Mardie Salt and Potash Project

Marine Turtle Monitoring Program

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BCI MINERALS LIMITED

Marine Turtle Monitoring Program

Mardie Salt Project

Document no. Rev 6: 311012-02566-EN-REP-0001

4 February 2026

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PROJECT 311012-02566 - 311012-02566-EN-REP-0001: Marine Turtle Monitoring Program - Mardie Salt Project

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DECLARATION OF ACCURACY

In making this declaration, I am aware that sections 490 and 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this Monitoring Plan is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed: 

Name: Snyman Van Straaten

Position: Manager Environmental Approvals & Compliance

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4 February 2026

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Executive Summary

Mardie Minerals Pty Ltd (Mardie Minerals, a wholly-owned subsidiary of BCI Minerals Limited, the Proponent) is implementing the Optimised Mardie Project (the Project), a large-scale salt and Sulphate of Potash (SoP) production facility in the Pilbara region of Western Australia. The Project operates within an approved development envelope and will produce approximately 3 – 3.5 million tonnes of salt and 50,000 tonnes of SoP annually through seawater evaporation and crystallisation.

The Project development envelope (DE) includes evaporation and crystalliser ponds (~10,200 ha), a processing plant, a bitterns disposal pipeline and outfall, a 2.4 km trestle jetty, and supporting export infrastructure (Figure 1-1). The Project's offshore export system comprises a transshipment berth pocket, and an approximately 4.9 km navigational channel constructed through capital dredging (~355,000 m^3), with dredge material placed offshore at DMPA4. Periodic maintenance dredging will ensure safe vessel access for ongoing operations. Transshipment activities will occur along a defined transshipment route and vessel anchorage area (Figure 1-1), forming the main interface between the Project and the marine environment. These offshore elements, including jetty lighting, navigational aids, and vessel operations, create the potential for artificial light visibility within the broader 20 km marine operational buffer, which encompasses key turtle nesting areas (Figure 2-1).

Environmental approvals under the *Environmental Protection Act 1986 (EP Act)* and the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* require the Project to achieve strict environmental outcomes for marine turtles. Under the most recent EP Act approval, Ministerial Statement (MS) **1264** and EPBC Act approvals (**EPBC2018/8236** and **EPBC2022/9169**, Appendix A) the Proponent must ensure **no adverse change in marine turtle orientation (misorientation or disorientation), nesting beach utilisation, nesting success, or hatchling survivorship** as a result of artificial light emissions at **Long Island, Sholl Island, the Passage Islands (Angle, Middle, Round)** and adjacent **mainland sandy habitat**.

To achieve this outcome, the Proponent will implement two key environmental plans:

- **Marine Turtle Monitoring Program (MTMP, this Plan)** – a plan outlining the compliance monitoring requirements to monitor turtle nesting activity, hatchling orientation, and light levels at regulated nesting beaches. The MTMP applies to beach-based light monitoring and behavioural metrics consistent with the **National Light Pollution Guidelines for Wildlife (DCCEEW, 2023)** and includes **management actions**, **management targets**, **trigger and threshold criteria**, and **adaptive management measures** as required by **Conditions B5-3, C4-1 and C4-2** (Appendix A).
- **Mardie Illumination Plan** – a Part IV Environmental Management Plan to manage and mitigate artificial light emissions from project infrastructure and operations, ensuring compliance with turtle protection outcomes and supporting MTMP findings. The Mardie Illumination Plan has been developed in accordance with the the current Environmental Protection Authority (EPA) Instructions and Templates for Part IV Environmental Management Plans (EPA 2024).

These plans will be implemented annually and will continue until the WA EPA **CEO confirms** that the outcomes of **MS 1264 Condition B5-1(1–3)** have been, and will continue to be, met. Annual cumulative results will be compared against baseline data (Pendoley Environmental 2019, 2022 and 2023) and reported in accordance with MS 1264 requirements. Where trigger or threshold criteria are exceeded, management responses will be scaled to the magnitude, persistence, and confidence of the observed effect. Early-warning triggers initiate investigation and precautionary mitigation (via contingency actions), while threshold exceedances require immediate corrective action and constitute non-compliance where impacts are attributable to Project lighting. Where a material risk to marine turtle behaviour is identified, mitigation actions may be implemented **immediately within the same nesting season**, rather than deferred to the following season, to prevent escalation or repetition of impacts.

1. Introduction

1.1 Project Background

The Optimised Mardie Project (the Project) development envelope (DE) encompasses approximately 10,200 ha of evaporation and crystalliser ponds, a processing plant, a bitterns disposal pipeline and outfall, a trestle jetty, and supporting export infrastructure. The disturbance DE, including shipping lanes and anchorage sites are illustrated in Figure 1-1. The Project is situated adjacent to a coastal landscape characterised by offshore islands, sheltered embayments and mainland beaches that support regionally significant marine habitats.

The West Pilbara coast is recognised as a Biologically Important Area (BIA) for marine turtles under the *Commonwealth Recovery Plan for Marine Turtles (2017)*. Offshore islands within this region provide critical nesting habitat: **Sholl Island** is essential for hawksbill turtles, while **Long Island** supports significant flatback nesting. Mainland beaches offer low-density nesting habitat, primarily for flatback and hawksbill turtles (Fossette et al., 2021). Nesting site selection and hatchling orientation are influenced by geomorphic features of these habitats. Offshore islands typically exhibit dynamic sand spits, wide supratidal zones, and vegetated dunes, whereas mainland beaches are low-energy systems with narrow supratidal zones and adjacent mangroves (Figure 1-2). These characteristics, combined with the visibility of horizon light sources, underscore the importance of beach-level light management and targeted turtle monitoring.

The Project was initially approved under the *Environmental Protection Act 1986 (EP Act)* in November 2021 (**Ministerial Statement (MS) 1175,** Appendix A) and as a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* in January 2022 (**EPBC2018/8236,** Appendix A). Subsequent amendments were approved under **MS 1211** in October 2023 and **EPBC2022/9169**, reflecting the Optimised Mardie Salt Proposal. Most recently, **MS 1264**, issued on 22 December 2025, superseded MS 1211 under section 40AA(6)(b) of the EP Act. MS 1264 (Appendix A) introduces updated Proposal limits and prescriptive MS conditions for marine fauna protection, including outcome-based mitigation and management requirements for marine turtles.

Prior to construction, a series of marine turtle monitoring programs were undertaken to establish a baseline of nesting and hatching activity at nearby offshore islands and coastal habitats potentially impacted by Project activities. These surveys, conducted by Pendoley Environmental between 2017 and 2023, confirmed the presence of flatback, green, and hawksbill turtles nesting along mainland beaches and offshore islands in the region. A summary of monitoring scopes and duration is presented in Table 1-1.

This Marine Turtle Monitoring Plan (MTMP) has been revised to align with these updated regulatory requirements. It addresses the key environmental factor Marine Fauna, focusing on marine turtles (flatback, hawksbill, green), their critical behaviours, such as nesting, hatchling orientation and hatchling survivorship within biologically important areas adjacent to the Project. The MTMP establishes compliance indicators, monitoring methods consistent with the *National Light Pollution*

Guidelines for Wildlife (DCCEEW, 2023), and adaptive management measures to ensure that significant impacts on marine turtle behaviour are avoided. The spatial scope of monitoring includes the Project development envelope and a 20 km artificial light buffer surrounding the export jetty (Figure 2-1**,** Appendix B), encompassing critical nesting habitats on offshore islands (Sholl Island, Long Island, Passage Islands) and adjacent mainland beaches east and west of Mardie Creek, as well as secondary nesting habitats at Stewart Island, Fortescue Island and Mardie Island.

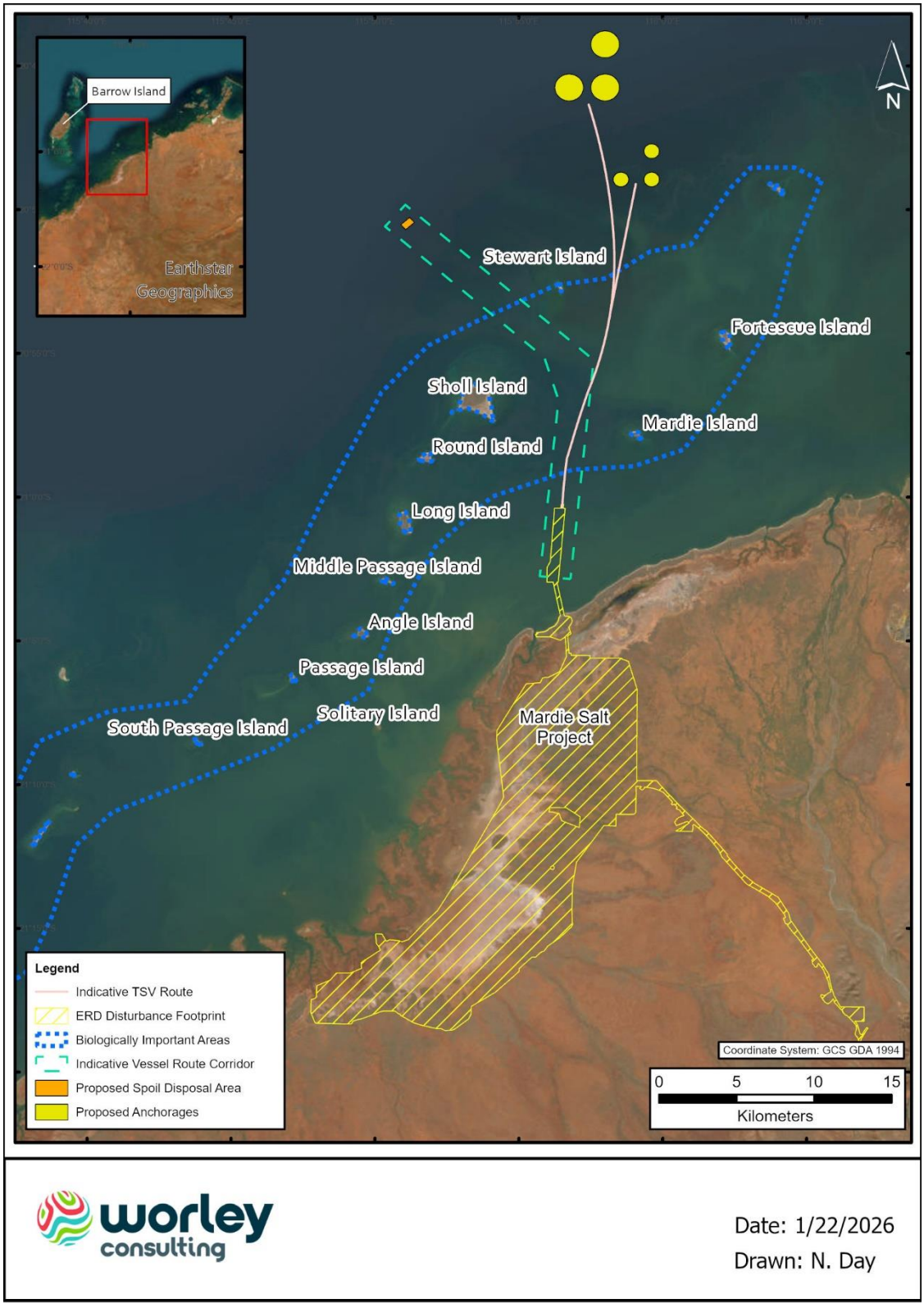

Figure 1-1: Mardie Salt Project development envelope and regional setting.

Figure 1-2: Example of nesting habitat on offshore islands (a. Angle Island) and on the mainland (b. Mardie Creek East). (Source: Pendoley Environmental 2022).

Table 1-1 Summary of monitoring work scopes to date (Routine= daily, Opportunistic = twice weekly minimum).

Monitoring Program	Survey Dates	Locations Monitored	Work Scopes Completed
Pre-construction			
2017/18	5 December 2017 13 January 2018	**Opportunistic:** Mardie Creek East and West	• Snapshot Survey
2018/19	**Field Survey 1:** 1-15 December 2018 **Field Survey 2:** 30 January – 12 February 2019	**Routine:** Sholl and Long Islands, Mardie Creek East and West **Opportunistic:** Round, Middle Passage and Angle Islands	• Track census • Incubation success • Hatchling orientation • Artificial light monitoring
2020/2021	**No surveys**		
2021/22	**Field Survey 1:** 20 October – 4 November 2021	**Routine:** Sholl, Long, Round, Middle Passage and Angle Islands, Mardie Creek East and	• Track census • Incubation success • Hatchling orientation

Monitoring Program	Survey Dates	Locations Monitored	Work Scopes Completed
	Field Survey 2: 3-17 December 2021 **Field Survey 3:** 4-14 February 2022	West **Opportunistic:** Stewart, Fortescue, Mardie, South Passage and Solitary Islands, Mardie Creek East and West	• Artificial light monitoring
2022/23	**Field Survey 1:** 17 - 31 October 2022 **Field Survey 2:** 3 - 17 December 2022 **Field Survey 3:** 13 – 27 February 2023	**Mainland:** Mardie Creek East to Fortescue River and West to mangroves	• Track census • Incubation success • Hatchling orientation • Artificial light monitoring
Post-construction			
2023/24	**Field Survey 1:** 16 - 30 October 2023 **Field Survey 2:** 4 - 18 December 2023 **Field Survey 3:** 5 – 19 February 2024	**Routine:** Long, Sholl, Marde Creek East, Mardie Creek West **Opportunistic:** Round, Middle, Angle, South Passage, Passage, Stewart, Fortescue, Solitary, Mardie Island	• Track census • Incubation success • Hatchling orientation • Artificial light monitoring
2024/25	**Field Survey 1:** 14 Oct - 2 November 2024 **Field Survey 2:** 30 Nov - 14 December 2024 **Field Survey 3:** 3 – 17 March 2025	**Routine:** Long, Sholl, Marde Creek East, Mardie Creek West **Opportunistic:** Round, Middle, Angle, South Passage, Passage, Stewart, Fortescue, Solitary, Mardie Island	• Track census • Incubation success • Hatchling orientation • Artificial light monitoring
2025/26	**Field Survey 1:** 10 – 24 Oct 2025 **Field Survey 2:** 9 - 23 December 2025 **Field Survey 3:** 9 – 23 Feb 2026	**Routine:** Long, Sholl, Marde Creek East, Mardie Creek West **Opportunistic:** Round, Middle, Angle, South Passage, Passage, Stewart, Fortescue, Solitary, Mardie Island	• Track census • Incubation success • Hatchling orientation • Artificial light monitoring

1.2 Regulatory Conditions

The MTMP has been prepared to address marine turtle protection requirements under the WA EP Act and Commonwealth EPBC Act approvals (Appendix A) for the Optimised Mardie Project.

