundation changes associated with the Proposal (i.e. due to drainage diversions and rainfall capture within the ponds); and
- Sea level monitoring to record changes in sea water levels due to climate change.

The monitoring information will be used to inform whether boundary changes to BCH or *Tecticornia* spp. shrublands are occurring as a result of changes to inundation or sea level rise. Inundation will be monitored by tide gauges with continuous sampling and real time display on a dedicated webpage. Specific details are included in Table 4.

Table 4: Inundation monitoring

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Tidal Inundation (Causeway and Ponds)				
Sampling Method Tide gauge Analytical Inundation levels relative to model predictions across full tidal range Mean trend relative to known land benchmarks and past yearly assessments.	Water levels	Tidal inundation monitoring points shown in Figure 8.	Continuous sampling with real time display on dedicated webpages. Annual data analysis, QAQC, and reporting.	-
Freshwater Inundation (Causeway and Ponds)				
Sampling Method Tide gauge Analytical Inundation levels relative to model predictions until flows cease	Water levels	Freshwater inundation monitoring points shown in Figure 8.	Continuous sampling with real time display on dedicated webpages. Annual data analysis, QAQC, and reporting.	Salinity levels (to determine proportion of freshwater inflows)
Sea Level Rise				
Sampling Method Tide gauge Analytical Mean sea level trend relative to known land benchmarks and past yearly assessments.	Sea level	Export Port / Jetty	Continuous sampling with real time display on dedicated webpages. Annual data analysis, QAQC, and reporting.	-

2.1.2 ALGAL MAT

Spatial Extent Survey

The spatial extent of algal mat BCH will be assessed using remotely-sensed multi-spectral data at an appropriate capture resolution, as part of the Integrated BCH Monitoring Program. The survey will be undertaken quarterly, with the entire algal mat extent within the spatial bounds of each monitoring program transect being assessed. Analysis will be undertaken to determine the area of decline or expansion / improvement, as well as any seasonal or annual photosynthetic trends. Further detail related to the health monitoring of algal mat is included in Table 5.

Table 5: Monitoring of Algal Mat BCH

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Nine BCH transects will be established as part of the integrated BCH monitoring program. Remotely-sensed multi-spectral data at appropriate capture resolution. Known extent of algal mat will be defined (using vector dataset), including ground-truthing of any potential dormant algal mats, and the raster data analysed only within the area of the known algal mat extent (i.e. it will act as a data mask). With a defined analysis extent, the difference in NDVI in each pixel from one time-period to the next can be calculated so that areas of decline or expansion/improvement can be identified and seasonal or annual photosynthetic trends determined.	NDVI = $\frac{NIR - Red}{(NIR + Red)}$ Pixel values can then be compared in a time-series to detect reduction in area (ha) of algal mat	Entirety of algal mat extent within the spatial bounds of each Integrated BCH monitoring transect (5)	Quarterly – a subscription service (e.g. Planet.com) will be established so that satellite acquired data can be downloaded and analysed each quarter	-

2.1.3 MANGROVES

Spatial Extent Survey

The spatial extent of the mangrove communities will be assessed using remotely-sensed multi-spectral data at an appropriate capture resolution. A total of five BCH transects will be established as part of the integrated program; (two control transects and three impact transects). The survey will be undertaken quarterly, with the entire mangrove extent within the spatial bounds of each monitoring program transect being assessed. Analysis will be undertaken to determine the area of decline or expansion / improvement, as well as any seasonal or annual photosynthetic trends. Further detail related to the spatial extent monitoring of mangrove communities is included in Table 6.

Mangrove Area Mapping

The spatial extent of mangrove assemblages will be mapped from aerial photograph using GIS. The mapping area will extend to LAUs 1-6 (see Section 1.5.2 for additional detail on LAUs). Further information including details around sampling and analysis methods and parameters measured can be found in Table 6.

Mangrove Health Monitoring

An on-ground mangrove health assessment will be undertaken every five years to monitor the health of mangrove communities adjacent to the Proposal. Mangrove health monitoring will be conducted across the nine transects, where mangroves are present.

Reactive health monitoring of mangrove assemblages will be undertaken after a trigger event, using the same sampling and analysis methods as routine health monitoring. Sampling locations for reactive monitoring will be determined based on the trigger event (e.g. sites where mangroves have been impacted directly with suitable reference sites will be monitored for a spillage, while routine transects M1 - M5 would be monitored post cyclone).

Further detail around sampling and analysis methods, parameters measured and trigger events can be found in Table 6.

Table 6: Monitoring of mangrove communities

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Spatial Extent Survey				
<u>Sampling Methods</u> Nine BCH transects will be established as part of the Integrated BCH Monitoring Program (including 2 x control transects and 3 x impact transects). Remotely-sensed multi-spectral data at appropriate capture resolution. Known extent of mangrove communities will be defined (using vector dataset) and the raster data analysed only within the area of the known mangrove community extent (i.e. it will act as a data mask). With a defined analysis extent, the difference in NDVI in each pixel from one time-period to the next can be calculated so that areas of decline or expansion / improvement can be identified and seasonal or annual photosynthetic trends determined. <u>Analytical Methods</u> 1. Analyse Multispectral imagery in GIS to create a orthomosaic image of the study area 2. Calculate NDVI from the orthomosaic image using GIS 3. Define the extent of mangrove coverage through extrapolating GPS coordinates along the transect line	NDVI = $\frac{NIR - Red}{(NIR + Red)}$ Pixel values can then be compared in a time-series to detect reduction in area (ha) of mangrove communities. Spatial extent of mangroves along transect	Entirety of mangrove community extent within the spatial bounds of each Integrated BCH Monitoring Program transects (M1-M5)	Quarterly – a subscription service (e.g. Planet.com) will be established so that satellite acquired data can be downloaded and analysed each quarter Reactive monitoring may be triggered by: • Toxicant spill • Reports of animal kills/disease/lesions • Health concern reports • Large scale disturbance event • As directed by an exceedance of Environmental Quality Guidelines (MEQMMP) • Investigations determining mangrove monitoring is required • Post cyclone, if warranted	-

