Biota Environmental Sciences

Turtle Monitoring at Bells Beach and Selected Rookeries of the Dampier Archipelago: 2008/09 Season

Rio Tinto Iron Ore

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Biota Environmental Sciences

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Bells Beach Turtle Monitoring 2008/09 Season

Contents

Tables

Figures

Plates

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1.0 Introduction

1.1 Background

Rio Tinto Iron Ore (RTIO) operates the port at Cape Lambert, on behalf of Robe River Iron Associates. The Cape Lambert operation was constructed in 1972 and has undergone various upgrades to meet increasing customer demand. The operations consist of an iron ore handling, processing and ship loading facility.

RTIO is proposing to construct a second ore handling, processing and ship loading facility at Cape Lambert. This Cape Lambert Port B Development is effectively a brown-field extension to the existing Cape Lambert operation.

Three species of marine turtle are known to regularly nest on beaches in the Dampier-Cape Lambert area: the Flatback Turtle (*Natator depressus*), Hawksbill Turtle (*Eretmochelys imbricata*) and Green Turtle (*Chelonia mydas*). There are also very occasional records of Loggerhead turtles (*Caretta caretta*) using the islands. All species of marine turtle are protected by the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (Commonwealth), and are also afforded protection under the *Wildlife Conservation Act 1950-1979* (Western Australia).

Flatback Turtles account for by far the majority of historical breeding records at Cape Lambert (Biota 2008a, Salinovich 2006, 2007). Known breeding sites at Cape Lambert include Bells Beach, which is adjacent to the area planned for the Cape Lambert Port B Development. A second smaller beach (Cooling Water Beach) is also utilised by marine turtles. This latter beach is located within the existing Cape Lambert operation, and is already subject to disturbance from power station cooling water discharge, rail and vehicle traffic, and stockyard activities, in addition to supporting a much smaller number of nesting events (Salinovich 2006, 2007). Figure 1.1 shows the proposed Port B Development in relation to Bells Beach and Cooling Water Beach.

The Cape Lambert Port B Development was referred to the EPA under Section 38 of the *Environmental Protection Act 1986*. The EPA determined that the proposal would be formally assessed at the level of Public Environmental Review (PER). The planned action of constructing the Port B Development was also referred to the Federal Department of the Environment, Water Heritage and the Arts (DEWHA), under the terms of the *EPBC Act 1999*. The Cape Lambert Port B Development was subsequently determined by the Minister to be a Controlled Action.

1.2 Cape Lambert Port B Development Marine Turtle Management Plan

A Marine Turtle Management Plan was prepared as a supporting document for the Cape Lambert Port B Development PER (Biota 2008b). It addressed environmental management and monitoring requirements for marine turtles during design, pre-construction, construction and operational phases of the Cape Lambert Port B Development.

The MTMP (Biota 2008b) sets out project design, construction and operations management measures to reduce impacts on marine turtles. Monitoring procedures were also detailed to measure the effectiveness of these design and management measures, and to provide continuous improvement feedback to the programme. The MTMP also incorporates the initial Draft Marine Turtle Management Plan for CLU-80 Expansion prepared by Guinea (2008) as Appendix 1 of that document. In addition, the MTMP highlighted the importance of collecting additional baseline data ahead of implementation of the project. The MTMP (Biota 2008b) effectively set the scope for the work presented in this report and is provided here as Appendix 1.