The MTMP establishes the monitoring framework required to detect, assess and substantiate whether the marine turtle environmental outcomes specified in **MS 1264** and EPBC approvals **EPBC2018/8236** and **EPBC2022/9169** are being achieved.

The MTMP has been developed having regard to the following approvals and guidelines:

- **MS 1264** (December 2025): particularly **Conditions B51, B53, C41** and **C42**, which require the implementation of a MTMP that:
  - Demonstrates that there is **no adverse change** in marine turtle orientation (misorientation or disorientation), nesting beach utilisation, nesting success or hatchling survivorship as a result of artificial light emissions.
  - Includes defined trigger criteria and threshold criteria.
  - Provides a framework for investigation and reporting where triggers or thresholds are exceeded.
  - Continues to be implemented until the CEO confirms that the required outcomes have been, and will continue to be, achieved.
- **EPBC2018/8236 and EPBC2022/9169**: including **Conditions 37, 38, 45 and 53(c)**, which require the implementation of a Marine Turtle Monitoring Program and ongoing monitoring and reporting of outcomes relevant to protected marine turtle species.
- **Environmental Protection Authority (WA) Instructions: How to Prepare *Environmental Protection Act 1986* Part IV Environmental Management Plans** (EPA, 2024) and the **EPA Interim Guidance: Environmental Outcomes and Outcomes-Based Conditions** (EPA, 2021). While the MTMP is a monitoring program rather than an environmental management plan, it has been structured to apply the EPA's outcomes-based principles for monitoring and substantiation, including clearly defined outcomes, measurable indicators, trigger and threshold criteria, and auditable reporting.
- **National Light Pollution Guidelines for Wildlife (DCCEEW, 2023),** which inform the design and interpretation of monitoring related to artificial light and marine turtle behaviour.

1.2.1 Application of Outcome-based and Objective-based Monitoring

Consistent with the WA EPA's outcomes-based regulatory framework, the MTMP applies a combination of **outcome-based** and **objective-based** monitoring indicators, reflecting differing causal pathways between artificial light exposure and marine turtle responses.

Outcome-based monitoring indicators are applied to marine turtle behaviours that have a direct and well-established causal relationship with artificial light exposure and are explicitly addressed by **MS 1264 Condition B51**. These indicators are:

- Hatchling orientation (misorientation and disorientation).
- Nesting beach utilisation.

For these indicators, the MTMP:

- Defines measurable indicators assessed at the nesting-beach and temporal scale.
- Applies **trigger** and **threshold criteria** to identify **early warning** signals and **limits of acceptable change.**
- Provides the basis for **determining** whether the relevant **environmental outcomes are being achieved** and whether **non-compliance** has occurred where **threshold criteria** are **exceeded** and **impacts are attributable to Project lighting**.

Trigger criteria are early-warning indicators intended to identify potential risk that an environmental outcome may not be achieved. Exceedance of a trigger criterion initiates investigation and reporting but does not, in itself, constitute non-compliance (EPA, 2024).

Threshold criteria represent the limit of acceptable change beyond which the relevant environmental outcome is not being achieved. Exceedance of a threshold criterion constitutes non-compliance where the exceedance is attributable to Project lighting, regardless of whether contingency measures have been implemented (EPA, 2024).

Objective-based and contextual monitoring indicators are applied to parameters that provide important ecological context but are not considered direct pathways for artificial light impacts (EPA, 2024).Under this MTMP these indicators include:

- Nesting success.
- Hatchling survivorship.

These parameters are monitored and trended to support interpretation of behavioural outcomes and to inform weight-of-evidence assessments, but are not, in isolation, used to determine compliance with artificial light-related outcomes.

The MTMP provides the mechanism to **identify, substantiate and report** any potential impacts on marine turtles. Where trigger or threshold criteria are exceeded, findings from this monitoring program inform investigation, reporting and any required response actions. Implementation of mitigation or operational responses occurs through the **Mardie Illumination Plan** and other relevant Project environmental management plans (EMPs), in accordance with the applicable State and Commonwealth approval conditions. A summary of mitigation and management responses can be found in Table 5-1 and Table 5-2.

This MTMP will be reviewed and revised to meet any updated WA EP Act compliance requirements, or EPBC Act approval conditions that may affect marine turtle protection measures and the Proponent will notify the Department of Climate Change, Energy, the Environment and Water (DCCEEW) within the timeframes stipulated in **EPBC2022/9160 (Conditions 95 and 96, Appendix A).** Appendix A outlines all State MS and EPBC Act conditions relevant to marine turtle protection for the Project.

1.3 Monitoring Program Aim

The MTMP aims to ensure compliance with **MS 1264, EPBC2018/8236** and **EPBC2022/9169** conditions by detecting and preventing project-attributable impacts on marine turtles. This monitoring program specifically aims to:

- **Detect and assess** any **project-attributable changes** in marine turtle behaviour **associated with artificial light emissions** at regulated nesting beaches, including:
    - hatchling orientation (misorientation or disorientation); and
    - nesting beach utilisation.
- **Apply outcome-based monitoring** to marine turtle behaviours with a direct and well-established causal relationship to artificial light exposure, using defined indicators, trigger criteria and threshold criteria, to substantiate achievement of the relevant environmental outcomes.
- **Collect and trend objective-based and contextual monitoring data**, including nesting success and hatchling survivorship, to support interpretation of behavioural outcomes and provide ecological context for weight-of-evidence assessments.
- **Apply monitoring methods consistent with the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023)** and recognised marine turtle monitoring standards to ensure results are scientifically robust, repeatable and comparable with baseline and cumulative datasets.
- **Provide an evidence base to inform investigation, reporting and response requirements** under the approval conditions where trigger or threshold criteria are exceeded, including informing actions implemented through the **Mardie Illumination Plan** and other relevant Project EMPs.
- **Support transparent and auditable compliance reporting** to regulatory agencies by documenting monitoring results, trend analyses and outcome assessments in accordance with MS 1264 and EPBC approvals reporting requirements.

The MTMP will be implemented annually and maintained until the WA EPA **CEO** confirms in writing that the outcomes of **Condition B51(1–3)** have been, and will continue to be, achieved.

1.4 Licences and Animal Ethics

All work will be conducted under a Section 40 Authorisation to take or disturb threatened species, issued by the Department of Biodiversity, Conservation and Attractions (DBCA) under the *Biodiversity Conservation Act 2016*. Should helicopters be used to access any of the islands of the Great Sandy Island Nature Reserve (including the survey islands listed in this report), a *Regulation 4 Lawful Authority Notice to conduct Activity on CALM Land* will be required.

Where applicable, the monitoring methods will be submitted for Animal Ethics approval prior to commencement of the monitoring season. Under the *Animal Welfare Act 2002* (AW Act*)*, activities involving the use of animals for scientific purposes must be conducted in accordance with a license to use animals for scientific purposes (Scientific License) issued by the Department of Primary Industries and Regional Development (DPIRD) and obtain ethical approval from an Animal Ethics Committee (AEC). From 31 July 2022 onwards, all projects that interact with wildlife, including those conducted by environmental consultancies, must be reviewed and approved by an AEC.

1.5 Responsibility

The responsibilities of the BCI Environment and Approvals Department are summarised in Table 1-2.

Table 1-2 Roles and Responsibilities

Role	Responsibility
Manager Environmental Approvals and Compliance	• Ensure annual compliance monitoring is conducted as per this MTMP. • Ensure reporting to regulatory agencies (Department of Water and Environmental Regulation (DWER), DCCEEW) is completed within required timeframes • Oversee implementation of contingency measures if triggers or thresholds are exceeded.
Site Environmental Advisors	• Support monitoring activities and data collection • Assist with investigations and implementation of mitigation actions if monitoring detects potential non-compliance. • Maintain accurate records for compliance reporting and public data obligations required under MS 1264 Part D

2. Monitoring Program

The s monitoring program outlined within this MTMP will be implemented annually for the life of the approval or until the DWER **CEO** confirms in writing that the outcomes of **MS 1264** and **EPBC2018/8236** and **EPBC2022/9169** have been, and will continue to be, met. It prescribes survey locations, schedules, methods, and analysis needed to detect, substantiate, and manage any project-attributable impacts of artificial light on turtle behaviour at regulated nesting beaches (Long Island, Sholl Island, Passage Islands (Angle, Middle, Round)) and adjacent mainland beaches. It provides the monitoring parameters and data pathways required by **MS 1264 Conditions B5-3, C4-1/C4-2** (thresholds, triggers, adaptive management, contingency measures) and ensures annual comparison to the baseline dataset (Pendoley Environmental 2019, 2022 and 2023).

To satisfy conditions outlined in Appendix A this monitoring program includes (but not is limited to):

- Identification of the species of turtles nesting on the beaches
- Identification of the abundance and the distribution of adult tracks on the nesting beaches
- Collection of data on the health of the nesting habitat (incubation success)
- Collection of data on hatchling orientation
- Measurements on the intensity, direction, and extent of light sources visible from nesting beaches.

2.1 Survey Locations

Annual monitoring will be conducted at the regulated nesting beaches identified in **MS 1264 Condition B5-1(2)**: Long, Sholl, Angle, Middle Passage, Round, and mainland beaches (Mardie Creak East (MCE) and Mardie Creek West (MCW)). Opportunistic monitoring may also include additional islands - Fortescue, Mardie and Stewart Island (Figure 2-1).

Nesting activity and hatchling orientation survey areas are presented in Appendix B. Hatchling monitoring survey areas are mapped to avoid dynamic sand spits (where natural cues confound interpretation). These locations and segments are fixed to ensure comparability with baseline and subsequent years.

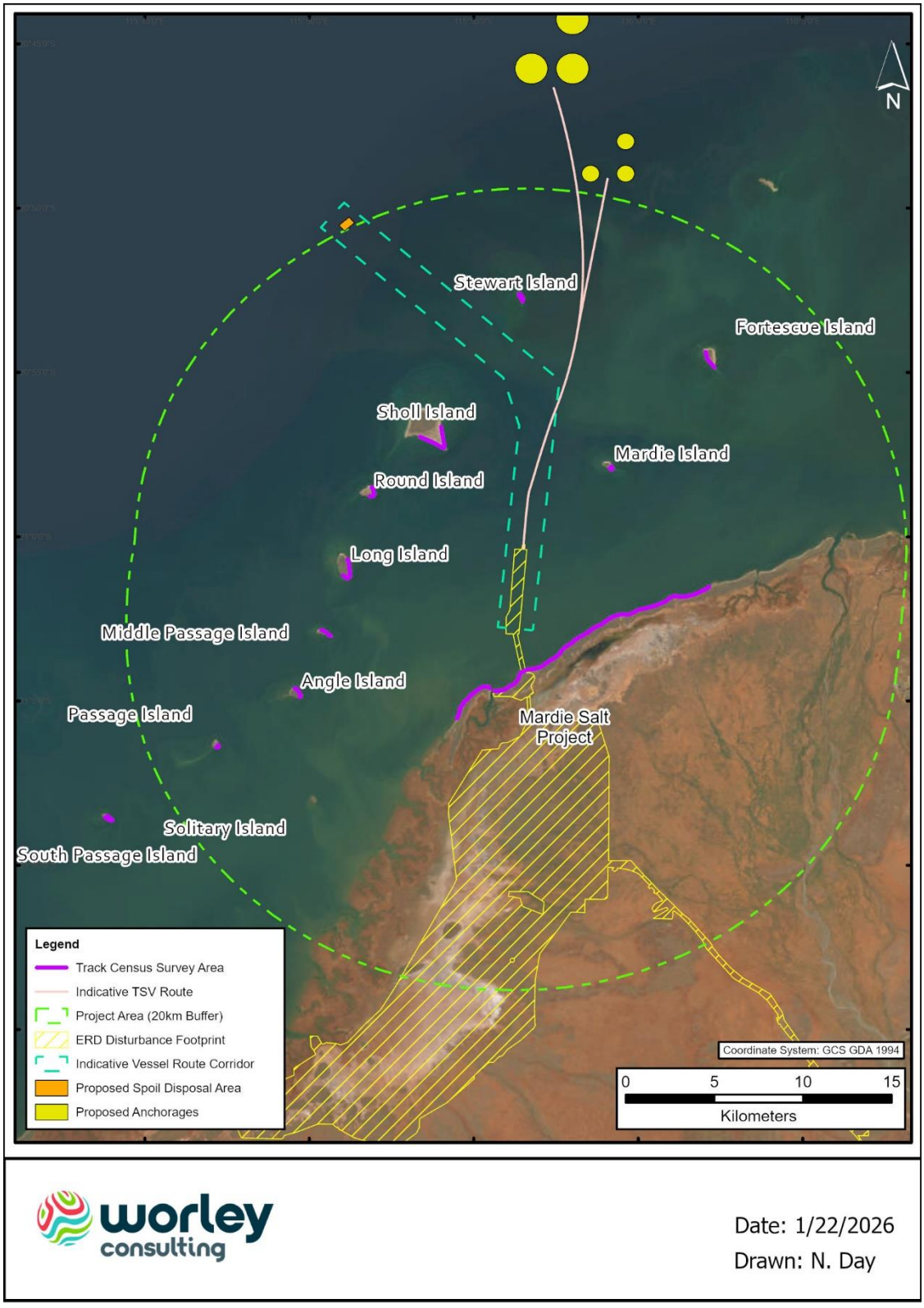

Figure 2-1 Marine Turtle Monitoring Areas

2.2 Site Access

Islands will be accessed by boat or by helicopter. Mainland sites may be accessed by road, boat or by helicopter. Mainland beaches include those beaches to the east and west of Mardie Creek. The beach habitat at least 3 km east and 2.5 km west of the loadout jetty will be monitored and will take place at the same time as the offshore island surveys.

Access to Mardie Creek West is difficult as there is no road access (road access is to Mardie Creek East only) and entering this location from the sea is limited to short time periods around the high tide due to the shallow intertidal area. Alternative methods such as remote drone track census or using a small vessel to cross Mardie Creek may be considered for this location. For the 2023-2026 surveys a helicopter has been used which will allow access to all sites, including Mardie Creek West, however future surveys may consider other options such as those suggested above.