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
4. Compare NDVI and Mangrove extent with baseline dataset to assess mangrove health				
Mangrove Area Mapping				
<u>Sampling Method</u> Purchase suitable aerial photography for the extent of the coastal LAUs. <u>Analytical Method</u> 1. Map the spatial area of mangrove assemblages for aerial photography using GIS 2. Calculate the spatial area coverage for each assemblage with the GIS 'calculate geometry' tool. 3. Create shape files for comparison with baseline dataset using GIS overlay function.	• Mangrove spatial area – remote • Species richness • No. of trees • Canopy Density • Canopy height • Canopy condition • Diameter Breast Height (DBH) of 10 stems • Biomass estimate (post-survey calculation) • General observations	Mangrove area: LAUs 1-6	Routine: Five yearly Reactive Monitoring: • A toxicant spill; • Reports of animal deaths / disease / lesions; • Health concern reports; • Large scale disturbance event; • As directed by an exceedance of Environmental Quality Guidelines (MEQMMP) AND investigation determines mangrove monitoring required • Post cyclone if warranted	-
Mangrove Health Monitoring				
<u>Sampling Method (routine and reactive monitoring)</u> 1. Select 3 locations at each monitoring site which represent seaward edge, centre closed canopy and landward edge communities 2. Survey 2 replicate flora quadrats (10 m x 10 m) at each location for list indicators (Column 1) <u>Analytical Method</u> 1. Upload data into ProUCL (or similar) and Excel databases 2. Calculate simple statics of sampled metrics 3. Convert DBH and results for the number of trees to above-ground biomass (AGB) using the allometric relationship between stem diameter and AGB for mangrove communities in the Pilbara described in Clough et al. (1997) 4. AGB is calculated based on mean DBH measurements and mean stem count results from each quadrat 5. Calculate biomass estimates using GIS spatial areas	As above	**Routine:** Mangrove transects M1 – M5 **Reactive Monitoring:** Determine sample locations based upon the event (e.g. sites where mangroves impacted directly with suitable reference locations for spillage or routine sites post cyclone)	Routine: Five yearly Reactive Monitoring: • A toxicant spill • Reports of animal deaths / disease / lesions • Health concern reports • Large scale disturbance event • As directed by an exceedance of Environmental Quality Guidelines (MEQMMP) AND investigation determines mangrove monitoring required • Post cyclone if warranted	-

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Mangrove Fauna Assessment				
Sampling Method 1. Place 4 x 1 m^2 quadrats randomly within each mangrove flora quadrat at low tide 2. Use fluorescent cotton string to mark the boundary of each quadrat 3. Reduce sample bias from fauna disturbance by: a) Delaying sampling by 10 minutes post-laying of quadrats b) Assess mangrove fauna prior to disturbing the site to undertake the flora assessment 4. Fauna is recorded to the lowest taxonomic level possible Analytical Method Calculation of simple statistics	• Number of burrows • Species abundance • Species diversity • Total abundance	Mangrove transects M1 – M5	Five yearly	-

2.1.4 SUB-TIDAL BCH

Table 7: Monitoring of Sub-tidal BCH

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Sub-tidal BCH Health Monitoring				
Sampling Method 1. Diver based survey 2. Undertake three (3) 50 m transects radiating in different bearings at each site coordinate 3. Capture still images within a 25 x 25 cm quadrat at each metre along the transects using an underwater camera. 4. Still camera shots are taken within <1 m of the substrate. Analytical Methods 1. Analyse still images using Coral Point Count software (or similar) 2. Interrogate database to calculate simple statistics to inform assessment against baseline dataset	Condition of subtidal BCH: • Health metrics of key habitats (seagrass / coral)	A pilot study will be undertaken to determine suitable seagrass sampling locations within LAU7 and reference locations	Routine: Every 2 years Reactive Monitoring: • A toxicant spill; • Reports of animal kills / disease / lesions • Health concern reports • Large scale disturbance event • As directed by an exceedance of Environmental Quality Guidelines (MEQMMP) AND investigation determines mangrove monitoring required	Outcomes from the dredge monitoring program will inform: • Final sample locations • Confirm sample methodology

Methods	Parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
			• Post cyclone if warranted	
Spatial Extent Survey				
Sampling Method • Sidescan sonar • Tow camera Analytical Method 1. Undertake post-analysis of sidescan sonar data and tow camera footage 2. Interpolate sidescan and tow camera data using GIS to create a habitat layer shapefile 3. Compare habitat layer with baseline data	Spatial extent of key habitats (seagrass / coral)	LAU 7	Routine: Five yearly Reactive Monitoring: as listed above	-

2.1.5 *TECTICORNIA* SPP. SHRUBLAND VEGETATION

Spatial Extent Survey

The spatial extent of *Tecticornia* spp. shrubland will be assessed using remotely-sensed multi-spectral data at an appropriate capture resolution, as part of the Integrated BCH Monitoring Program along the integrated monitoring transects. The assessment will be undertaken quarterly, with the entire *Tecticornia* shrubland extent within the spatial bounds of each monitoring program transect being assessed. Analysis will be undertaken to determine the area of decline or expansion / improvement, as well as any seasonal or annual photosynthetic trends. Further detail related to the health monitoring of *Tecticornia* spp. shrubland is included in Table 9.