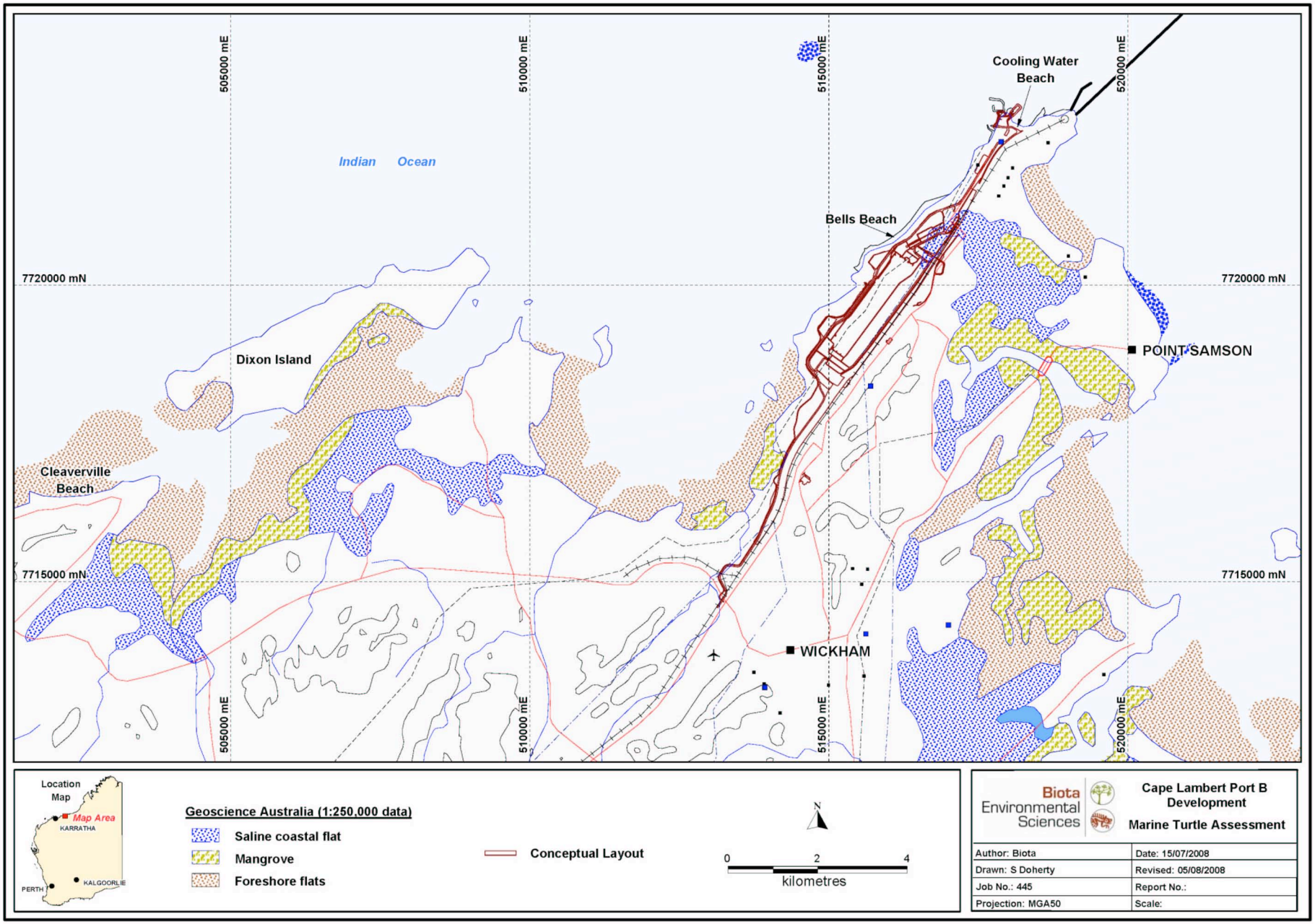

Figure 1.1: Locality plan showing Bells Beach and Cooling Water Beach relative to the conceptual layout for the Cape Lambert Port B Development.

1.3 Structure of this Report

This document reports on the following:

- methodology employed and any refinements arising from the 2008-09 field work;
- summary descriptive statistics documenting the relative levels of turtle nesting activity at Bells Beach and Cooling Water Beach compared to other reference sites in the Archipelago;
- summary of number of individuals tagged on the various monitored beaches;
- GIS mapping of all nesting locations at Bells and Cooling Water beaches;
- comparative review of WPCTP track count monitoring data from the field survey periods and the balance of the season;
- field illuminance data and GIS mapping of relative light levels at nest sites;
- relevant observation data on adult and hatchling behaviour; and
- raw data appendices.

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2.0 Methods

2.1 Study Site

The main foci of the monitoring component were the two beaches that may be impacted by the Port B Development: namely Bells Beach and Cooling Water Beach. Contextual monitoring data on selected aspects of turtle nesting activity were also collected at key reference sites in the immediate locality: at Delambre, Legendre and Dixon Islands. A fourth site, Cleaverville Beach, was also visited on two occasions (Figure 2.1). Nightly attendance at each of the beaches is shown in Tables 2.1 and 2.2.