2.3 Survey Schedule

2.3.1 Seasonal survey schedule

Each monitoring year will comprise of three, 14-day field surveys timed to the species/seasonal peaks and aligned with the new moon window for light monitoring:

- **Field Survey 1 (FS1):** A 14-day survey targeted at the October peak of the hawksbill turtle nesting season.
- **Field Survey 2 (FS2):** A 14-day survey targeted at the December peak of the green and flatback turtle nesting season, and the peak of the hawksbill hatching season.
- **Field Survey 3 (FS3):** A 14-day survey targeted at the February peak of the green and flatback hatching season.

This schedule will capture one full internesting cycle per peak, consistent with regional turtle programs and baseline surveys, enabling robust estimates of nesting beach utilisation and orientation.

2.3.2 Work Scope Schedule

The MTMP is comprised of four work scopes to satisfy regulatory compliance, including track census, incubation success, hatchling orientation and artificial light monitoring. The schedule of work scopes is provided in Table 2-1, with methodology detailed in Section 3. This schedule is designed to achieve compliance with **MS 1264, EPBC2018/8236** and **EPBC2-22/9169** in a manner that is scientifically robust, risk-proportionate, and logistically and operationally feasible.

Daily monitoring of all beaches across the 12-site program is not realistically achievable due to helicopter/vessel constraints, environmental conditions, fatigue, heat-stress, and the need to minimise unnecessary landings in sensitive habitats. The schedule prioritises higher-intensity monitoring at sites with greater risk of project-related light exposure and higher nesting value, while reducing effort at low-value, low-density, and difficult-to-access sites.

While every effort will be made to complete each work scope, logistical, human health and safety limitations will ultimately dictate what can be achieved in each field survey.

Table 2-1: Proposed work scopes to be conducted at each location during each field survey (FS).

Location	Track Census			Incubation Success			Hatchling Orientation			Light Monitoring
	FS1	FS2	FS3	FS1	FS2	FS3	FS1	FS2	FS3	
Routinely surveyed – daily										
Sholl Island	X	X	X	X	X	X	X	X	X	x
Long Island	X	X	X	X	X	X	X	X	X	x
Round Island	X	X	X					X	X	x
Middle Passage Island	X	X	X					X	X	x
Angle Island	X	X	X					X	X	x
Opportunistically surveyed – minimum twice per survey week										
Mardie Creek East	X	X	X	X	X	X		X	X	x
Mardie Creek West	X	X	X	X	X	X		X	X	x
Passage Island	X	X	X							
Mardie Island	X	X	X					X	X	
Stewart Island	X	X	X					X	X	
Fortescue Island	X	X	X					X	X	

Note:

Hatchling orientation will not be undertaken at Passage Island as all the nesting habitat occurs on or adjacent to the spit (Section 3.4.3).

3. Work Scope Methodologies

The survey methods detailed in the following sections are consistent with those outlined in the *North West Shelf Flatback Turtle Conservation Program Turtle Monitoring Field Guide* (DBCA, 2023), including survey timing, duration and techniques. The methods are also consistent with the recommendations of the National Light Pollution Guidelines (DCCEEW 2023).

3.1.1 Track Census

Adult nesting is monitored via Track census to quantify nesting effort and the spatial distribution of tracks at compliance sites (Long, Sholl, Round, Middle Passage, Angle and mainland sites), and to demonstrate **no adverse project-related change in nesting beach utilisation and nesting success** as a result of project-attributed light, as required by **MS 1264 Condition B5-1(2).**

Field Method

A track census involves recording the type of marine turtle nesting activity and species derived from tracks encountered on a nesting beach. For this MTMP marine turtle nesting activity will be identified by air-based (helicopter) or ground-based (on foot). Monitoring extent for each site can be found in Appendix B.

Prior to the start of each survey, all visible tracks are crossed off during a 'line-in' day to ensure only new tracks from overnight activity were recorded on subsequent survey days.

A track census will be undertaken as one of the following:

- **Routine daily** monitoring which will occur on Long, Sholl, Round, Middle Passage and Angle islands where sites are visited daily to identify overnight nesting activity. All visible tracks are marked during a 'line-in' day (i.e., first day of each survey) prior to the commencement of the track census survey, and overnight activity is recorded on subsequent days.
- **Routine (opportunistic)** monitoring (at least twice a week) will occur on the mainland beaches (MCE and MCW) and Fortescue, Mardie and Stewart islands to determine the presence/absence of nesting activity. All visible tracks are counted and marked on the first day the nesting beach is visited. Track activity is recorded on subsequent days and averaged over the survey period.

Marine turtle species and nesting activity (false crawl, attempt, or nest) will be determined using track and nest characteristics, including track width, shape and orientation of flipper marks, trail drag marks, displaced sand, and the depth of the nest pit and associated mound (Eckert *et al*. 1999). Any adult tracks that traverse the dunes and move inland will also be followed and documented.

Predator activity will be recorded and identified by tracks, scratchings and holes dug in the sand in the vicinity of a nest, which may have resulted in eggshells being scattered at the sand surface.

3.1.2 Hatchling survivorship

Hatchling survivorship is monitored to meet compliance requirements under **MS 1264 Condition B5-1(2).** Survivorship is assessed through characterisation of the incubation environment and determination of hatch success and emergence success.

Field Methods

Nest marking: Nests will be marked in FS1 (October) and FS2 (December) on the two main offshore rookeries (Sholl and Long islands), and if they are encountered on the mainland (Mardie Creek East and West). Where possible, nests selected for marking will consider the spring high tide level to avoid nests being lost to erosion from high tides and wind as found in previous surveys (Pendoley Environmental 2022).

Clutches will be located by carefully digging into fresh overnight nests identified during the track census and locating the eggs at the top of the nest. A temperature logger tethered to a marking post will be placed amongst the eggs to record the temperature profile during incubation. This data is used in nest success analysis. Control temperature loggers will also be deployed in the sand at 500 mm depth during FS1 at routine monitoring locations to track natural changes in sand temperature during the incubation period of marked nests.

Nest Excavation: Marked nests will be excavated in FS2 (where possible) and FS3. Marked clutches will be excavated by removing and sorting the contents of each egg chamber. Clutch contents will be sorted into the following categories:

- Live hatchlings
- Dead hatchlings
- Live Pipped eggs
- Dead pipped eggs
- Hatched eggs
- Partially developed embryos (dead)
- Fully developed embryos (dead)
- Undeveloped embryos
- Egglet

In addition to marked clutches, opportunistic clutches will also be excavated during FS3. Recently emerged nests will be identified in the first three days of the field survey and excavated in the final three days of the field survey to allow sufficient time for the nest to finish hatching. The clutches will be excavated with caution to avoid disturbance to any remaining live hatchlings within the clutch or to developing embryos that may not have hatched. The contents of the egg chamber will be sorted as per the marked clutches.

Incubation metrics will be discussed on a year-by-year basis and in context with the incubation environment metrics determined for marked clutches in pre-construction surveys. Control logger temperatures will be used to calculate the mean daily temperature for the entire incubation period of marked clutches (October to December) each year as a tool to understand natural fluctuation in sand temperature, to compare to marked nests.

3.1.3 Hatchling Orientation

Monitoring is undertaken to demonstrate compliance with **MS 1264 Condition B5-1(2)**, which requires no adverse change in hatchling orientation at **mainland beaches** and **Long, Sholl** and **the Passage Islands (Angle, Middle and Round)**. Hatchling seaward movement is assessed to identify any misorientation or disorientation associated with artificial light, using methods aligned with the National Light Pollution Guidelines for Wildlife (2023) and DBCA field standards.

Field Methods

Hatchling orientation monitoring areas are defined in Appendix B and correspond to the mapped non-spit beach sectors at each compliance site (mainland east/west of Mardie Creek, Long Island, Sholl Island, Angle Island, Middle Island, and Round Island); survey transect bounds and GPS waypoints for these sectors are shown in Appendix B**, Figures B1–B8**, and must be used for all orientation measurements and site-specific comparisons.

Hatchling orientation will be recorded at compliance sites during FS2 and FS3. A nest fan will be recorded when ≥5 tracks radiate from the nest cone depression. Using a sighting compass, measure bearings of the two outermost tracks (vectors A & B) and the most direct route to the ocean (vector X), at the high tide line or 5 m from the emergence point (whichever is shorter, Figure 3-1). Any tracks > 30° outside of the main fan (defined by vectors A and B) are considered outliers, these are recorded separately but excluded from spread/offset calculations.

Two metrics will be used to track fan spread and offset:

- **Spread angle**: this describes track dispersion from the emergence point, capturing the spread of all hatchling pathways toward the ocean (distance between A & B). A larger value indicates greater dispersion or variation in ocean finding bearings and may indicate disruption to natural hatchling sea finding ability.
- **Offset angle (C)**: this describes the degree of deflection of tracks from the most direct route to the ocean. A smaller value indicates a more direct route (i.e., less deviation from the most direct route) and a larger value demonstrates greater deviation from the most direct route, which may indicate disruption to natural hatchling sea finding ability.

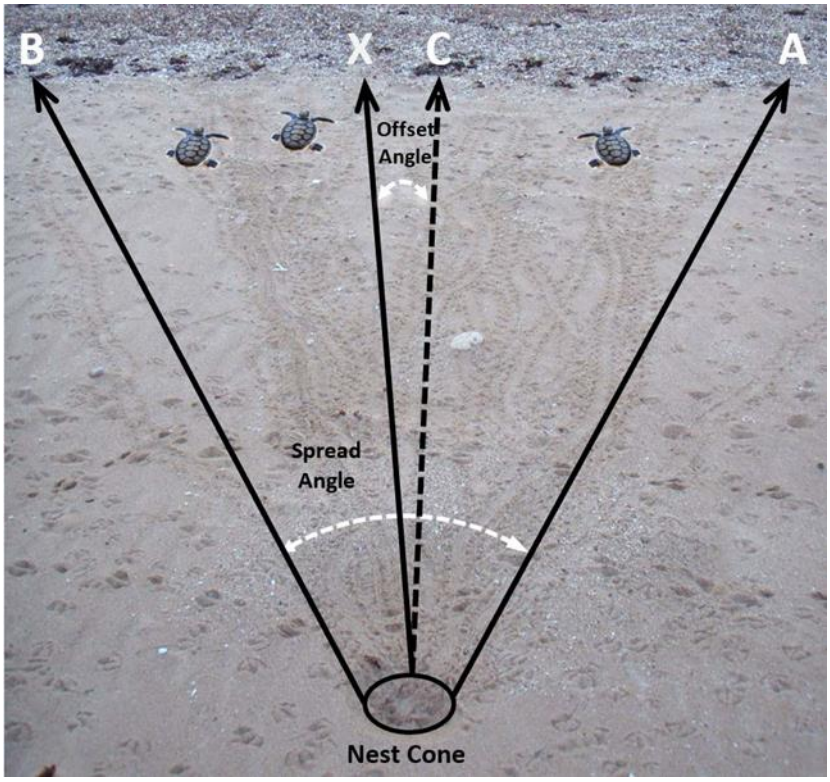

Figure 3-1: Hatchling orientation indices measured from the emergence point identified as the nest cone. A and B: the outermost bearings of the main fan, X: the bearing of the most direct route to the sea and C: offset angle. (Source: Pendoley Environmental 2022).

3.1.4 Artificial light Monitoring

To measure intensity, direction and extent of artificial light visible from nesting beaches at compliance sites; link ALAN to orientation and beach use; align with *National Light Pollution Guidelines for Wildlife (2023)* and **MS 1264 Conditions C4-2(3)**; support **B5-3(1) Mardie Illumination Plan** requirements.

Field Methods

Light monitoring will occur over two field surveys annually during new moon phases to ensure adequate capture of useable images. Monitoring locations will be located within the defined hatchling fan monitoring zones (see Appendix B) at each compliance site (mainland **east/west of Mardie Creek, Long Island, Sholl Island, Angle Island, Middle Island,** and **Round Island**). Equipment will be deployed above the spring high tide line under new moon conditions. Images of night-time light emissions on a 360° horizon are captured automatically by the cameras at 10-minute intervals between sunset and sunrise.

3.2 Data Analysis

Data analysis methods applied under the MTMP are described below, while interpretation and application of monitoring results for compliance purposes are addressed in Section 4.

3.2.1 Track Census

Descriptive statistics of abundance (mean ± standard deviation, range and sample size) will be generated for the following parameters for each species and each beach across all field surveys:

- Overnight nests.
- Overnight tracks (includes false crawls and nesting attempts).

Nesting success is calculated as the proportion of successful nesting events relative to the total number of overnight tracks, stratified by census beaches (surveyed daily or at least bi-weekly) and turtle species. A successful nesting event is confirmed by visual sighting of eggs only where the nest is selected for the incubation study; all other nesting events are determined from visual assessment of the completed nest and are not confirmed by excavation. Consequently, this parameter is treated as an estimate.

The **spatial distribution** of nesting activity across monitoring areas is quantified using the heatmap tool in QGIS 3.36.0. Heatmaps incorporate all nesting activity records captured on track census days (excluding line-in days) and are generated using Kernel Density Estimation with a quartic interpolation function and a 20 m search radius around each activity record. A nearest-neighbour spatial analysis is then applied to quantify clustering or dispersion of nesting attempts within each monitoring area. This analysis measures the distance between each track and its nearest neighbour, averages these distances, and compares the result to a hypothetical random distribution. If the average distance is less than expected for a random distribution, nesting activity is considered clustered; if greater, it is considered dispersed. The nearest-neighbour index is calculated as the actual mean distance divided by the expected mean distance, with expected values based on a hypothetical random distribution of the same number of sightings across the same area. High levels of clustering in nesting activity are indicated by large negative Z-scores. Distribution patterns are compared against baseline datasets to detect any project-attributable changes.

In addition to spatial distribution analyses, seasonal variation in nesting activity is assessed using descriptive abundance statistics generated for each species and beach. Seasonal counts of nests and tracks are compared against baseline and historical datasets to identify broad trends or anomalous reductions in nesting activity. Interpretation of seasonal abundance considers natural inter-annual variability and environmental influences and is used to support contextual understanding of beach utilisation patterns, rather than as a standalone compliance indicator.

3.2.2 Hatchling Survivorship

Clutch fate

To provide context for hatch and emergence success, Clutch fate will be classified into four categories:

- **Complete:** A clutch will be considered complete if it is not lost, inundated, disturbed, or predated, i.e., it remains undisturbed for the entire incubation period.
- **Lost:** A clutch will be classified as lost if it cannot be located by the field team. Causes may include excessive sand deposition, erosion, disturbance from predators or other nesting turtles, or displacement of marking equipment.
- **Inundated:** A clutch will be classified as inundated if its temperature profile shows a sudden substantial drop below the control temperature.
- **Disturbed or predated:** A clutch will be classified as disturbed or predated if its temperature profile shows a sudden substantial increase in temperature.