Pre-clearance Survey Commitments

Vegetation and boundary mapping

Due to difficulties in distinguishing community boundaries from aerial imagery the coastal and inland *Tecticornia* communities have been mapped as a single unit, therefore impacts from the Proposal have been assigned to this unit and not determined individually for the inland and coastal communities. Previous surveys (Phoenix, 2019) identified a clear distinction between coastal samphire vegetation types and those found further inland, with coastal samphire vegetation consisting of notably higher plant density and foliage cover compared to inland communities. In the EPA response to the ERD it was noted: "The ERD states that Samphire Communities with higher plant density have greater ecological value when discussing the significance of the impacts of the proposal, but when quantifying the impacts, the ERD treates all of the Samphire Communities as a single unit. This amalgamation reduces the scale of the impacts on the less-dense Samphire Communities. It is likely that the less-dense Samphire communities on the landward side of the project are floristically, as well as structurally, different from the more-dense vegetation on the seaward side".

Pre-disturbance surveys will involve setting up permanent belt transects for *Tecticornia* vegetation health monitoring and revisiting previous survey sites (Phoenix, 2019). When setting up *Tecticornia* monitoring, the species makeup will be recorded to assist in mapping the zonation

of *Tecticornia* vegetation types (Figure 9) (Actis, 2020; Preston Consulting, 2020). Pre-disturbance surveys will seek to further delineate individual *Tecticornia* vegetation types, in particular coastal and inland, this in turn will facilitate clearer impact quantification on the inland communities from the Proposal. Ground truthing (via helicopter) will aid in visually inspecting *Tecticornia* community boundaries, these will be monitored annually thereafter.

To accurately map the vegetation types, two analyses will be run; an initial analysis will be allocated to each 3 m x 3 m quadrat within each transect. This will allocate a vegetation type to each individual quadrat. Quadrats of the same vegetation type will be grouped for the second analysis; this will rule out any pseudo replication. The second analysis will determine vegetation types across the survey area, separating coastal and inland communities so a proportional impact of coastal communities can be determined.

Targeted Searches

Targeted searches and collections will be undertaken to identify previously unidentified specimens, and undescribed, possibly new *Tecticornia* taxon. These will be undertaken in early summer and late summer to ensure adequate collection of fruiting and flowering bodies for identification of species. Individual plants will be marked with tags and a unique code to facilitate accurate future recollection of specimens that cannot be identified to species level.

Previous sites will be revisited to collect samples of previously identified significant *Tecticornia* species and species that were unable to be identified in previous surveys.

Several *Tecticornia* species were unable to be identified due to the specimens collected being sterile. Due to lower than average rainfall over the past few years, it has been recommended by *actis* Environmental Services that further surveys be conducted after a substantial rain event to increase likelihood of flowering or fruiting and therefore the collection of fertile specimens (Actis, 2020).

Vegetation Monitoring

Prior to vegetation clearing, a baseline survey will be undertaken to monitor the health of *Tecticornia* communities. Surveys will be conducted to provide baseline data for each transect against which data from future monitoring may be compared. Transects will be selected as analogue (non-impact) sites and impacts sites within both coastal and inland communities. See Figure 9 for the location of *Tecticornia* monitoring sites:

- 12 impact monitoring sites; and
- nine analogue/control sites.

Proposed quadrat locations are shown in Figure 9, however quadrat locations will be subject to change dependent on initial targeted searches.

Vegetation monitoring will be conducted using belt transects utilising 3 m x 3 m (9 m^2) quadrats spaced evently along permanent linear transects in accordance with EPA (2016) methods. Health will be measured using a plant health scale based on Casson *et al.* (2009), as outlined in Table 8.

The use of permanent belt transects will allow monitoring to account for variation in samphire assemblages due to changes in dune or fringe profile, soil type and groundwater composition. Placement of quadrats along the transect line will cover zonation changes within the samphire

vegetation; if samphire vegetation remains the same over a distance the transect can be stopped and resumed when the samphire species change.

Other factors to be monitored prior to, and after clearing, will include climate (temperature and rainfall), sediment monitoring, surface water (inundation) monitoring and groundwater monitoring.

Table 8: Modified plant health scale based on Casson *et. al* (2009).