Table 2.1: Beach monitoring during the November/December 2008 survey (shading indicates attendance on the beach).

	24/11	25/11	26/11	27/11	28/11	29/11	30/11	1/12	2/12	3/12	4/12	5/12	6/12
Bells Beach													
CW Beach													
Cleaverville													
Delambre Is													
Legendre Is													
Dixon Is.													

Table 2.2: Beach monitoring during the January 2009 survey (shading indicates attendance on the beach).

	7/1	8/1	9/1	10/1	11/1	12/1	13/1	14/1	15/1	16/1	17/1	18/1	19/1
Bells Beach													
CW Beach													
Cleaverville													
Delambre Is													
Legendre Is													
Dixon Is.													

2.1.1 Project Area Beaches

2.1.1.1 Bells Beach

This beach is located between 20°36'47"S, 117°9'08"E and 20°36'37"S, 117°9'22"E and is approximately 550 m in length, with a north-west facing aspect (Figure 2.1; Plate 2.1). Bells Beach was one of the primary focus sites for the assessment, given its proximity to the proposed Port B Development. This site was visited on every evening of both surveys (Table 2.1 and Table 2.2).

Plate 2.1: Bells Beach.

2.1.1.2 Cooling Water Beach

This beach is located between 20°36'07"S, 117°10'29"E and 20°36'51"S, 117°11'11"E, at the tip of Cape Lambert within the existing port operations. Cooling Water Beach is a small beach, approximately 200 m long, and is subject to a range of existing industrial port disturbance factors (Plate 2.2). This site was visited on 25 of the 26 monitoring evenings (Table 2.1 and Table 2.2).

Plate 2.2: Cooling Water Beach.

2.1.2 Reference Beaches

2.1.2.1 Cleaverville Beach and Adjacent Smaller Beaches

This beach is located midway between Cape Lambert and Karratha and extends approximately 2.1 km from 20°39'5"S, 117°1'18"E to 20°38'57"S, 117°01'50"E. There are also several other smaller beaches to the west of Cleaverville Beach (e.g. at 20°39'20"S, 117°0'20"E and 20°39'46"S, 116°59'05"E). This site was visited on two occasions during the 2008/09 program (Table 2.1 and Table 2.2).

2.1.2.2 Delambre Island

This island is situated within the Dampier Archipelago and located at 20°27'01"S, 117°04'41"E (Figure 2.1). A section of beach approximately 1.5 km in length, and taking in the southern headland of the island, was monitored during both trips (Plate 2.3). The bounding coordinates at either end of the beach are roughly demarcated by 20°27'35"S, 117°4'45"E and 20°27'40"S, 117°4'22"E.

Plate 2.3: Delambre Island (monitored area identified in red).

2.1.2.3 Legendre Island

This island is located within the Dampier Archipelago at 20°23'28.30"S and 116°52'31.98"E and supports several beaches, all of which appear to be used by turtles for nesting. A single beach with a north-east aspect at the eastern end of the island was monitored during the January 2008

survey (Plate 2.4). The beach is located between 20°24'40.69"S, 116°55'12.20"E and 20°25'13.43"S, 116°56'24.82"E and is approximately 2.3 km in length. Legendre Island was monitored for the majority of both surveys (Table 2.1 and Table 2.2).

Plate 2.4: Main beach on Legendre Island.

2.1.2.4 Dixon Island

This island is located within the Dampier Archipelago and is located at 20°37'46.20"S, 117°3'25.85"E (Figure 2.1). Monitoring during the current season was focussed on several small north facing beaches at the eastern end of the island between 20°37'0.69"S, 117°4'29.28"E and 20°36'57.64"S, 117°5'1.58"E. The total length of the beaches is approximately 600 m. Due to logistical constraints, Dixon Island was only able to be monitored during the second survey in January 2009 (Table 2.2).