Mean clutch size (total number of eggs laid in a single nest, determined by egg counts, ± SD, range) will be calculated for each species. These values will be compared to baseline datasets from previous surveys (e.g., 2018/19 and 2021/22) to identify potential differences in reproductive output between seasons and habitat types (mainland vs islands). Comparisons will provide context for interpreting incubation success and hatchling survival.

Hatch and Emergence Success

Hatch success will be calculated by dividing the number of hatched eggs by the total number of eggs in the clutch. Hatchling **emergence success** (the percentage (%) of hatchlings successfully leaving the nest) will be calculated by subtracting the number of live and dead hatchlings encountered in the egg chamber from the number of hatched eggs and then dividing by the total number of eggs in the clutch.

Annual **mean hatch and emergence success** (± SD, range) will be compared across seasons and against baseline.

Incubation Period

The **incubation period (IP)** is the duration between the date a clutch was marked and the date the clutch hatched. The hatch date of each marked clutch classified as 'complete' will be determined by comparing the clutch temperature profile to the control temperature profile, whereby an independent drop in temperature in the clutch profile indicates that the nest has hatched and emerged. Incubation periods will be compared across seasons and to baseline data to assess potential temperature-related impacts.

Thermal Environment: Clutch Temperature

Following identification of the hatch date for each clutch, descriptive statistics will be generated to describe the incubation environment of each clutch, including:

- Mean clutch temperature for the incubation period.

- Mean clutch temperature during the Thermosensitive Period (TSP), which represents the middle trimester of development and determines the sex ratio of a clutch (Yntema & Mrosovsky 1980, 1982; Hewavisenthi & Parmenter 2002).
- The proportion of the incubation period where the mean daily temperature is greater than 33°C. This temperature is considered the lower bound of the upper thermal tolerance range (TTR) for flatback turtle incubation, above which embryo development is impaired (Ackerman 1997, Van Lohuizen et al. 2016).

These metrics will be summarised (mean ± SD, range) and compared across surveys and to baseline data to evaluate thermal stress and potential impacts on hatchling survival and sex ratios.

Thermal Environment: Sand Temperature

Temperature loggers deployed at control sites on each beach section will be retrieved during FS3. Control logger temperatures will be used to calculate the mean daily temperature for the entire incubation period of marked clutches to provide context for interoperating incubation success and thermal environment metrics.

Thermal Environment: Air Temperature and Rainfall

To facilitate comparison of the above metrics with environmental conditions experienced across the monitoring period, air temperature and rainfall data for the Mardie weather station (ID: 005008) will be accessed from the Bureau of Meteorology (BoM) website (BoM 2025a).

3.2.3 Hatchling orientation

Offset and **spread angles** will be calculated for bearings measured from each nest fan (Figure 3-1) to determine the spread of hatchling tracks from the point of emergence (angle between vectors A and B, Figure 3-1) and the degree to which hatchlings diverge from the most direct route to the ocean (angle between vector X and C, where C is the mid-point between vectors A and B, Figure 3-1).

Any tracks > 30° outside of the main fan (defined by vectors A and B) are considered outliers, these are recorded separately but excluded from spread/offset calculations.

Orientation patterns will be compared to the most direct route to the ocean and assessed against baseline data to identify potential misorientation or disorientation.

3.2.4 Artificial Light

Identification of Potential Light Sources

Potential sources of artificial light captured by the Sky42 cameras will be identified using Google Earth and Visible Infrared Imaging Radiometer Suite (VIIRS) satellite imagery (Elvidge et al., 2021; available at: https://eogdata.mines.edu/products/vnl/).

Data Processing

The quality of an image captured by a Sky42 light monitoring camera can be influenced by atmospheric factors such as the presence of the moon, twilight, cloud, rain, dust, humidity, or physical factors such as accumulation of sand or dust on the lens. Any images that are affected by physical factors will be removed from the analysis, as well as any images that are affected by the moon or twilight.

Following quality checks, all suitable images will be processed using specialised software to determine "whole-of-sky", "horizon", and "zenith" sky brightness levels. Whole-of-sky (WOS) is the mean value of sky glow in the entire image. Horizon is the mean value of sky glow within the 60°–90° band across the horizon. Zenith is the mean value of sky glow within the 0°–30° band directly overhead.

Nights with the clearest imagery and least amount of cloud cover will then be selected for presentation within this report. It should be noted that the colour-coding used in these images represents sky brightness (described below) and is not indicative of how the visible light would be perceived by humans or wildlife.

Sky brightness will be measured in units of visual magnitudes per square arcsecond (Vmag/arcsec²); a standard unit used in astronomical measurements and emerging as a global standard for sky glow monitoring. The Vmag/arcsec² unit quantifies light intensity on an inverse logarithmic scale, where higher values represent lower intensity light, and lower values represent higher intensity light. Qualitative descriptions of the WOS values used to classify the night sky at each monitoring location will be presented.

Measuring Changes in Sky Brightness

In order to measure changes in WOS sky brightness between the present season (i.e. 2024/25) and baseline (i.e. 2021/22 for the offshore islands; 2022/23 for the mainland), WOS sky brightness values – measured in logarithmic units of Vmag/arcsec^2 – will be converted to a linear scale. Changes in sky brightness will then be presented as a percentage change in these converted metrics at each monitoring site. Where baseline data is not available, the change in brightness is calculated from the first year of available data for that monitoring site.

Light-Orientation Integration

Light–orientation integration is undertaken by comparing hatchling orientation outcomes derived from nesting fan analysis with the directional characteristics of artificial light identified from concurrent all-sky imaging. For each monitored beach, azimuthal light profiles derived from filtered all-sky images are used to identify the bearing of Project-related artificial light sources visible from the nesting area.

Hatchling orientation is summarised using a **hatchling rose plot** generated from nesting-fan data. Each nest emergence event produces a single nesting fan, representing the overall direction and spread of hatchling movement from that nest. Each nesting fan contributes one orientation outcome to the analysis.

Fan orientation outcomes are grouped into predefined **angular bins** of equal width (5 - 10° increments) based on fan offset relative to the most direct route to the ocean. Bins are centred on the oceanward direction and extend symmetrically to either side. Each nesting fan is assigned to a single angular bin based on its central bearing offset.

Hatchling bearing frequency is calculated as the number of nesting fans within each angular bin, expressed as a proportion of the total number of emergence events recorded for a given beach and monitoring season. These frequencies are used to construct the **hatchling rose plot**, which illustrates the distribution of fan offsets and the relative frequency of different orientation outcomes (Figure 3-2).

To examine the relationship between artificial horizon lighting and hatchling orientation, median **horizon sky brightness by azimuth** (Vmag/arcsec², 60–90° band) will be overlaid with the **hatchling rose** (5–10° bins) per site/season to test for **co-directionality** of elevated sky glow and track bearings (Figure 3-2). Spread bearings will be shown as red bars and offset bearings as white bars. This approach will allow visual assessment of hatchling orientation relative to the distribution of horizon light intensity.

This integrated presentation allows visual assessment of the alignment between elevated horizon sky glow and hatchling track bearings, providing an intuitive evaluation of potential light-mediated influences on hatchling orientation.

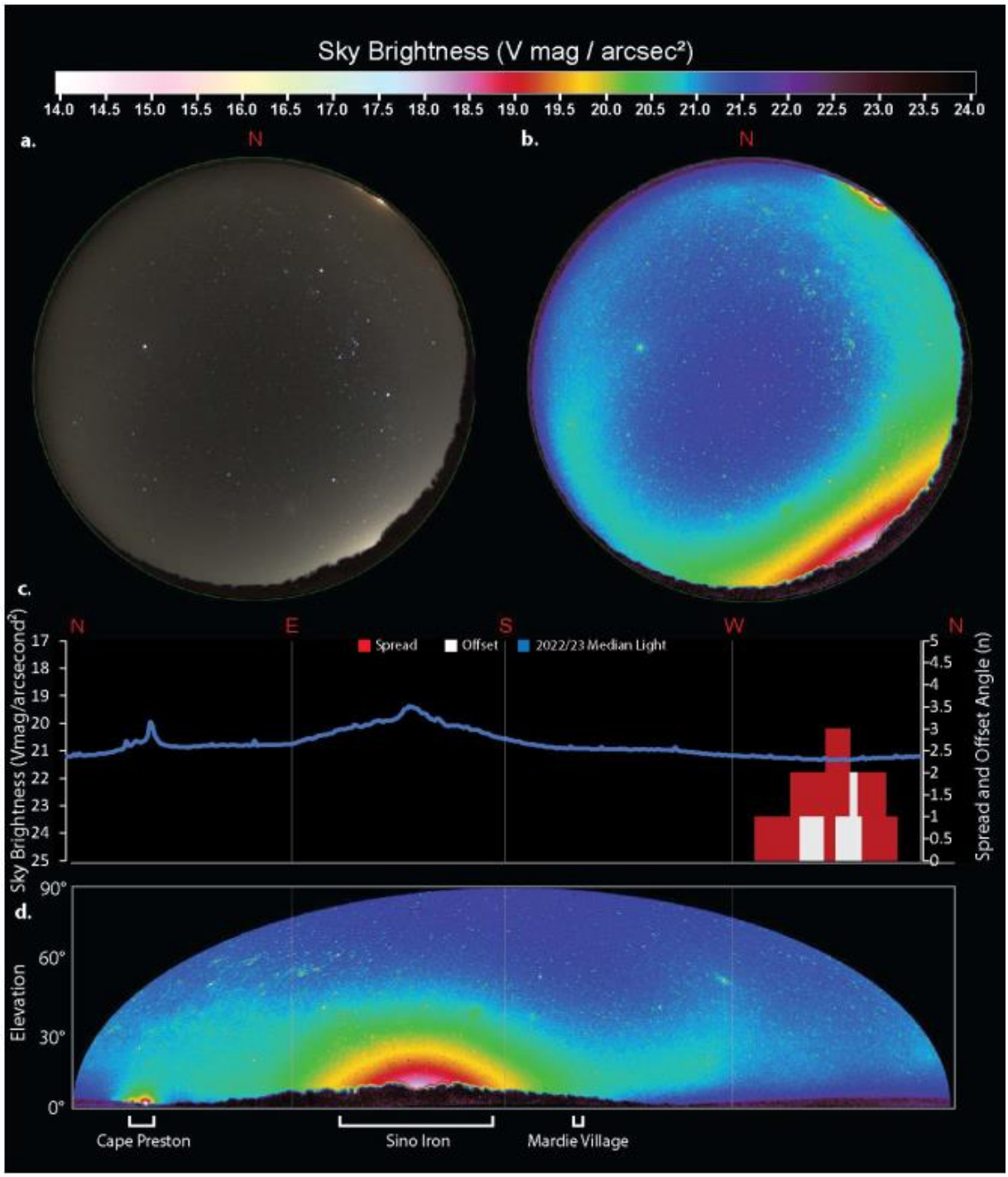

Figure 3-2 Light-Orientation Assessment example. a. Clearest raw circular image; b. Processed circular image; c. Light bearing graph showing sky brightness in 2022/23 and associated hatchling bearing frequency for spread (red bars) and offset (white bars); d. Processed hammer-aitoff image. (Pendoley, 2023).

3.2.5 Data sufficiency and exclusions

- **Orientation:** A minimum of 15 nest fans per beach per season is targeted for compliance assessment. If n < 10, orientation results are reported descriptively and no compliance call is made; n = 10–14 triggers a cautionary interpretation, flagged for increased effort in the subsequent survey window. Fans are excluded if: fewer than 5 tracks; nest on dynamic spit sectors mapped in Appendix B.

- **Light:** Only images captured under full night-time conditions are considered useable, defined as periods when the sun is more than 12° below the horizon (Solar Depression ≤ −12°), the moon is below the horizon (moon elevation ≤ 0°),, and low cloud cover is < 4 oktas. Nights failing these filters are excluded. All Sky42 units are field-calibrated pre-season and post-season (flat-fielding; clock sync); images failing lens contamination checks are removed.

- **Attribution:** Orientation bias is attributed to **Project light** when all three conditions are met: (i) directional bias (>20% of combined seasonal hatchling bearings per beach and >30° deviation from the most direct route to the ocean) (ii) the azimuth of elevated horizon glow coincides with Project azimuth(s), and (iii) there is no confounding natural cue (e.g., bright surf/reflection, dune gap) on the same azimuth. Otherwise, the finding is recorded as non-attributed and investigated.

4. Compliance Criteria

This section describes how monitoring data collected under the MTMP will be used to assess, substantiate and report whether the marine turtle outcomes specified in **MS 1264** and relevant **EPBC Act approvals** are being achieved.

Compliance assessment under the MTMP recognises that baseline data availability varies across monitoring locations, particularly at mainland and Passage Island sites where historical hatchling emergence densities and monitoring coverage have been limited and inconsistent between seasons. While baseline data provides an important reference for historical site characteristics, these constraints limit the suitability of relying solely on fixed statistical thresholds derived from baseline datasets.

Accordingly, compliance with **MS 1264** is assessed using a hybrid **outcomes-based** and **objective-based** framework that focuses on biologically meaningful behavioural responses that can be evaluated on a seasonal, site-specific basis. Hatchling orientation has been selected as the primary outcome-based indicator because it represents a direct and observable response to artificial light exposure and can be robustly assessed within individual monitoring seasons through comparison of seaward orientation and directional bias relative to identified light sources. Nesting beach utilisation is also assessed as an outcome-based indicator, with emphasis on spatial distribution, persistence of core nesting areas and directional change over time, rather than reliance on fixed numerical baselines.

Seasonal monitoring results are compared against available baseline information and evaluated in the context of expanding cumulative datasets at each location. This approach enables detection of project-attributable change through:

- Seasonal comparison of behavioural patterns at the same site
- Assessment of directional or spatial trends over successive seasons
- Increasing confidence in interpretation as datasets accumulate over time.

Artificial light measurements, including whole-of-sky brightness, are used to characterise light conditions and to support interpretation and attribution of observed marine turtle behavioural responses. While artificial light has a well-established direct biological influence on hatchling behaviour and orientation, whole-of-sky brightness represents an integrated measure of multiple light sources and environmental factors and cannot be reliably attributed to Project lighting alone. Accordingly, light metrics are used as interpretive and not applied as standalone compliance trigger or threshold values.