Health rating	Description
0	Healthy, no dead articles
1	Occasional dead articles
2	Tips of branches stressed or dying
3	Entire or whole branches dying or dead
4	More than half shrub dead
5	Shrub dead

Table 9: Monitoring of *Tecticornia* spp. shrubland vegetation

Methods	Health parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
Sampling Method Parameters to be measured in each quadrat (3 m x 3 m) will include: • No. of *Tecticornia* species present • No. of individuals of each species • Total foliage cover (% of quadrat) of each species • % living foliage cover and % dead foliage cover of each species • Plant health for each *Tecticornia* shrub (modified classification of (Casson *et al.* 2009), plants will be individually tagged so they can be identified in future monitoring • Photographic log of quadrat Analytical Method Following the establishment of baseline data for indirect impact areas and control sites all subsequent monitoring data for each transect will be compared to this baseline data to determine whether there has been any deleterious change including: • Decrease in species diversity • Decrease in total plant numbers or numbers of individual species • Decrease in population boundaries (monitored via ground truthing and helicopter) • Decrease in total foliage cover of all shrubs or for individual species • Increase in proportion of dead foliage to living foliage in any species • Decrease in vegetation health measures Any apparent deleterious change in indirect impact areas will be compared to control sites to establish whether impact maybe attributed to the Proposal	Modified plant health scale based on (Casson *et al.* 2009) (see Table 8)	See Figure 9	Vegetation monitoring will be undertaken at least annually (late summer) or may be triggered if a potential impact on the *Tecticornia* spp. shrublands or significant *Tecticornia* species is identified. *Tecticornia* community boundaries will be monitored prior to ground disturbing activities, and annually thereafter.	-

Methods	Health parameters	Location of monitoring sites	General timing + additional/other	Other parameters to be measured
or is likely due to seasonal conditions (i.e. decline in indirect impact area is reflected in control site).				
Nine BCH transects will be established as part of the Integrated BCH Monitoring Program (including 2 x control transects and 3 x impact transects). Remotely-sensed multi-spectral data at appropriate capture resolution. Known extent of *Tecticornia* shrublands will be defined (using vector dataset) and the raster data analysed only within the area of the known *Tecticornia* shrubland extent (i.e. it will act as a data mask). With a defined analysis extent, the difference in NDVI in each pixel from one time-period to the next can be calculated so that areas of decline or expansion/improvement can be identified and seasonal or annual photosynthetic trends determined.	NDVI = $\frac{NIR - Red}{(NIR + Red)}$ Pixel values can then be compared in a time-series to detect reduction in area (ha) of *Tecticornia* spp. shrubland.	Entirety of *Tecticornia* spp. shrubland extent within the spatial bounds of each Integrated BCH Monitoring Program transect (5)	Quarterly – a subscription service (e.g. Planet.com) will be established so that satellite acquired data can be downloaded and analysed each quarter	-