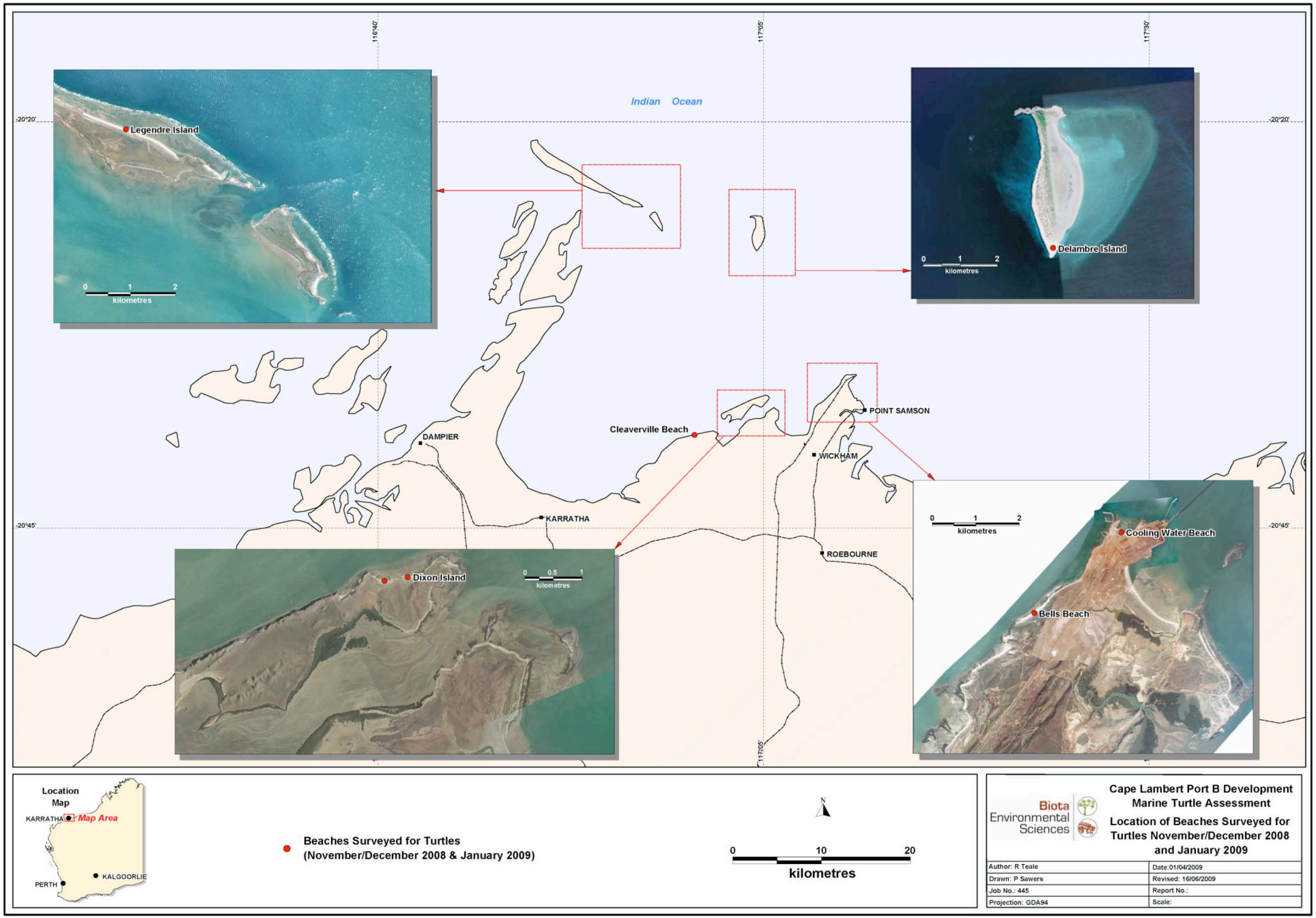

Figure 2.1: Location of beaches surveyed for turtles during 2008/09.

2.2 Survey Timing

Tide charts for November 2008 – January 2009 were reviewed with the objective of picking two two-week periods when the evening high tide was optimal for turtle nesting activity (and thereby data collection for the programme). Based on this rationale, the work was conducted as follows:

- Phase I: 24th November – 8th December 2008; and
- Phase II: 7th – 20th January 2009.