Compliance assessment under the MTMP follows a structured, outcomes-based process, in which biologically meaningful behavioural indicators are assessed against defined trigger and threshold criteria, supported by contextual ecological information. **Trigger criteria** are early-warning indicators set conservatively to **forewarn of approach to the threshold** and

prompt **trigger-level actions** (EPA, 2024). **Threshold criteria** represent the **limit of acceptable change** beyond which the **environmental outcome is not achieved**; exceeding a threshold constitutes **non-compliance** (MS 1264 Condition C4-5) where attributable to Project lighting (EPA, 2024).

Outcome-based indicators form the primary basis for determining whether the relevant environmental outcomes are being achieved, while objective-based indicators are assessed concurrently to provide supporting context and strengthen weight-of-evidence interpretation. Compliance is assessed at the **nesting-beach scale** and interpreted at the **seasonal scale**, with results evaluated in the context of available baseline information, cumulative datasets, natural inter-annual variability and contemporaneous environmental conditions.

Trigger/threshold criteria apply **to all compliance beaches** (Long Island, Sholl Island, Angle, Middle and Round Islands, and mainland beaches east and west of Mardie Creek) as required by **MS 1264 Condition B5-1(2).** Other sites are monitored opportunistically for context only.

Trigger and threshold criteria applicable outcome-based indicators are defined in Section 4.1 and summarised in Table 5-1. Objective-based indicators are defined in Section 4.2 and summarised in Table 5-2.

4.1 Outcome-Based Indicators

4.1.1 Hatchling Orientation

Hatchling orientation is assessed to demonstrate compliance with **MS 1264 Condition B51(2)** and relevant EPBC approval conditions, which require that **no adverse change in hatchling orientation (misorientation or disorientation) occurs as a result of Project-related artificial light**.

Assessment is undertaken using a combined seasonal dataset for each compliance site. All suitable hatchling emergence events recorded at a nesting beach within a monitoring season are combined to provide a site-level seasonal assessment of hatchling orientation behaviour. For each emergence, hatchling tracks are mapped to define a nesting fan, from which the fan offset and angular spread are calculated relative to the most direct route to the ocean at that location. Individual emergence events are reviewed for context; however, compliance determination is made at the nesting beach level on a seasonal basis, consistent with an outcome-based assessment framework.

Where the **offset** of a nesting fan deviates by more than 30° from the most direct route to the ocean, the emergence event is classified as **misoriented**. Misoriented nesting fans are subsequently assessed for alignment with identified Project-related artificial light azimuths using concurrent light monitoring data.

For each monitored beach, hatchling emergence bearings (spread and offset angles), **and** associated **artificial light data** are **analysed together to determine** whether hatchling movement exhibits a systematic directional bias toward **Project-related artificial light**, rather

than natural seaward cues. Hatchling bearing distributions are compared with horizon sky brightness by azimuth to enable direct attribution of any observed orientation bias to Project lighting.

Compliance triggers and threshold criteria are defined as follows and assessed per nesting beach per season:

- **Trigger:**
  A trigger is reached where **20 percent or more (≥20%) of hatchling fans** per compliance site within the combined seasonal dataset exhibit both an offset greater than **30 degree (°) deviation** from the most direct route to the ocean and alignment with identified Project-related artificial light azimuth, within one monitoring season.

- **Threshold:**
  A threshold exceedance occurs where **30 percent or more (≥30%) of hatchling fans** per compliance site within the combined seasonal dataset exhibit both an offset greater than **30 degree (°) deviation** from the most direct route to the ocean and alignment with identified Project-related artificial light azimuth, within one monitoring season.

Trigger exceedance initiates investigation and adaptive management, however it does not constitute non-compliance. **Threshold exceedance** represents failure to achieve the environmental outcome specified in **MS 1264 Condition B51(2)** and constitutes **non-compliance**, where the behaviour is attributable to Project lighting.

Compliance is demonstrated where **combined seasonal hatchling bearings** remain predominantly seaward-oriented, **no systematic bias toward Project lighting is evident**, and **threshold criteria are not exceeded.**

4.1.2 Beach Utilisation

Nesting beach utilisation is assessed to demonstrate compliance with **MS 1264 Condition B51(2),** which requires **no adverse change** in beach utilisation and marine turtles are not deterred or displaced from historically used nesting beaches as a result of Project-related artificial light.

Beach utilisation is evaluated using site-specific, multi-season spatial analysis, focusing on where nesting occurs along a beach rather than total nesting abundance. Metrics include the spatial extent of nesting activity, persistence of core nesting areas, and longitudinal distribution along each monitored shoreline. These parameters are interpreted collectively to identify biologically meaningful change in how nesting habitat is used over time, rather than relying on absolute nesting abundance.

For the purpose of this MTMP these indicators are assessed as follows:

- **Nesting activity**
  Nesting activity refers to the presence, relative density and spatial distribution of recorded nesting attempts along each monitored beach during a monitoring season, as determined through track census surveys. Seasonal nesting activity is compared with historical patterns

at the same site to identify sustained reductions or displacement in nesting behaviour that cannot be explained by natural inter-annual variability or short-term environmental influences.

- **Persistence of core nesting areas:**

  Persistence of core nesting areas refers to the continued use of historically preferred nesting zones within each monitored beach. Core nesting areas represent areas of relatively high and repeated nesting use within a season and are identified through spatial assessment of nesting density and clustering patterns. Contraction, loss or failure of previously persistent core nesting areas to be utilised across successive seasons may indicate potential avoidance or displacement where such change is not attributable to natural drivers.

- **Longitudinal distribution along the shoreline**

  Longitudinal distribution refers to the along-shore positioning and spread of nesting activity along each monitored beach, assessed by comparing the relative distribution of nesting attempts between beach segments across seasons. Directional shifts in nesting activity away from beach sections exposed to Project-related artificial light, particularly where such shifts persist over time, are used to inform assessment of nesting beach utilisation outcomes. Longitudinal distribution analysis is confined to detecting redistribution within monitored beaches, particularly away from light-exposed sections, and does not infer relocation of nesting females to alternative beaches outside the monitoring footprint.

For each **compliance site**, **nesting distributions** are compared to available baselines and across seasons to identify **directional change or loss of historically utilised nesting areas**. Individual seasonal results are interpreted in the context of known sources of natural variability, including beach morphology, erosion or accretion, access constraints and prevailing environmental conditions.

Compliance assessment is **trend-based**, recognising that b**ehavioural avoidance responses develop over time** and may not be evident in a single season.

Compliance triggers and threshold criteria are defined as follows and **assessed per nesting beach per season**:

- **Trigger:**

  A trigger is reached where **one or more** of the following **patterns** are observed at a monitored nesting beach and persist across **two consecutive nesting seasons**:

  - **Contraction of the core nesting utilisation area** relative to the site-specific reference range.
  - **Loss of persistent nesting "hotspots**" in historically preferred beach sections.
  - **Directional redistribution of nesting activity** away from beach areas exposed to Project-related artificial light.

- **Threshold:**

  Continued or **progressive exclusion** from historically utilised sections, or a **substantial reduction in core utilisation (≥30%) or ≥30% reduction in density within persistent hotspots, within a single season**, and is **attributable to project lighting**.

Trigger and threshold criteria are applied to detect biologically meaningful change in nesting distribution, rather than short-term or isolated variation in nesting abundance. A **trigger exceedance** prompts investigation to determine causation and attribution but does not constitute non-compliance. **Threshold exceedance** represents failure to achieve the environmental outcome (non-compliance), where a sustained or substantial reduction in nesting utilisation of historically preferred areas is demonstrated and the change is attributable to Project-related artificial light.

Compliance is demonstrated where nesting activity continues to occur within historically utilised areas, core nesting zones remain persistent over time, and no systematic redistribution away from light-exposed beach sections is evident. Interpretation is informed by spatial metrics, temporal persistence across seasons, and artificial light exposure data, and considers natural variability in beach morphology and environmental conditions.

While the compliance requirements focus on spatial utilisation of monitored beaches, changes in overall nesting abundance are also documented and reported for each site and season to provide ecological context and to support broader regional assessments of nesting behaviour only and are not directly linked to compliance performance.

In the event a threshold criteria is exceeded, in order to confirm and demonstrate that a sustained reductions in nesting activity is attributable to project lighting, an investigation will be conducted that to identify the occurrence/presence of natural drivers that may contribute to, or be a sole causal factor of reduction in beach utilisation, Natural drives in sustained reduced utilisation may include , include regional population dynamics, environmental variability, or relocation of nesting females to alternative beaches beyond the monitoring footprint. Although such changes cannot be reliably attributed to Project-related artificial light at a single site, nesting abundance trends are reported to provide ecological context and to support broader regional assessments of nesting behaviour.

4.2 Objective-Based Indicators

4.2.1 Nest Success

Nesting success is assessed to support compliance with **MS 1264 Condition B51(2)** and relevant **EPBC Act approval conditions**. The objective of monitoring nesting success is to confirm **no adverse change in nest success** and that marine turtles are able to successfully complete nesting events at monitored beaches and **are not being prevented or deterred** from nesting as a result of Project activities.

Nesting success represents the proportion of successful nesting events relative to total adult nesting attempts recorded at a monitored nesting beach. It provides contextual information on nesting

behaviour and nesting habitat condition and is interpreted alongside nesting beach utilisation, hatchling orientation and artificial light exposure data.

Nesting success is **not used as a primary compliance indicator for artificial light impacts**. This is because nesting success is influenced by a wide range of environmental and behavioural factors unrelated to lighting, including beach profile, sand moisture, tidal inundation, weather conditions and individual turtle behaviour. As such, **changes in nesting success alone do not, in isolation, indicate an impact from Project-related lighting.**

Nesting success is calculated for each nesting beach and turtle species using data collected from beaches surveyed at sufficient frequency to reliably record both successful nests and failed nesting attempts. Seasonal results are assessed using a site-specific, trend-based approach and compared to the historical range of values observed at each site. Sustained or notable deviations from site-specific reference ranges are investigated as part of weight-of-evidence assessments, but nesting success is not assigned trigger or threshold criteria for artificial light-related compliance.

4.2.2 Hatchling Survivorship

Hatchling survivorship is assessed to support compliance with **MS 1264 Condition B51(2)** and relevant **EPBC Act approval conditions.** The objective of monitoring hatchling survivorship is to confirm that **incubation and emergence outcomes remain within the range of natural variability** for monitored nesting beaches and to provide context for interpretation of hatchling orientation and nesting outcomes.

Hatchling survivorship reflects the success of incubation and emergence and provides information on nesting habitat condition and the incubation environment. Survivorship outcomes are primarily influenced by natural environmental factors such as sand temperature, moisture, inundation, predation, beach morphology and weather conditions, and are **not expected to be directly affected by artificial light emissions**. Accordingly, hatchling survivorship is **not used as a primary compliance indicator for artificial light impacts**, but as a **contextual indicator** to support **interpretation** of marine turtle **behavioural outcomes**.

No trigger or threshold values are defined specifically for hatchling survivorship, as survivorship is not considered a pathway through which artificial light would reasonably cause impact. Where unusually low survivorship outcomes are observed, investigation findings and contextual interpretation will be documented and reported in annual compliance reporting.

Hatchling survivorship will be assessed using the following approach:

- **Calculate seasonal survivorship metrics**

  Hatch success and emergence success will be calculated for each nesting beach where sufficient data are available, using standard nest excavation and emergence monitoring methods.

- **Compare seasonal results to site-specific baseline conditions**

  Seasonal hatchling survivorship metrics will be compared against baseline data derived from all available pre-construction and early operational monitoring seasons at each nesting beach, to determine whether outcomes fall within the typical range of natural variability observed at the site.

- **Interpret deviations in context**

  Where survivorship results fall outside the typical site-specific baseline range, results will be investigated and interpreted in the context of environmental conditions (e.g. sand temperature profiles, inundation or erosion, predation, nest placement and weather patterns) and considered alongside nesting success, nesting beach utilisation and hatchling orientation outcomes. Changes in hatchling survivorship alone do not indicate an impact from Project-related artificial light.

Hatchling survivorship outcomes are used to inform understanding of site condition, incubation environment and background ecological variability that may influence observed behavioural responses at monitored nesting beaches. Patterns identified through survivorship monitoring assist in distinguishing Project-related behavioural change from natural or environmentally driven variation. Management actions associated with hatchling survivorship therefore focus on investigation, context-setting and continual improvement of monitoring confidence, rather than direct response to exceedance of behavioural outcomes. These actions are summarised in Table 5-2.

5. Adaptive Management and Contingency Response

Adaptive management under this MTMP provides a structured and responsive process to ensure that monitoring results are continually assessed, that any detectable change in marine turtle behaviour is addressed promptly, and that management measures remain effective and fit-for-purpose throughout implementation. This framework supports achievement of the required outcomes under **MS 1264 Conditions B53, C41, C42 and relevant EPBC approval conditions 37, 38, 45, 53(c), 105 and 115**, and provides a clear pathway for responding to changes in hatchling orientation, nesting beach utilisation, nesting success and or artificial light exposure.

In determining appropriate management and contingency responses, monitoring results are considered in the context of both environmental outcomes and monitoring objectives, consistent with the framework described in Section 1.2.

Outcome-based indicators are used to determine whether investigation, escalation or regulatory reporting is required in response to a potential risk to, or failure of, an environmental outcome. Objective-based indicators, including nesting success and hatchling survivorship, do not independently trigger management responses, but are used to inform the interpretation, confidence and proportionality of responses initiated by outcome-based indicators. When monitoring identifies a departure from expected behavioural patterns, the results are evaluated in the context of beach conditions, environmental factors, and operational circumstances. Where the change cannot be attributed to natural variability, further assessment is undertaken to determine the likelihood of a lighting-related pathway and whether additional measures are required.

Where adaptive management is initiated, lighting controls and operational measures specified in the **Mardie Illumination Plan** are reviewed and refined as necessary. This may include temporary or permanent modifications to fixture direction, shielding, spectral characteristics, intensity, operating times or other practicable adjustments that reduce artificial light exposure at the affected beaches while maintaining safety. Any refinements to management measures are implemented as soon as practicable and subsequently reassessed during the next monitoring period to confirm their effectiveness.

Adaptive management outcomes, including investigations, actions taken, and monitoring results, are documented and reported in accordance with **MS 1264 Conditions D1–D2** and relevant EPBC conditions. This ensures transparent and traceable management decisions and supports continual improvement of the MTMP.

5.1 Mitigation Hierarchy

The MTMP adopts the following mitigation hierarchy:

- **Avoidance**: Integrate lighting design and operational controls during planning to prevent artificial light spill toward nesting beaches.

- **Minimisation**: Apply shielding, fixture orientation, spectrum adjustments, intensity reductions, and adaptive controls where possible, during peak nesting and hatching periods.
- **Remediation**: Implement corrective actions promptly where triggers or thresholds are attributed to project lighting.