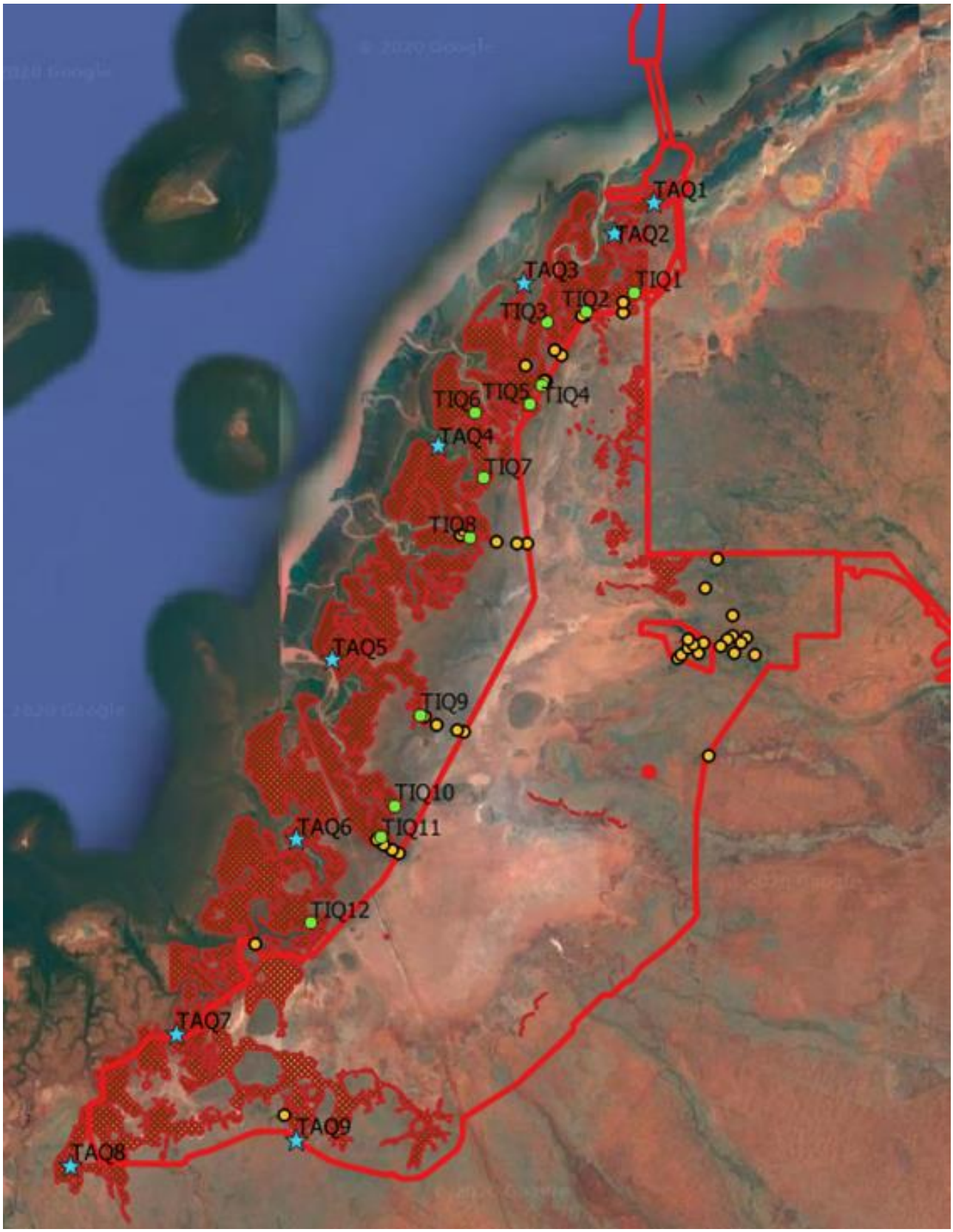


Figure 9: *Tecticornia* impact (TI) and analogue (TA) monitoring quadrat locations

2.2 MANAGEMENT ACTIONS

Table 10: Management actions - BCH Key Environmmental Factor

	EPA Objective: To protect BCH so that biological diversity and ecological integrity are maintained. **BCHMMP Objective:** To avoid and minimise significant residual impacts to BCH **Key environmental values:** General intertidal BCH, mangrove communities, algal mat habitat, samphire / samphire mudflat habitat; and sub-tidal BCH **Key impacts and risks:** • Clearing of up to 8,282 ha of intertidal BCH, including up to 17 ha of Mangrove habitat, 88 ha of Algal mat habitat, 954 ha of Samphire / samphire mudflat habitat and 19 ha of Sub-tidal BCH • Indirect impacts associated with hydrological changes			
Management Targets	**Management Actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Condition clause: TBD				
The direct disturbance of BCH does not exceed the permitted limits in the Ministerial Statement	Vegetation clearing will be managed through internal ground disturbance procedures	Ground disturbance procedures / permits	During construction and dredging activities	Clearing Permit Process Annual Compliance Assessment Report
	Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to equipment operators	Ground disturbance procedures / permits	During construction and dredging activities	Clearing Permit Process Annual Compliance Assessment Report
	The disturbance footprint will be developed to the minimum required to ensure safe and adequate construction and operation, and compliance with approved limits	Ground disturbance procedures / permits	During construction and dredging activities	Clearing Permit Process Annual Compliance Assessment Report
	Dredging will be conducted in accordance with the Dredge Management Plan	As per Dredge Management Plan	As per Dredge Management Plan	As per Dredge Management Plan
The causeway does not impede the natural flow of surface water (tidal or fresh)	Re-run the causeway inundation model using final causeway design to ensure it aligns with the outcomes presented in the Environmental Review Document	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to Department of Water and Environmental Regulation (DWER)
	Verify model predictions post-construction	As listed in Table 4	Within 3 months of the completion of construction of the causeway Within 3 months after a significant flood event	Verification report to be provided to DWER
	Verify model predictions if sea level rise is identified	As listed in Table 4	If mean sea level rise of more than 5 cm is identified	Verification report to be provided to DWER
	Re-run model if BCH monitoring records an impact to BCH that is attributed to the causeway	As listed in Table 5 and Table 6	If BCH monitoring records an impact to BCH that is attributed to the causeway	Modelling report to be provided to DWER
	If the model determines that the causeway is having a greater impact on surface water flows or BCH than previously predicted then additional floodway lengths and/or culverts will be installed to ensure flows are no longer impeded	Monitoring listed in Table 4 to be repeated after additional floodway lengths and/or culverts have been installed BCH monitoring listed in Table 5 and Table 6 to continue	Within 3 months of the completion of construction of the additional floodway lengths and/or culverts Within 3 months after a significant flood event Ongoing BCH monitoring as per Table 5 and Table 6	Verification report to be provided to DWER Annual Compliance Assessment Report
	All surface water drainage structures will be inspected and repaired if required	Inspections	After each spring tide period or after significant flood event	Inspection reports
The ponds do not cause inundation of the intertidal zone such that BCH is impacted more than presented in the Environmental Review Document	Re-run the inundation model using final pond design to ensure it aligns with the outcomes presented in the ERD	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to DWER
	Verify model predictions post-construction	As listed in Table 4	Within 3 months of the completion of construction of the ponds Within 3 months after a significant flood event	Verification report to be provided to DWER