2.3 Turtle Nesting Activity Monitoring

A key component of the monitoring programme is the long-term quantification of turtle nesting activity at Bells Beach and Cooling Water Beach, relative to the monitored reference sites in the Dampier-Cape Lambert locality (see Biota 2008b and Appendix 1 and 2 for an expanded discussion). Basic parameters recorded at Bells Beach and Cooling Water Beach included:

- number of successful nests;
- spatial location of successful nest sites (recorded using a GPS);
- number of emergences (past high tide mark); and
- number of false crawls.

A tagging programme was also implemented at each of the study sites and followed the accepted procedures of the Western Australian Marine Turtle Monitoring Programme, consistent with that used elsewhere in the bioregion. A single tag was applied to the first scale of the trailing edge of the left front flipper and relevant data were recorded on the DEC datasheets shown in Appendix 2. The tag sequences used as part of the current program ranged from WA73901 to WA75400.

More detail on the methods followed in the study is supplied in Appendix 1 and 2.

2.4 Incident Light Monitoring

Field measurement of incident light levels was completed at both Bells Beach and Cooling Water Beach during the first monitoring period. Illuminance data were collected using a TopCon IM5 Lux Meter at each confirmed nest location. The device was also trialled at Delambre and Legendre Islands but incident light levels were consistently below the detectable limit and no data were therefore collected. Locations where incident light data were collected at Bells Beach and Cooling Water Beach are shown in Figure 3.7 and Figure 3.8 respectively.

2.5 Beach Temperature Measurement

To examine beach temperature profiles, ten ibutton temperature loggers were buried at a depth of 50 cm (typical Flatback nest depth) at each of Bells Beach, Cooling Water Beach, Delambre Island and Legendre Island. A further five loggers were buried at Cleaverville Beach (45 loggers in total). The recording interval was set at 30 minutes. All loggers were installed during the November/December 2008 survey and collected at the completion of the January 2009 survey. Seventeen of the 55 loggers could not be re-located, most likely due to turtle activity as indicated in Table 2.3. Locations were loggers were installed are shown in Figure 3.3 to Figure 3.6.

2.6 Hatchling Activity

Hatchling behavioural patterns on emergence from the nest and animal orientation were recorded by direct observation of tracks.

Table 2.3. Locations at which the iButton temerature loggers were buried on each of five beaches. (Loggers in bold were not recovered subsequent to installation; coordinates in WGS84 datum).

Bells Beach	Easting	Northing
BB1	**515877mE**	**7720640mN**
BB2	515927mE	7720669mN
BB3	515969mE	7720686mN
BB4	516037mE	7720726mN
BB5	**516076mE**	**7720749mN**
BB6	516122mE	7720781mN
BB7	516170mE	7720816mN
BB8	516237mE	7720866mN
BB9	**516266mE**	**7720908mN**
BB10	516306mE	7720951mN

Cooling Water Beach	Easting	Northing
CW1	518217mE	7722618mN
CW2	518200mE	7722626mN
CW3	518185mE	7722631mN
CW4	518168mE	7722628mN
CW5	518151mE	7722643mN
CW6	518134mE	7722647mN
CW7	518119mE	7722658mN
CW8	518181mE	7722666mN
CW9	518082mE	7722677mN
CW10	518061mE	7722688mN

Delambre Island	Easting	Northing
DEL1	**507878mE**	**7737029mN**
DEL2	**507884mE**	**7737026mN**
DEL3	507891mE	7737019mN
DEL4	507896mE	7737019mN
DEL5	507903mE	7737016mN
DEL6	507752mE	7737062mN
DEL7	607755mE	7737063mN
DEL8	507759mE	7737065mN
DEL9	507763mE	7737065mN
DEL10	**507769mE**	**7737065mN**

Legendre Island	Easting	Northing
LEG1	493042mE	7743061mN
LEG2	493042mE	7743057mN
LEG3	**493040mE**	**7743052mN**
LEG4	493037mE	7743045mN
LEG5	**493031mE**	**7743037mN**
LEG6	**493296mE**	**7742973mN**
LEG7	**493294mE**	**7742967mN**
LEG8	**493293mE**	**7742959mN**
LEG9	**493296mE**	**7742956mN**
LEG10	**493302mE**	**7742944mN**

Cleaverville Beach	Easting	Northing
CLV1	**502969mE**	**7716539mN**
CLV2	**502971mE**	**7716531mN**
CLV3	**502974mE**	**7716525mN**
CLV4	**502974mE**	**7716518mN**
CLV5	**502975mE**	**7716513mN**

2.7 Limitations

Some of the data presented in this document were not collected by the authors and therefore may be subject to potential limitations that the authors are not aware of. All data collected should be treated as indicative and the appropriate sources quoted should any of the data be referenced.