5.2 Management Actions

Management actions under this MTMP are triggered by monitoring results that meet predefined criteria (Section 4). These actions ensure timely and proportionate responses to potential project-related impacts on marine turtles. Contingency measures are structured to address both early warning triggers and threshold exceedances requiring immediate intervention.

Table 5-1 provides a summary of contingency responses for each outcome-based parameter, including habitat use, hatchling orientation, and marine fauna incidents. For each indicator, the table specifies trigger and threshold criteria, required management actions, reporting obligations, and applicable approval conditions. Actions include investigation of causative factors, implementation of lighting audits, modification of fixtures, reduction of light intensity and colour temperature, installation of adaptive controls, and revision of the **Mardie Illumination Plan** where necessary. All responses will be documented and reported in accordance with **MS 1264 Conditions D1** and **D2** and **EPBC Condition 115.**

Table 5-2presents management targets, monitoring measures and reporting requirements for objective-based parameters, including nesting success and hatchling survivorship. These measures do not include trigger or threshold criteria and are used to support interpretation of outcome-based monitoring results and inform the appropriateness and proportionality of management responses.

5.2.1 Outcome-based Management Actions

Table 5-1 Environmental Outcome and Contingency response actions

Environmental Outcome	Indicator	Trigger/Threshold Criteria	Contingency Response	Reporting	Applicable approvals
Nesting beach utilisation is not adversely changed by project lighting	Nesting beach utilisation by adult nesters	**A trigger criteria** are reached where one or more of the following patterns are observed at a monitored nesting beach and persist across **two consecutive nesting seasons**: Contraction of the core nesting utilisation area relative to the site-specific reference range; Loss of persistent nesting "hotspots" in historically preferred beach sections; or Directional redistribution of nesting activity away from beach areas exposed to Project-related artificial light.	• Undertake review of the marine turtle monitoring data, artificial light data, and other data as relevant, to determine if this change could be due to natural variability in nesting behaviour or artificial light impacts • Consider whether change could be due to natural influences (e.g. cyclones, heavy rain events inundating beaches, El Nino/ La Nina impacts, or global warming and sea level rise) • Assess Project lighting (including from vessels, where applicable) together with the light audit results to identify any problem lighting • Identify individual lights that are directly visible or poorly shielded. Potential mitigations, where these do not compromise health and safety standards, may include: • Modification of light fixtures to include additional shielding and/ or re-orientate light fixtures, if required • Reduction in the colour temperature or intensity of light sources, if required • Elimination of lights that are surplus to operational needs and will not impact on health and safety requirements. • Implementation of seasonal lighting restrictions during peak nesting and hatching season	• Performance against criteria to be reported annually in MS1264 and EPBC approvals compliance report • Notify DWER (CEO) within 7 days of exceedances to threshold criteria, or suspected non-compliance and submit a report within 21 days of being aware of the threshold exceedance/potential noncompliance in accordance with condition D1-1(1-6) and D1-2 (MS1264) • Notify DCCEEW within 5 business days of exceedances to threshold criteria and submit an investigation report within 15 business days of the exceedance being identified in accordance with condition 115 (EPBC 2022/9169) • If marine turtle monitoring data identifies potential impacts due to artificial lighting from the Project, additional avoidance and mitigation measures will be implemented, where practicable, to reduce impacts and the Mardie Illumination Plan will be revised prior to the	MS1264 Condition B5-1(2-3), C4, D1-1(1-7), D1-2, D2-1. EPBC2018/8236 and EPBC2022/9169, Condition 37(a) and 115

Environmental Outcome	Indicator	Trigger/Threshold Criteria	Contingency Response	Reporting	Applicable approvals
			• Installation of timers, dimmers, or motion sensors If the trigger is not attributed to natural variability or project-related artificial light impacts, further investigation may be required to determine the cause. In consultation with a suitably qualitied subject matter expert, this may include assessment of the effects of physical infrastructure on the quality/availability of nesting habitat potential, investigation of noise levels from offshore/onshore construction and/or vibration levels at nesting beaches.	beginning of the next nesting season. • The trigger and threshold criteria may be reviewed at the end of each season to ensure that they remain suitable.	
		A Threshold criteria are reached when**:** Nesting activity shows continued or progressive exclusion from historically utilised beach sections, or A substantial reduction in core nesting utilisation (typically on the order of ~30% or greater) is observed within a single season, **and** the pattern cannot be adequately explained by natural drivers and is attributable to Project-related artificial light.	• Undertake review of the marine turtle monitoring data, and other data as relevant, to determine if this change could be due to natural variability in nesting behaviour or artificial light impacts • If determined likely to be the result of Project lighting impacts, undertake lighting audit within one month and implement measures to reduce light spill/ glow levels at impacted site(s) • An additional lighting survey should be undertaken after implementation of any proposed actions to determine whether the actions have been successful. This additional survey would be conducted prior to the next turtle nesting season. • Review the implementation of lighting management actions within the Mardie Illumination Plan.		

Environmental Outcome	Indicator	Trigger/Threshold Criteria	Contingency Response	Reporting	Applicable approvals
		Threshold exceedance represents failure to achieve the environmental outcome specified in **MS 1264 Condition B51(2)** and constitutes **non-compliance.**	If threshold exceedance is not attributed to natural variability or project related artificial light impacts, further investigation, in consultation with a suitably qualitied subject matter expert, is required. This may include assessment of the effects of physical infrastructure on the quality/availability of nesting habitat potential, investigation of noise levels from offshore/onshore construction and/or vibration levels at nesting beaches.		
No adverse change in hatchling orientation (misorientation / disorientation) attributable to project lighting	Hatchling Orientation	**Trigger**: A **trigger criteria** is reached where **20 percent or more** of hatchling bearings within the combined seasonal dataset are oriented toward an identified Project related artificial light azimuth **and exceed a 30° deviation from the most direct route to the ocean.**	• Undertake review of the hatchling orientation data, and other data as relevant, to determine if this change could be due to natural variability or artificial light impacts. • Other data could include changes in beach profile or slope, or the existence of new or additional light sources within the region that are non-Project related. • If determined likely to be the result of Project lighting impacts, undertake lighting audit within one month and implement measures to reduce light spill/ glow levels at impacted site(s) • Undertake review of Project lighting to determine if artificial lighting is the likely cause of the variation • Identify individual lights that are directly visible or poorly shielded • Modify light fixtures to include additional shielding and/ or re-orientate light fixtures, if required • Reduce the colour temperature or intensity of light sources, if required • Eliminate lights that are surplus to operational needs that will not	• Performance against criteria to be reported annually in MS1264 and EPBC approvals compliance report • Notify DWER (CEO) within 7 days of exceedances to threshold criteria, or suspected non-compliance and submit a report within 21 days of being aware of the threshold exceedance/potential noncompliance in accordance with condition D1-1(1-6) and D1-2 (MS1264) • Notify DCCEEW within 5 business days of exceedances to threshold criteria and submit an investigation report within 15 business days of the exceedance being identified in accordance with condition 115 (EPBC 2022/9169) • If marine turtle monitoring data identifies potential impacts due to artificial lighting from the Project,	MS1264 Condition B5-1(2-3), C4, D1-1(1-7), D1-2 and D2-1. EPBC2018/8236 and EPBC2022/9169, Condition 37(a) and 115

Environmental Outcome	Indicator	Trigger/Threshold Criteria	Contingency Response	Reporting	Applicable approvals
			impact on health and safety requirements.	additional avoidance and mitigation measures will be implemented to reduce impacts and the Mardie Illumination Plan will be revised prior to the beginning of the next nesting season. • The trigger and threshold criteria may be reviewed at the end of each season to ensure that they remain suitable.	
		Threshold: A **threshold criteria exceedance** occurs where **30 percent** or more of hatchling bearings within the combined seasonal dataset are oriented toward a Project related artificial light azimuth and exceed a **30° deviation from the most direct route to the ocean.**	• Undertake review of the hatchling orientation data, and other data as relevant, to determine if this change could be due to natural variability or artificial light impacts • Other data could include changes in beach profile or slope, or the existence of new or additional light sources within the region that are non-Project related. • If determined likely to be the result of Project lighting impacts, undertake lighting audit within one month and implement measures to reduce light spill/ glow levels at impacted site(s) • Undertake review of artificial light monitoring and hatchling orientation data to determine cause • The review will also rate the level of impact associated with this exceedance and recommend remedial actions to reduce light spill on the impacted site(s) • Remedial actions will be implemented and monitored for success • Additional engineering and/ or operational solutions will be implemented where practicable to control or modify the 'problem light(s)' (see Section 8.2.1 of the Mardie Illumination Plan) • Review the implementation of lighting management actions within this MTMP and the Mardie Illumination Plan		

Environmental Outcome	Indicator	Trigger/Threshold Criteria	Contingency Response	Reporting	Applicable approvals
No injury or mortality to marine turtles as a result of project activities	Marine fauna injury/mortality	Confirmed injury or death due to dredging, disposal or vessel strike	• Contact DBCA for response/action and implement recommendation • Managed through the DSDMP • Suspend relevant operations • Review and revise operational procedures	• Notify DBCA within 2 hours • Notify DCCEEW within 2 business days • Notify DWER within 7 business days • Record all marine fauna injury/mortality in Marine Fauna Sightings Register. • All marine fauna sightings will also be reported in the next compliance reporting period for the Project and published on the website when each compliance report is submitted to the Department.	MS1264 Condition B5-2 EPBC2018/823 and EPBC2022/9169 Condition 25, 26, and 27(c).

5.2.2 Objectives Based Management Actions

Table 5-2 Environmental Objectives, Management and Monitoring actions

Management Target	Management Actions	Monitoring Indicators, Methods and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
Marine turtles are able to successfully complete nesting events at monitored beaches (Long, Sholl, the Passage Islands and mainland beaches) and are not being prevented or	Ongoing monitoring of nesting habitat condition and nesting activity to provide context for interpretation of behavioural outcome.	**Indicator:** Nesting success (proportion of successful nests relative to total nesting attempts). **Method:** Track census surveys to record nesting attempts and successful nests, undertaken in accordance with methods described in Section 3.1.1. Results are assessed at the nesting-beach and seasonal scale.	As per the MTMP survey schedule Section 2.3.	Annual reporting of results, interpretation and trends in the Compliance Assessment Report (ACAR) required under MS 1264, and in the EPBC Act Annual Environmental Report (AER), where applicable.	MS 1264 (Conditions B51, B53, C41, C42) EPBC2018/8236 and EPBC2022/9169 (Conditions 37, 38, 45).

Management Target	Management Actions	Monitoring Indicators, Methods and Locations	Monitoring Timing and Frequency	Reporting	Applicable Approvals
deterred from nesting as a result of Project activities		**Locations:** Monitored nesting beaches including Mardie Creek East (MCE), Mardie Creek West (MCW), the Passage Islands (Angle, Middle and Round) Sholl Island and Long Island.			
Incubation and emergence outcomes remain within the range of natural variability for monitored nesting beaches (MCE, MCW, Sholl and Long Island).	Ongoing monitoring of hatchling survivorship to characterise incubation and emergence outcomes and provide ecological context.	**Indicator:** Hatchling survivorship, including hatch success and emergence success. **Method:** Nest marking and excavation, temperature monitoring and emergence assessments conducted in accordance with methods described in Section 3.1.2. Results are summarised at the nesting-beach and seasonal scale and compared with baseline and cumulative datasets. **Locations:** Mardie Creek East (MCE), Mardie Creek West (MCW), Sholl Island and Long Island	As per the MTMP survey schedule Section 2.3.	Annual reporting of survivorship outcomes, interpretation and contextual assessment in the ACAR under MS 1264 and the EPBC Act AER, where required.	MS 1264 (Conditions B51, B53, C41, C42); EPBC2018/8236 and EPBC2022/9169 (Conditions 37, 38, 45)

5.3 Reporting

All reporting will be undertaken in accordance with statutory requirements and regulator guidance:

Immediate Incident Reporting

- Notify **DBCA Pilbara Regional Office** within **2 hours** of any marine fauna injury or mortality:
  • **Phone:** 08 9182 2000
  • **Email:** fauna.data@dbca.wa.gov.au; karratha.admin@dbca.wa.gov.au
- BCI to record incidents associated with nesting marine turtles and hatchlings including date, time, coordinates, activity and injury.
- Implement any actions requested by DBCA.

Threshold Exceedance Reporting

- Notify **DWER (CEO)** within **7 days** and submit a detailed investigation report within **21 days** in accordance with **MS 1264 D1-1** and **D1-2.**
- Notify **DCCEEW** within **5 business days** and provide investigation findings within **15 business days** in accordance with **EPBC Condition 115**.

Annual Compliance Reporting

- Submit MTMP results in the Compliance Assessment Report (**MS 1264 Condition D2, EPBC 2022/9169 and EPBC2018/8236 varied).**
- Provide monitoring data (including raw datasets) to DCCEEW within **20 business days** of each anniversary (**EPBC Condition 105**).

Plan Revision and Publication

1) Apply minor or material revision pathways under **MS 1264 Condition C2.**
2) Publish confirmed plans within **20 business days** of implementation (**Condition C2-6**).

5.4 Continuous Improvement

Annual Review

The MTMP will be reviewed annually for effectiveness to confirm that monitoring schedules, work scopes, monitoring sites and trigger/threshold criteria remain appropriate. This review will consider cumulative monitoring results, operational constraints, and any implemented contingency actions. Findings will be documented in annual compliance reporting.

Where the annual effectiveness assessment identifies that the MTMP, or any component of the monitoring program, is not achieving its intended objectives or is no longer fit for purpose, a Comprehensive Assessment will be undertaken. This process will evaluate the adequacy of monitoring objectives, methodologies, spatial and temporal coverage, trigger and threshold criteria, and management responses, taking into account updated environmental information, operational experience, and regulatory requirements.

Comprehensive Review

A full review of the MTMP and Mardie Illumination Plan will be undertaken at least every five years, consistent with **EPBC Condition 54**, or sooner if monitoring results indicate the need for additional controls, or if project changes require plan revision under **MS 1264 Condition C2**.

In the event a **comprehensive review** of the MTMP determines that revisions are required, the MTMP will be updated noting the following compliance requirements that must be adhered to:

- EPBC Act approvals **EPBC 2018/8236** and **EPBC 2022/9169**, including the Revised Action Management Plan (RAMP) provisions (**Conditions 84–90**).
- And **MS 1264 Condition C2**

As such, any required updates of the MTMP plan will be communicated appropriately with both DWER and DCCEEW, prior to the implementation of the revised MTMP.