	EPA Objective: To protect BCH so that biological diversity and ecological integrity are maintained. **BCHMMP Objective:** To avoid and minimise significant residual impacts to BCH **Key environmental values:** General intertidal BCH, mangrove communities, algal mat habitat, samphire / samphire mudflat habitat; and sub-tidal BCH **Key impacts and risks:** • Clearing of up to 8,282 ha of intertidal BCH, including up to 17 ha of Mangrove habitat, 88 ha of Algal mat habitat, 954 ha of Samphire / samphire mudflat habitat and 19 ha of Sub-tidal BCH • Indirect impacts associated with hydrological changes			
Management Targets	**Management Actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
	Verify model predictions if sea level rise is identified	As listed in Table 4	If mean sea level rise of more than 5 cm is identified	Verification report to be provided to DWER
	Re-run model if BCH monitoring records an impact to BCH that is attributed to the causeway	As listed in Table 5 and Table 6	If BCH monitoring records an impact to BCH that is attributed to the ponds	Modelling report to be provided to DWER
	If any of the model re-runs or verifications determine that the ponds are having a greater impact on tidal inundation than previously predicted then BCH monitoring information will be reviewed to determine if there is an associated impact to BCH	As listed in Table 5 and Table 6	Within 1 month of identifying potential impact	Annual Compliance Assessment Report
	If an impact to BCH is attributed to the Proposal then Mardie Minerals will investigate the installation of additional drainage measures to reduce the inundation impact of the pond walls (such as directing the water to dissipate to other areas) and install measures that are deemed suitable	Re-run of model based on proposed drainage design Monitoring of inundation as listed in Table 4 BCH monitoring as listed in Table 5 and Table 6	Re-run of model prior to installation of drainage measures As per Table 5, Table 6 and Table 4	Verification report to be provided to DWER
The inland surface water drainage diversions do not cause inundation or drying of the intertidal zone such that BCH is impacted more than presented in the Environmental Review Document	Re-run the inundation model using final pond and drainage structure designs to ensure it aligns with the outcomes presented in the ERD	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to DWER
	Verify model predictions post-construction	As listed in Table 4	Within 3 months after a significant flood event	Verification report to be provided to DWER
	Re-run model if BCH monitoring records an impact to BCH that is attributed to freshwater drainage	As listed in Table 5 and Table 6	If BCH monitoring records an impact to BCH that is attributed to fresh water drainage	Modelling report to be provided to DWER
	If any of the model re-runs or verifications determine that the fresh water drainage diversions are having different inundation impacts than previously predicted then BCH monitoring information will be reviewed to determine if there is an associated impact to BCH	As listed in Table 5 and Table 6	Within 1 month of identifying potential impact	Annual Compliance Assessment Report
	If an impact to BCH is attributed to the drainage diversions then Mardie Minerals will investigate the installation of additional drainage measures to reduce the impact of the diversions (such as directing the water to dissipate to other areas) and install measures that are deemed suitable	Re-run of model based on proposed drainage design Monitoring of inundation as listed in Table 4 BCH monitoring as listed in Table 5 and Table 6	Re-run of model prior to installation of drainage measures As per Table 5, Table 6 and Table 4	Verification report to be provided to DWER
Construction activities do not result in visible sediment outside the Proposal boundary	Implement Sediment and Erosion Control Plan (SECP), which includes the following controls: • Flow controls along access roads and tracks • Staging works in low-lying areas to suit favourable tidal periods (as far as practical) • Promptly stabilise exposed areas once works are completed • Installation of silt curtains in at-risk creeks • Stabilising stockpiles • Use of geotextiles in wall design to improve stability.	As per Sediment and Erosion Control Plan: • Visual assessment of site runoff • TSS/turbidity monitoring of intake creek and Mardie Creek	• Weekly in dry areas / periods; daily in wet areas / periods, and immediately following significant rainfall events • Continuous loggers	Annual Compliance Assessment Report
BCH boundaries and composition are monitored against sea level rise	-	As listed in Table 4	As listed in Table 4	Annual Compliance Assessment Report

Table 11: Management actions - Flora and Vegetation Key Environmental Factor

	EPA Factor: Flora and Vegetation **EPA Objective:** To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective:** To prevent significant residual impacts to unidentified and potentially undescribed *Tecticornia* species and *Tecticornia* spp. shrubland vegetation **Key environmental values:** • Unidentified and potentially undescribed *Tecticornia* species • *Tecticornia* spp. shrubland vegetation including locally significant vegetation type TtSvTc **Key impacts and risks:** • Clearing of up to 1,108 ha of *Tecticornia* spp. shrubland • *Tecticornia* species may be impacted by changes to salinity and hydrological regimes. Indirect impacts may result from the following or a combination of the following changes: ○ Unintentional spillage or seepage of brine from concentrator and crystalliser ponds or pipelines ○ Alteration of hydrological regimes ○ Reduced rehabilitation success due to high salinity			
Management Targets	**Management Actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Condition clause: TBD				
The direct disturbance of *Tecticornia* spp. shrubland vegetation does not exceed the permitted limits in the Ministerial Statement	Vegetation clearing will be managed through internal ground disturbance procedures	Ground disturbance procedures / permits	During construction activities	Clearing Permit Process Annual Compliance Assessment Report
	Boundaries of areas to be cleared or disturbed will be identified by GPS coordinates and maps of boundaries will be provided to equipment operators	Ground disturbance procedures / permits	During construction activities	Clearing Permit Process Annual Compliance Assessment Report
	The disturbance footprint will be developed to the minimum required to ensure safe and adequate construction and operation, and compliance with approved limits	Ground disturbance procedures / permits	During construction activities	Clearing Permit Process Annual Compliance Assessment Report
The Proposal does not result in the direct disturbance of a new *Tecticornia* species that is restricted to the Proposal disturbance footprint	Conduct pre-clearance targeted surveys	As described in Section 2.1.5.	Prior to clearing	Clearing Permit Process Annual Compliance Assessment Report Pre-clearance survey reports
	If a potentially new *Tecticornia* species is recorded only within the disturbance footprint then either: • Additional targeted surveys will be conducted to locate it outside the disturbance footprint; or • Mardie Minerals will relocate infrastructure to avoid the recorded location	Additional targeted surveys if required	Prior to the disturbance of any potentially new *Tecticornia* species	Clearing Permit Process Annual Compliance Assessment Report Targeted survey reports
The causeway does not impede the natural flow of surface water (tidal or fresh)	Re-run the causeway inundation model using final causeway design to ensure it aligns with the outcomes presented in the Environmental Review Document	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to DWER
	Verify model predictions post-construction	As listed in Table 4	Within 3 months of the completion of construction of the causeway Within 3 months after a significant flood event	Verification report to be provided to DWER
	Verify model predictions if sea level rise is identified	As listed in Table 4	If mean sea level rise of more than 5 cm is identified	Verification report to be provided to DWER
	Re-run model if *Tecticornia* spp. shrubland monitoring records an impact to *Tecticornia* spp. shrubland that is attributed to the causeway	As listed in Table 9	If *Tecticornia* spp. shrubland monitoring records an impact to BCH that is attributed to the causeway	Modelling report to be provided to DWER
	If the model determines that the causeway is having a greater impact on surface water flows or *Tecticornia* spp. shrubland than previously predicted then additional floodway lengths and/or culverts will be installed to ensure flows are no longer impeded	Monitoring listed in Table 4 to be repeated after additional floodway lengths and/or culverts have been installed *Tecticornia* spp. shrubland monitoring listed in Table 9 to continue	Within 3 months of the completion of construction of the additional floodway lengths and/or culverts Within 3 months after a significant flood event	Verification report to be provided to DWER Annual Compliance Assessment Report