Known limitations of these other data sources include:

- tagging saturation on some key beaches where numbers of turtles were compiled from tagging data alone (e.g. Mundabullangana Beach and Barrow Island beaches);
- different monitoring methods (e.g. confirmed nest counts versus next day track counts) and inter-observer variation may have limited the assessment of individual sites and comparisons between sites; and
- it is not clear whether all beaches have been monitored during the entire range of nesting opportunities (often considered to be 3-4 hours either side of the high tide for Flatback turtles).

3.0 Results

3.1 Tagging Programme

The results of the tagging programme conducted during November/December 2008 are tabulated in Table 3.1 whilst those for January 2009 are shown in Table 3.2. A total of 509 turtles was tagged during the December survey, comprising 363 Flatbacks, 99 Hawksbills, 46 Greens and one Loggerhead (Table 3.1). The majority of beaches investigated were predominantly Flatback rookeries, though the 2 km of beach on Legendre Island is clearly a mixed species rookery.

Table 3.1 Total number of newly tagged turtles across study beaches during the November/December 2008 survey.

Rookery	Nights	Flatbacks	Hawksbills	Greens	Loggerhead	Total
Bells	13	29†	0	0	0	**29**
Cooling Water	13	3	0	0	0	**3**
Delambre	11	158	9	1	0	**168**
Legendre	12	171	90	45	1	**307**
Dixon	0	-	-	-	-	**-**
Cleaverville	1	2	0	0	0	**2**
	Total:	**363**	**99**	**46**	**1**	**509**

† Includes the re-migrant WA27272

Fewer turtles were tagged during the January 2009 survey (Table 3.2). This may in part be explained by the reduced effort on the key islands of Legendre and Delambre (Tables 2.1 and 2.2), as well as a clear reduction in the number of Hawksbill turtles using Legendre Island during the January 2009 survey[1]. However, this is mostly because nearly 20% of all turtles encountered during the January 2009 survey were already tagged during the November/December 2008 survey. This result is borne out in Table 3.3, which shows the total number of individuals recorded during the January 2009 survey (i.e. newly tagged turtles plus first time re-sightings of November/December 2008 tagged animals). These data indicate that the number of Flatbacks using the monitored beaches on Legendre and Delambre increased across the two surveys, whilst Greens remained largely unchanged and Hawksbills dropped substantially (by nearly two thirds; cf. Table 3.1 and Table 3.3).

Table 3.2 Total number of newly tagged turtles across study beaches during January 2009 survey.

Rookery	Nights	Flatbacks	Hawksbills	Greens	Loggerhead	Total
Bells	13	11	0	0	0	**11**
Cooling Water	13	1	0	0	0	**1**
Delambre	10	183	1	1	0	**185**
Legendre	10	132	16	22	0	**170**
Dixon	7	18	0	0	0	**18**
Cleaverville	1	1	0	0	0	**1**
	Total:	**346**	**17**	**23**	**0**	**386**

Table 3.3 Total number of individual turtles recorded during January 2009 survey

Rookery	Nights	Flatbacks	Hawksbills	Greens	Loggerhead	Total
Bells	13	19	0	0	0	**19**
Cooling Water	13	1	0	0	0	**1**
Delambre	10	206	1	1	0	**208**
Legendre	10	163	32	39	0	**234**
Dixon	7	18	0	0	0	**18**
Cleaverville	1	1	0	0	0	**1**
	Total:	**408**	**33**	**40**	**0**	**481**

[1] This is to be expected given that peak nesting for this species is much earlier in the season.