5.5 Risk Assessment

The risk that the MTMP will not sufficiently detect changes or adverse changes in marine turtle behaviour attributable to Project-related artificial light has been assessed as ***low***. This assessment recognises the inherent challenges associated with monitoring naturally variable biological systems in dynamic coastal environments, particularly where historical baseline datasets differ in spatial coverage, survey intensity and temporal extent between locations. In response to these challenges, the MTMP has been designed to prioritise biologically meaningful, outcome-based indicators, supported by multiple temporal and spatial safeguards, to provide a defensible and sensitive framework for detecting Project-related behavioural change.

Baseline data for marine turtle nesting collected for this Project span several years and survey programs but vary between offshore islands and mainland beaches due to logistical constraints, environmental conditions and evolving monitoring objectives. These limitations reduce the reliability of rigid statistical thresholds derived solely from short baseline periods and increase the risk of either failing to detect meaningful change or misinterpreting natural variability as impact. The MTMP addresses this risk by applying seasonal, site-specific assessments that compare current monitoring results with expanding cumulative datasets, allowing confidence in interpretation to increase over time while maintaining clear compliance decision points within each monitoring season.

Monitoring effort is structured to ensure that formal compliance triggers and thresholds are applied only at locations monitored at sufficient frequency to reliably detect behavioural change, with

higher-intensity monitoring focused on nesting beaches with both greater nesting value and higher potential exposure to Project-related light. This approach reduces the risk of non-detection by ensuring that outcome-based compliance assessments are grounded in robust seasonal datasets, while opportunistic monitoring at additional locations provides contextual information that strengthens interpretation without over-reliance on sparse data.

The use of outcome-based indicators, specifically hatchling orientation and nesting beach utilisation, further reduces the risk of non-detection by focusing on behaviours with a direct and well-established causal pathway to artificial light exposure. These indicators are assessed at the nesting-beach scale and interpreted across entire monitoring seasons, avoiding reliance on isolated observations and increasing sensitivity to persistent or directional behavioural change. Concurrent artificial light monitoring at nesting beaches supports attribution and ensures that observed behavioural patterns can be evaluated in relation to Project-related light exposure rather than natural or external influences.

Clear trigger and threshold criteria provide an additional safeguard by separating early-warning signals from limits of acceptable change. Trigger exceedances prompt investigation and review, reducing the likelihood that emerging impacts remain undetected, while threshold exceedances establish unambiguous non-compliance where adverse change is demonstrated and attributable to Project lighting. This structure ensures that uncertainty associated with baseline variability does not delay investigation or management response.

The MTMP is supported by an adaptive management framework that allows monitoring results, site coverage and analytical approaches to be reviewed and refined as cumulative data increase and understanding of site-specific responses improves. Residual risk will be reassessed annually through review of monitoring outcomes and following any trigger or threshold exceedance, ensuring that the program remains fit-for-purpose and continues to provide a high level of confidence in detecting Project-related changes in marine turtle behaviour.

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Appendix A. Regulatory Approval Conditions

Table 6-1 Approval Conditions that relate to marine turtle management as outlined in the Environmental Protection Authority Ministerial Statement 1264 and the Environment Protection and Biodiversity Conservation Act 1999 EPBC 2018/8236 and 2022/9169

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
MS1264			
B5-1	The Proponent shall implement the proposal to achieve the following environmental outcomes: 2) no **adverse** change in marine turtle orientation (i.e. misorientation or disorientation) nesting beach utilisation, nesting success or hatchling survivorship as a result of artificial light emissions at both sandy beach habitat adjacent to the development and Long Island, Sholl Island and the Passage Islands (Angle, Middle and Round); and 3) **significant marine fauna** are not prevented/deterred from undertaking critical behaviours in **biologically important areas.**	This Plan - Sections 3, 4 and 5 Mardie Illumination Plan – Section 6, 7 and 8	The Proponent has committed to undertaking annual monitoring of nester abundance and distribution, hatchling orientation and artificial light emissions on both mainland and offshore islands to detect any adverse impacts to marine turtle behaviour. Adaptive management measures are outlined in Outcome-based Management Actions Table 5-1 and the Mardie Salt and Potash Illumination Plan Rev7 [0000-EV-PLN-0014] to mitigate such impacts.
B5-2	The Proponent shall implement the proposal to achieve the following environmental objectives: 1) minimise the risk of physical injury or mortality from vessel strike on **significant marine fauna as low as reasonably practicable**; and 2) minimise the risk of behavioural changes, health impacts, physical injury or mortality from underwater noise emissions from construction or operations to **significant marine fauna** (including temporary or permanent hearing loss) **as low as reasonably practicable.**	Refer to DSDMP - Section 6	The Proponent has prepared a Dredge and Spoil Disposal Management Plan (DSDMP) Rev5 [0000-EV-PLN-0021] that outlines vessel speed limits and underwater noise mitigation protocols to reduce the risk of injury or behavioural disturbance to significant marine fauna.
B5-3	The Proponent must in consultation with DWER: 1) implement a **Mardie Illumination Plan** environmental management plan	This Plan –Sections 3, 4 and 5 Mardie Illumination Plan - Section 6, 7 and 8	The Proponent has committed to implementing this Marine Turtle Monitoring Program (MTMP) and the Mardie Illumination Plan to monitor nesting success, hatchling orientation, and light levels. Results will be

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	that satisfy the requirements of condition C4 and demonstrates how achievement of the **significant marine fauna** outcomes in B5-1(2-3) will be monitored and substantiated, and submit it to the **CEO**; and 2) implement **the Marine Turtle Monitoring Program** environmental management plan that satisfies requirements of condition C4 and demonstrates how achievement of the significant marine fauna outcomes in B5-1(2-3) will be monitored and substantiated and submit it to the **CEO**.		compared annually against baseline data to substantiate compliance with condition B5-1.
B5-9	Clearing in the fauna habitat type identified as low-quality turtle nesting habitat (sandy beach habitat) in the Mardie Project – Environmental Review Document (June 2020) is limited to a width of fifty (50) metres, parallel to the high water mark.	Construction Environmental Management Plan (CEMP) [0000-EV-PLN-00001] Section 9.1 and 9.2	Clearing of low quality habitat will not occur outside a width of 50 m parallel to the high water mark.
C1-1	The Proponent must not undertake: 1) dredging activities, marine construction or operations associated with the Mardie Project until the **CEO** has confirmed in writing that the environmental management plan required by condition **B5-3** meet the requirements of that condition and condition C4.	This plan - Sections 4 DSDMP Section 7.3, 8.3 and 9.	The Proponent has committed to submitting the required environmental management plans and will not commence dredging or marine construction until written confirmation is received from the CEO.
C4-1	The environmental management plans required under condition B1-4, condition B2-2, condition B3-2, condition B4-3, condition B5-3, condition B5-4, condition B6-4, condition B6-6 and condition B8-3 must contain provisions which enable the substantiation of whether the relevant outcomes of those conditions are met, and must include:	This Plan – Sections 3, 4 and 5 Mardie Illumination Plan Section 6, 7 and 8. DSDMP Section 7.3, 8.3 and 9.	The Proponent has included threshold and trigger criteria, monitoring parameters and methodology, baseline data, adaptive management strategies, and contingency measures in the MTMP to ensure outcomes are substantiated.

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	1) **threshold criteria** that provide a limit beyond which the environmental outcomes are not achieved 2) **trigger criteria** that will provide an early warning that the environmental outcomes are not likely to be met 3) monitoring parameters, sites, control/reference sites, methodology, timing and frequencies which will be used to measure **threshold criteria** and **trigger criteria**. Include methodology for determining alternative monitoring sites as a contingency if proposed sites are not suitable in the future 4) baseline data 5) data collection and analysis methodologies 6) adaptive management methodology 7) **contingency measures** which will be implemented if **threshold criteria** or **trigger criteria** are met, and 8) reporting requirements.		
C4-2	The environmental management plan required under condition B5-3 is also required to: 1) be updated to include **management actions, management targets** and **contingency measures** that will establish whether the proposal is having a detectable difference on marine turtle orientation (i.e. misorientation or disorientation), and nesting beach utilisation as described in condition B5-1(2). 2) include a commitment to annually compare cumulative results against the baseline assessment (Pendoley Environmental 2019, Mardie Salt Project Marine Turtle Monitoring Program 2018/2019. Rev 0, Report No. RP-59001)	This Plan – Section 3, 4 and 5	The Proponent has committed to annually comparing cumulative results against the baseline assessment and has incorporated monitoring aligned with the National Light Pollution Guidelines. Criteria for revision of the Mardie Illumination Plan are included.

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	3) Include a monitoring plan that is in accordance with the recommendations published in the National Light Pollution Guidelines (2020) 4) provide criteria for when the Mardie Illumination Plan required by condition B6-5 will be revised in response to outcomes of the monitoring required by condition B5-3; and 5) Continue to be implemented until the CEO has confirmed by notice in writing, on advice from DBCA and DWER, that the outcome of condition B5-1(1-3) has been, and will continue to be met.		
C4-5	Without limiting condition C3-1, failure to achieve an environmental outcome, or the exceedance of a **threshold criteria**, regardless of whether threshold contingency measures have been or are being implemented, represents a non-compliance with these conditions.		
D1-1	if the Proponent becomes aware of a potential non-compliance, the Proponent must: 1) report this to the CEO within seven (7) days 2) implement contingency measures; 3) investigate the cause 4) investigate environmental impacts 5) advise rectification measures to be implemented 6) advise any other measures to be implemented to ensure no further impact 7) provide a report to the CEO within twenty-one (21) days of being aware of the potential non-compliance, detailing the measures required in conditions D1-1(1) to D1-1(6) above.	This Plan – Sections 3, 4 and 5	The Proponent has committed to reporting any potential non-compliance to the CEO within seven days and to implementing contingency measures, investigating causes and impacts, and submitting a detailed report within twenty-one days.

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
D1-2	Failure to comply with the requirements of a condition, or with the content of an environmental management required under a condition, constitutes a noncompliance with these conditions, regardless of whether the contingency, rectification or other measures in condition D1-1 above have been or are being implemented.		
EPBC2018 and EPBC2022			
25	The approval holder must ensure that any vessel strike or incident involving marine turtles, Green Sawfish, Short-nosed Sea snake, Giant manta ray, Humpback Whale, Australian Humpback Dolphin, or Dugong is reported to DBCA within 2 hours of the occurrence of the vessel strike and/or incident and that any consequent request made by DBCA is implemented.	DSDMP Section 6	The Proponent has committed to reporting any vessel strike incidents involving marine fauna to DBCA within two hours and to implementing any consequent requests from DBCA as outlined in the DSDMP.
26	To avoid harm to marine fauna individuals as a result of vessel use, the approval holder must comply with condition B5-2 and B5-5 of the WA Approval, to the extent that the WA Approval conditions relate to protected matters.	DSDMP Section 6	The DSDMP aligns with WA conditions to minimise vessel-related impacts.
27(c)	ensure that all vessels operated or contracted by the approval holder do not exceed 8 knots within 500 metres of any identified cetacean, dugong, or marine turtle.	DSDMP Section 6	The DSDMP outlines vessel speed restrictions of no more than 8 knots within 500 metres of identified marine fauna.
37(a)	To avoid and mitigate harm to marine turtles, the approval holder must: a) comply with conditions B5-1, B5-3, and B5-9 of the WA Approval, to the extent that the WA Approval conditions relate to protected matters.	This Plan	The Proponent has committed to implementing the MTMP and Mardie Illumination Plan in accordance with WA Approval conditions to avoid and mitigate harm to marine turtles.
38	Prior to commencing any marine construction within the marine turtle nesting beach, submit the findings of the Marine Turtle Monitoring Surveys specified in conditions, B5-3, and of the WA Approval electronically to the department.	This Plan – Section Sections 3, 4 and 5	The Proponent has committed to submitting the findings of the MTMP surveys electronically to the Department prior to commencing any marine construction within nesting beach areas.
45	To achieve the environmental outcomes specified in conditions	This Plan	The Proponent has committed to implementing the MTMP from the commencement of the action and

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	B5-1(2-3) of the WA Approval, the approval holder must: a) implement the Marine Turtle Monitoring Program. The approval holder must commence implementing the Marine Turtle Monitoring Program no later than the commencement of the Action and continue to implement at least until the expiry date of this approval. comply with condition B5-1, B5-3 and C4-2 of the WA Approval.		continuing until the expiry of the approval, in compliance with WA conditions B5-1, B5-3, and C4-2.
53(c)	Prior to operation of the Sulphate of Potash Plant, secondary seawater intake, or any additional lighted structures not included in the modelling provided in Appendix 1 of the Mardie Illumination Plan, the approval holder must submit to the department for the Minister's approval, a revised Mardie Illumination Plan. The plan must be approved in writing by the Minister prior to the operation of any structures which will use artificial light at night which were not included in the Mardie Illumination Plan. The plan must: b) include methods of monitoring the light impacts from the action on marine turtles, migratory shorebirds and terrestrial fauna.	Mardie Illumination Plan	Monitoring plans include methods for light impacts on marine turtles and other fauna.
54	The Mardie Illumination Plan must be reviewed every 5 years starting after the commencement of the action. The review must consider the monitoring data collected through the Marine Turtle Monitoring Program, the Long-term Migratory Shorebird Monitoring and Management Plan to adapt the operational lighting to further minimise impacts.	Mardie Illumination Plan	The Proponent has committed to reviewing the Mardie Illumination Plan every five years, incorporating monitoring data from the MTMP and shorebird management plans to adapt lighting and minimise impacts.
84	The approval holder may, at any time, apply to the Minister for a variation to an action management plan approved by the Minister or as subsequently revised in accordance with the	This Plan – Section 5.3	The Proponent has committed to revising this Marine Turtle Monitoring Program in accordance with EPBC2022/9169 Conditions 84 and 85.