	EPA Factor: Flora and Vegetation **EPA Objective:** To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective:** To prevent significant residual impacts to unidentified and potentially undescribed *Tecticornia* species and *Tecticornia* spp. shrubland vegetation **Key environmental values:** • Unidentified and potentially undescribed *Tecticornia* species • *Tecticornia* spp. shrubland vegetation including locally significant vegetation type TtSvTc **Key impacts and risks:** • Clearing of up to 1,108 ha of *Tecticornia* spp. shrubland • *Tecticornia* species may be impacted by changes to salinity and hydrological regimes. Indirect impacts may result from the following or a combination of the following changes: o Unintentional spillage or seepage of brine from concentrator and crystalliser ponds or pipelines o Alteration of hydrological regimes o Reduced rehabilitation success due to high salinity			
Management Targets	**Management Actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Condition clause: TBD				
			Ongoing *Tecticornia* spp. shrubland monitoring as per Table 9	
	All surface water drainage structures will be inspected and repaired if required	Inspections	After each spring tide period or after significant flood event	Inspection reports
The ponds do not cause inundation of the intertidal zone such that *Tecticornia* spp. shrubland is impacted more than presented in the Environmental Review Document	Re-run the inundation model using final pond design to ensure it aligns with the outcomes presented in the ERD	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to DWER
	Verify model predictions post-construction	As listed in Table 4	Within 3 months of the completion of construction of the ponds Within 3 months after a significant flood event	Verification report to be provided to DWER
	Verify model predictions if sea level rise is identified	As listed in Table 4	If mean sea level rise of more than 5 cm is identified	Verification report to be provided to DWER
	Re-run model if *Tecticornia* spp. shrubland monitoring records an impact to *Tecticornia* spp. shrubland that is attributed to the causeway	As listed in Table 9	If *Tecticornia* spp. shrubland monitoring records an impact to *Tecticornia* spp. shrubland that is attributed to the ponds	Modelling report to be provided to DWER
	If any of the model re-runs or verifications determine that the ponds are having a greater impact on tidal inundation than previously predicted then *Tecticornia* spp. shrubland monitoring information will be reviewed to determine if there is an associated impact to *Tecticornia* spp. shrubland	As listed in Table 9	Within 1 month of identifying potential impact	Annual Compliance Assessment Report
	If an impact to *Tecticornia* spp. shrubland is attributed to the Proposal then Mardie Minerals will investigate the installation of additional drainage measures to reduce the inundation impact of the pond walls (such as directing the water to dissipate to other areas) and install measures that are deemed suitable	Re-run of model based on proposed drainage design Monitoring of inundation as listed in Table 4 *Tecticornia* spp. shrubland monitoring as listed in Table 9	Re-run of model prior to installation of drainage measures As per Table 4 and Table 9	Verification report to be provided to DWER
The inland surface water drainage diversions do not cause inundation or drying of the intertidal zone such that *Tecticornia* spp. shrubland is impacted more than presented in the Environmental Review Document	Re-run the inundation model using final pond and drainage structure designs to ensure it aligns with the outcomes presented in the ERD	Verification of model results against original model outcomes	Prior to construction	Verification report to be provided to DWER
	Verify model predictions post-construction	As listed in Table 4	Within 3 months after a significant flood event	Verification report to be provided to DWER
	Re-run model if *Tecticornia* spp. shrubland monitoring records an impact to *Tecticornia* spp. shrubland that is attributed to freshwater drainage	As listed in Table 9	If *Tecticornia* spp. shrubland monitoring records an impact to BCH that is attributed to fresh water drainage	Modelling report to be provided to DWER
	If any of the model re-runs or verifications determine that the fresh water drainage diversions are having different inundation impacts than previously predicted then *Tecticornia* spp. shrubland monitoring information will be reviewed to determine if there is an associated impact to *Tecticornia* spp. shrubland	As listed in Table 9	Within 1 month of identifying potential impact	Annual Compliance Assessment Report