3.1.1 Monitoring Data from Bells Beach

Forty Flatbacks were tagged on Bells Beach across both the November/December 2008 and January 2009 surveys, with the majority (n=29) tagged during November/December 2008. The tally of November/December 2008 tagged turtles includes a re-migrant (WA27272) previously tagged at Bells Beach on 12/6/1995 (R. Prince, DEC, pers. comm.). Another Flatback re-migrant (WA42944 / WA42943) recorded during both the November/December 2008 and January 2009 surveys was originally tagged approximately 100 km to the ENE at Mundabullangana Station (Cowrie Beach) on 12/6/2000. In addition to these re-migrants, the January survey recorded four Flatbacks that had moved between beaches across the surveys:

- WA74317 originally tagged on Cleaverville Beach on 27/11/08 was recorded on Bells Beach on the 7/1/09;
- WA74008 originally tagged on Delambre Island on 25/11/08 was recorded on Bells Beach on the 9/1/09;
- WA73947 originally tagged on Bells Beach on the 11/1/09 was recorded on Boat Beach on the 12/1/09 (a member of the public noted the tag number and reported it) and then again on Bells Beach later the same night; and
- WA76270 was recorded on Bells Beach on 10/1/09 and was originally tagged on Munda Beach in December 2008 (Dr. K. Pendoley pers comm. 2009).

Nightly emergence of Flatbacks on Bells Beach ranged between nil and 10 animals, with one to three being common (Table 3.4 and Table 3.5). Total activity was very similar across the two survey periods, with 35 emergences in November/December 2008 and 34 in January 2009 (Table 3.4 and Table 3.5). The spatial distribution of nests is shown in Figure 3.1.

Table 3.4 **Nightly emergence of Flatbacks on Bells Beach during the November/December 2008 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
24/25	4	0	0	**4**
25/26	3	1	1	**5**
26/27	4	2	0	**6**
27/28	2		0	**2**
28/29	1	0	0	**1**
29/30	1	1	0	**2**
30/1	3	0	0	**3**
1/2	1	0	0	**1**
2/3	1	1	0	**2**
3/4	0	0	0	**0**
4/5	3	0	0	**3**
5/6	2	1	0	**3**
6/7	3	0	0	**3**
Totals:	**28**	**6**	**1**	**35**

Table 3.5 **Nightly emergence of Flatbacks on Bells Beach during the January 2009 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
7/8	1	2	0	**3**
8/9	1	1	0	**2**
9/10	1	3	0	**4**
10/11	1	7	0	**8**
11/12	3	7	0	**10**
12/13	2	0	0	**2**
13/14	1	0	0	**1**
14/15	0	0	0	**0**
15/16	1	0	0	**1**
16/17	0	0	0	**0**
17/18	0	1	0	**1**
18/19	0	0	0	**0**
19/20	0	2	0	**2**
Totals:	**11**	**23**	**0**	**34**