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	following conditions, by submitting an application in accordance with the requirements of section 143A of the EPBC Act. If the Minister approves a revised action management plan (RAMP) then, from the date specified, the approval holder must implement the RAMP in place of any previous version of the action management plan.		
85	The approval holder may choose to revise an action management plan approved by the Minister as subsequently revised in accordance with these conditions, without submitting it for approval under section 143A of the EPBC Act, if the taking of the Action in accordance with the RAMP would not be likely to have a new or increased impact.		
95	The approval holder must notify the department in writing of any proposed change to the WA Approval that may relate to protected matters **within 2 business days** of formally proposing such a change and within **5 business days** of becoming aware of any formally proposed change imposed by the WA EPA.	This Plan – Section 1.2	The Proponent has committed to notifying DCCEEW of any proposed changes to the WA Approval (Optimised Mardie Project) within 2 business days of changes to the proposal that may impact protected matters proposed by BCI, and within 5 business days of changes imposed by WA EPA.
96	The approval holder must notify the department in writing of any change to WA Approval conditions that may relate to protected matters, **within 5 business days** of such a change to conditions coming into effect. Such notification must include a copy of the changed WA Approval conditions showing what changes have been made.	This Plan – Section 5.3	The Proponent has committed to notifying DCCEEW within 5 business days (from effect)) of changes to MS 1211 that may relate to protected matters.
105	The approval holder must submit all monitoring data (including sensitive ecological data), surveys, maps, other spatial and metadata and all species occurrence record data (sightings and evidence of presence) electronically to the department within **20 business days** of each anniversary of the date of this approval decision except where otherwise specified in a plan.	This Plan – Section 5.3	The Proponent has committed to submit annual monitoring data outlined in this Plan to DCCEEW.
115	In the event that any threshold specified in any Plan is exceeded, the approval holder must:	This Plan – Section 5.3	The Proponent has committed to report exceedance of thresholds to the appropriate governing body.

Condition No.	Condition	Plan reference	Demonstration of how the plan addresses condition requirements and key commitments
	a) Report the exceedance to the department in writing within **5 business days** of the exceedance being identified. b) Investigate the exceedance to determine its cause and submit a report of the findings of this investigation to the department in writing within **15 business days** of the exceedance being identified. This investigation must aim to determine the cause of the threshold being exceeded the extent of any harm to protected matters as a result of the exceedance. This report must include: i) the findings of the exceedance investigation ii) details of corrective measures implemented iii) an evaluation of the effectiveness of the corrective measures implemented, iv) propose measures to be implemented by the approval holder to prevent the threshold being exceeded in the future. v) Comply with condition D1-1 of the WA Approval where the plan that exceedance occurred under is also approved in accordance with the WA Approval.		

Appendix B. Nesting Data and Survey Extents for Monitoring Location

Figure B 1: Marine turtle nests recorded on Sholl Island during pre-construction surveys (left) and routine monitoring survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

Figure B 2: Marine turtle nests recorded on Round Island during pre-construction surveys (left) and opportunistic survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

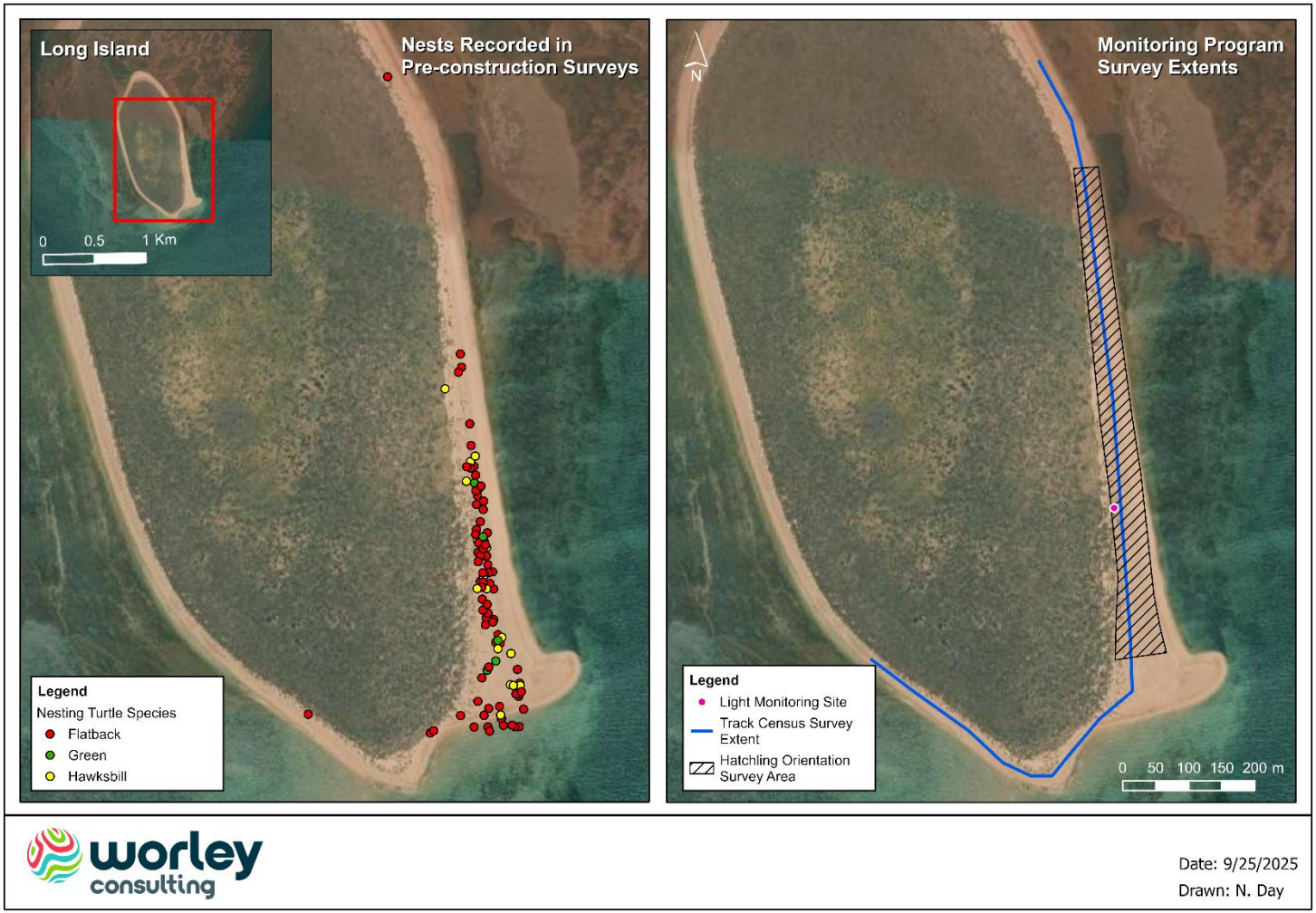

Figure B 3: Marine turtle nests recorded on Long Island during pre-construction surveys (left) and routine monitoring survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

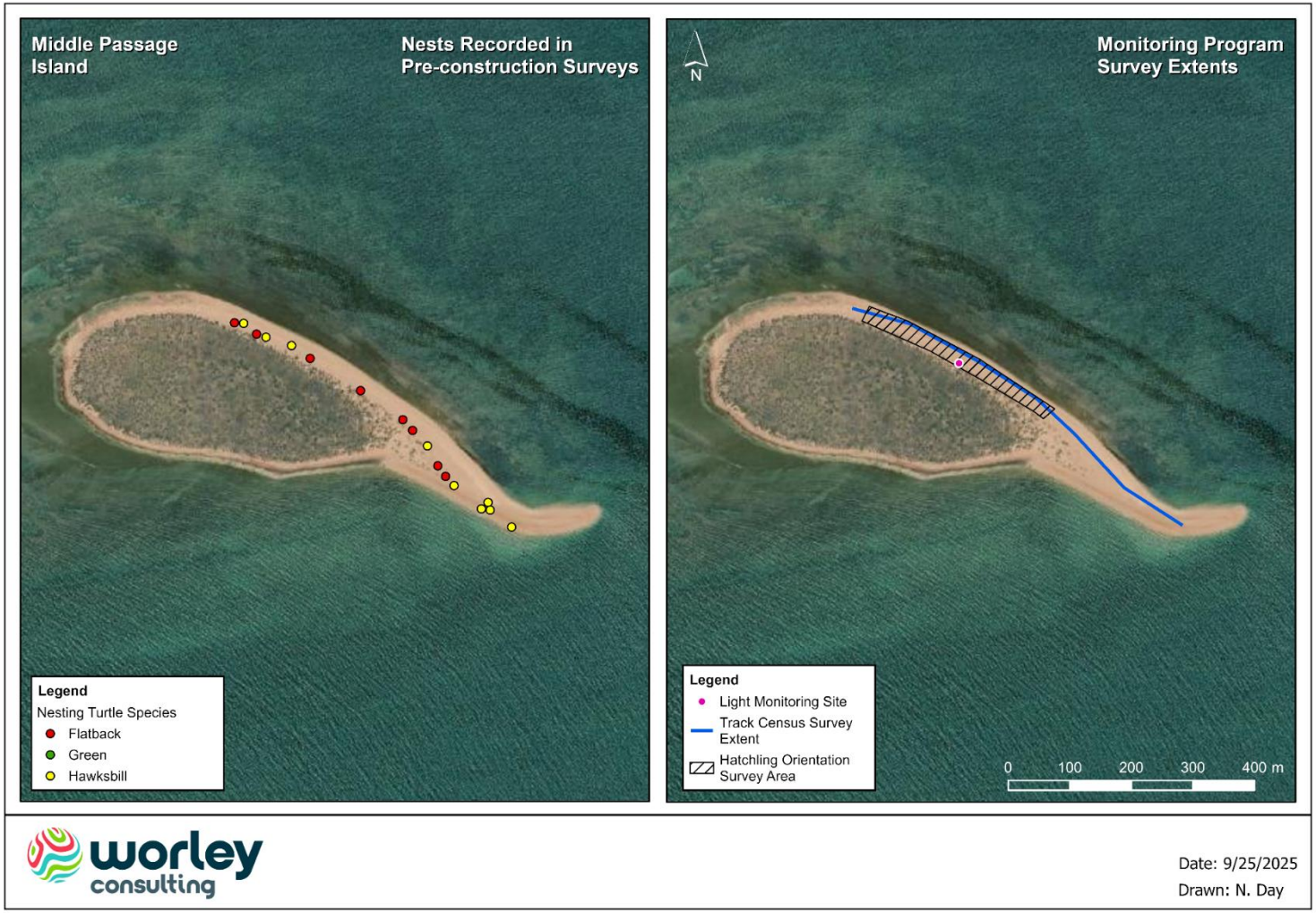

Figure B 4: Marine turtle nests recorded on Middle Passage Island during pre-construction surveys (left) and opportunistic survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

Figure B 5: Marine turtle nests recorded on Angle Island during pre-construction surveys (left) and opportunistic survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

Figure B 6: Marine turtle nests recorded on Passage Island during pre-construction surveys (left) and opportunistic survey extents defined for work scopes under the Marine Turtle Monitoring Program (right). (Source: Pendoley Environmental, 2022).

Figure B 7: Marine turtle nests recorded on mainland beaches during pre-construction surveys. (Source: Pendoley Environmental, 2023).

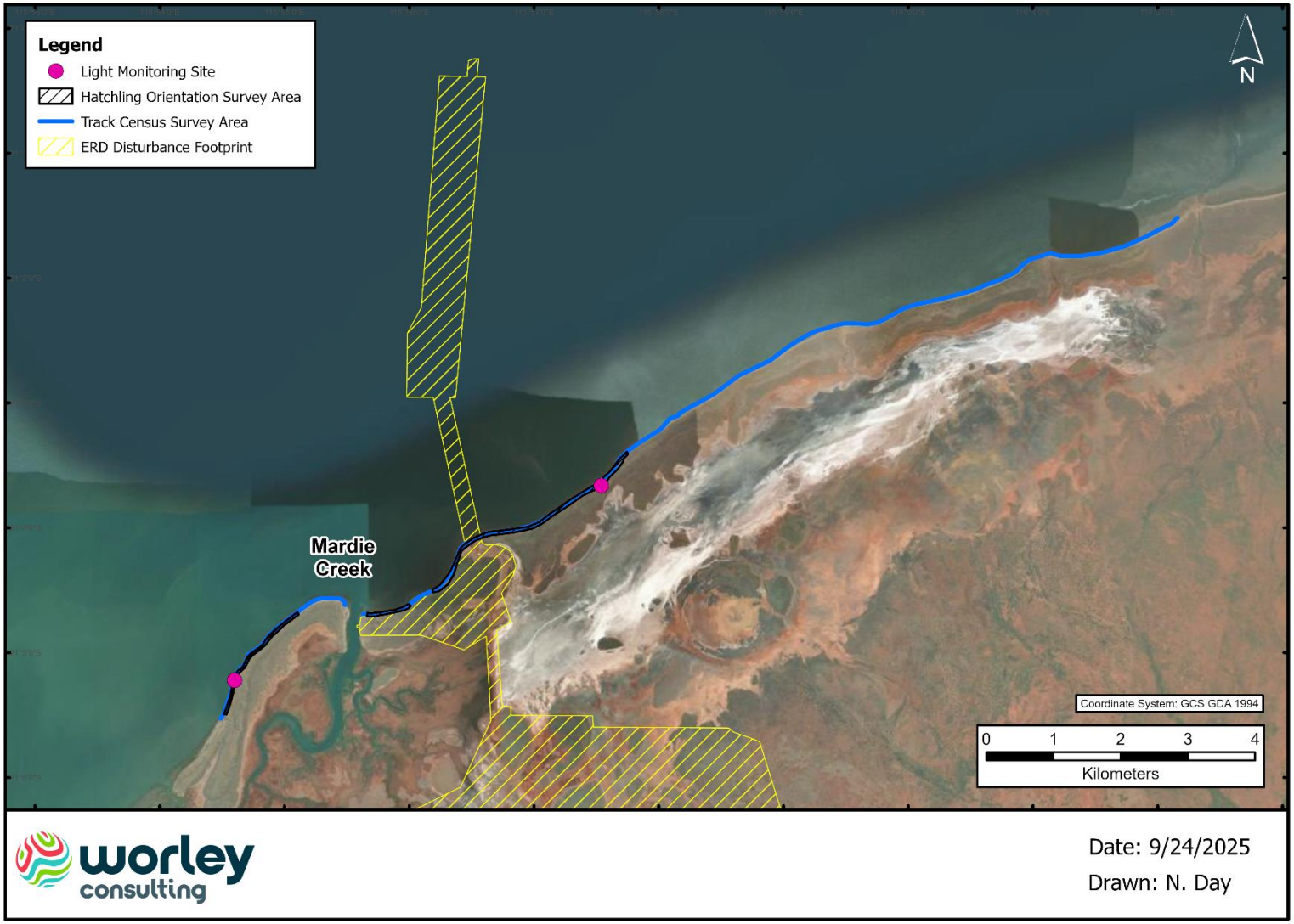

Figure B 8: Mainland survey extents defined for the Marine Turtle Monitoring Plan. Note that the track census survey area will be reduced if site access is by foot. (Source: Pendoley Environmental, 2022)