	EPA Factor: Flora and Vegetation **EPA Objective:** To protect flora and vegetation so that biological diversity and ecological integrity are maintained. **Objective:** To prevent significant residual impacts to unidentified and potentially undescribed *Tecticornia* species and *Tecticornia* spp. shrubland vegetation **Key environmental values:** • Unidentified and potentially undescribed *Tecticornia* species • *Tecticornia* spp. shrubland vegetation including locally significant vegetation type TtSvTc **Key impacts and risks:** • Clearing of up to 1,108 ha of *Tecticornia* spp. shrubland • *Tecticornia* species may be impacted by changes to salinity and hydrological regimes. Indirect impacts may result from the following or a combination of the following changes: o Unintentional spillage or seepage of brine from concentrator and crystalliser ponds or pipelines o Alteration of hydrological regimes o Reduced rehabilitation success due to high salinity			
Management Targets	**Management Actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Condition clause: TBD				
	If an impact to *Tecticornia* spp. shrubland is attributed to the drainage diversions then Mardie Minerals will investigate the installation of additional drainage measures to reduce the impact of the diversions (such as directing the water to dissipate to other areas) and install measures that are deemed suitable	Re-run of model based on proposed drainage design Monitoring of inundation as listed in Table 4 *Tecticornia* spp. shrubland monitoring as listed in Table 9	Re-run of model prior to installation of drainage measures As per Table 4 and Table 9	Verification report to be provided to DWER
Construction activities do not result in visible sediment outside the Proposal boundary	Implement Sediment and Erosion Control Plan (ESCP), which includes the following controls: • Flow controls along access roads and tracks • Staging works in low-lying areas to suit favourable tidal periods (as far as practical) • Promptly stabilise exposed areas once works are completed • Installation of silt curtains in at-risk creeks • Stabilising stockpiles • Use of geotextiles in wall design to improve stability.	As per ESCP: • Visual assessment of site runoff • TSS/turbidity monitoring of intake creek and Mardie Creek	• Weekly in dry areas / periods; daily in wet areas / periods, and immediately following significant rainfall events • Continuous loggers	Annual Compliance Assessment Report
Tecticornia spp. shrubland boundaries and composition are monitored against sea level rise	-	As listed in Table 4 and Table 9	As listed in Table 4	Annual Compliance Assessment Report

3 ADAPTIVE MANAGEMENT AND REVIEW

3.1 ADAPTIVE MANAGEMENT

Mardie Minerals is committed to improving environmental results and management practices throughout the implementation of the Proposal and therefore will use an adaptive management approach for this BCHMMP. Adaptive management practices will include:

- Annual review of monitoring data and information gathered;
- Annual evaluation of monitoring and management outcomes against management targets and the objectives of this BCHMMP; and
- Review of management actions throughout the implementation of the Proposal, and identification of potential new management measures and technologies that may be more effective.

3.2 REVIEW REQUIREMENTS

The BCHMMP will be reviewed annually through the construction phase and every two years during operation. It will also be updated based on review outcomes. The review will take into account whether management targets are being achieved or are likely to be achieved and will identify any updates required to realise the targets.

3.3 APPROVAL REQUIREMENTS FOR REVISED BCHMMP

This BCHMMP has been developed as part of the response to submissions that were made to the EPA. It is anticipated that the requirement for the BCHMMP will be included within the Ministerial Conditions for the Proposal. Therefore, formal approval will be sought from DWER for any significant revisions to the BCHMMP as a result of information gained through adaptive management.

3.4 ROUTINE AND REACTIVE MONITORING

The BCHMMP incorporates routine monitoring and management actions for BCH and *Tecticornia* spp. shrubland vegetation, to be carried out over various timelines outlined in Section 2.2. In additional to these routine events, reactive monitoring and management is proposed in response to a trigger event, which may include but is not limited to:

- A wall breach;
- A toxicant spill;
- Monitoring data suggests a significant change;
- Reports of fauna deaths or impacts;
- As directed by an exceedance of Environmental Quality Guidelines (managed under the MEQMMP); or
- After cyclones, if warranted.

Implementation of reactive monitoring and management will allow Mardie Minerals to respond to unforeseen potential impacts to BCH and *Tecticornia* spp. shrubland vegetation and therefore have improved success in achieving the management targets of the BCHMMP.

3.5 EARLY RESPONSE INDICATORS, CRITERIA AND ACTIONS

This BCH includes early response indicators and actions regarding inundation impacts, with the intent of making design or operational changes as soon as practicable, before significant BCH impacts occur.

4 STAKEHOLDER CONSULTATION

The Proposal ERD was released for public comment and this BCHMMP has been prepared in response to several of the comments received. Mardie Minerals has also consulted with the following stakeholders specifically regarding the content of this BCHMMP:

- EPA Services at DWER;
- Phoenix;
- O2 Marine;
- Actis Environmental Services (Bindy Datsun);
- Edith Cowan University (Dr Kathryn McMahon); and
- Preston Consulting.

GLOSSARY

Term	Meaning
BCH	Benthic Communities and Habitats
BCHMMP	Benthic Communities and Habitat Monitoring and Management Plan
DWER	Department of Water and Environmental Regulation
Ktpa	Kilotonne per annum
GLpa	Gigalitres per annum
LAU	Assessment Unit
MEQMMP	Marine Environmental Quality Monitoring and Management Plan
Mtpa	Million tonnes per annum
NaCl	Sodium Chloride
NDVI	Normalised Difference Vegetation Index
Proposal	Mardie Project
SoP	Sulphate of Potash
WA	Western Australia

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