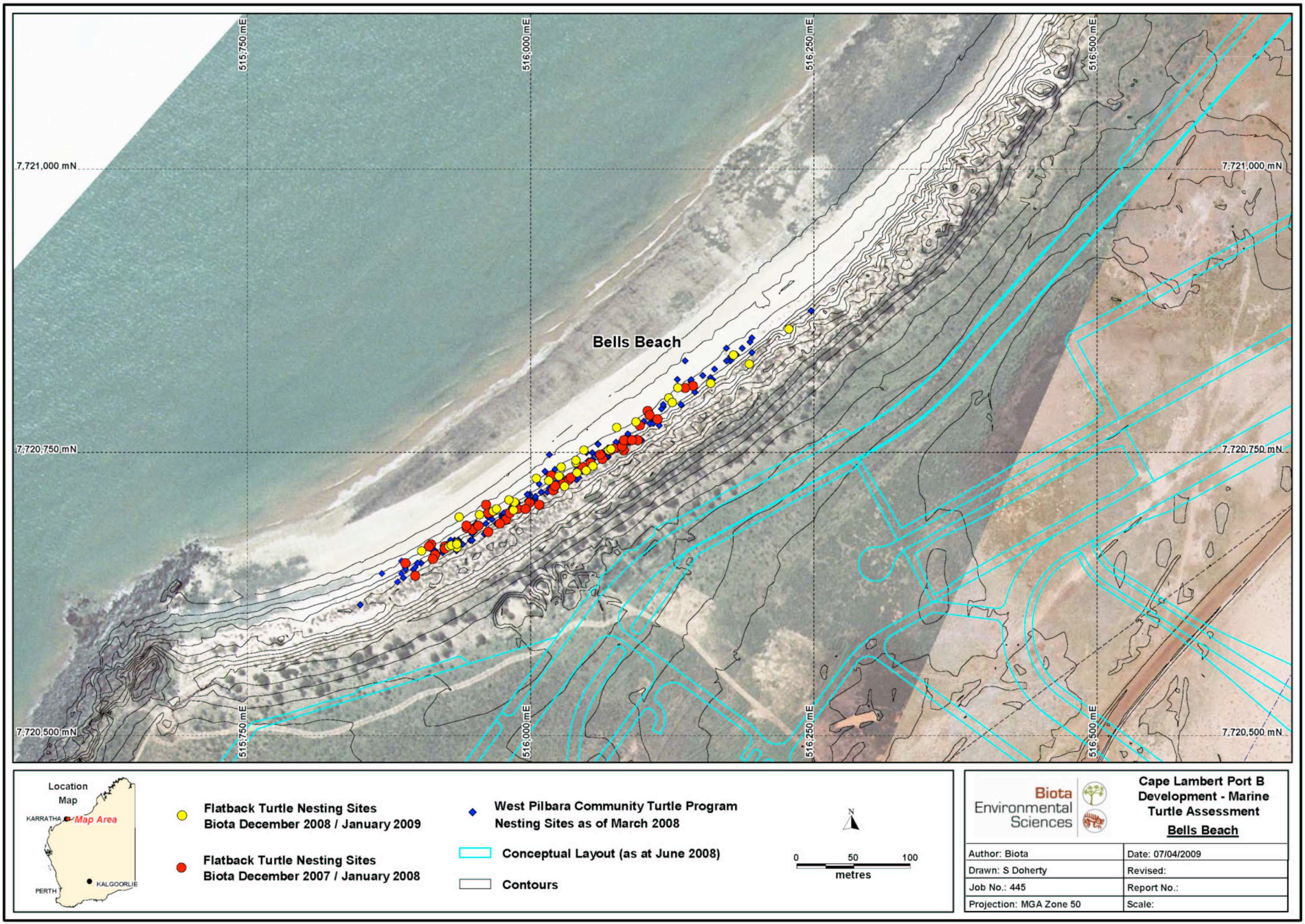

Figure 3.1: Nest location on Bells Beach (data gathered across two seasons).

3.1.2 Monitoring Data from Cooling Water Beach

Cooling Water Beach yielded very little nesting activity over the monitoring periods, with just three Flatbacks tagged during the November/December 2008 survey and one tagged during the January 2009 survey. This was despite this beach being visited on 25 of the 26 monitoring evenings (Section 2.1.1.2).

3.1.3 Monitoring Data from Delambre Island

Recorded nightly Flatback emergences along the monitored section of Delambre Island ranged between 10 and 28 in the November/December survey, and from 9 to 44 in the January 2009 survey (Tables 3.6 and 3.7). A total of 400 emergences was recorded across the two surveys, with a small increase from November/December 2008 to January 2009 despite the shorter monitoring duration. Many additional turtles were missed along the monitored section of the island, especially on busy nights due to tagging saturation (i.e. over the period it took to tag 10 to 15 animals many others would have completed nesting activities and returned to the water unrecorded).

Table 3.6 **Nightly emergence of Flatbacks on Delambre Island during the November/December 2008 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
24/25	No survey	-	-	**-**
25/26	21	7	0	**28**
26/27	No survey	-	-	**-**
27/28	13	4	0	**17**
28/29	22	6	0	**28**
29/30	11	1	0	**12**
30/1	9	1	0	**10**
1 /2	17	0	0	**17**
2/3	23	3	0	**26**
3/ 4	No survey	-	-	**-**
4/5	17	3	0	**20**
5/6	11	3	0	**14**
6/7	14	0	0	**14**
Totals:	**158**	**28**	**0**	**186**

Table 3.7 **Nightly emergence of Flatbacks on Delambre Island during the January 2009 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
7/8	17	2	0	**19**
8/9	25	3	0	**28**
9/10	11	3	0	**14**
10/11	32	12	0	**44**
11/12	21	11	0	**32**
12/13	17	4	0	**21**
13/14	21	3	0	**24**
14/15	3	6	0	**9**
15/16	22	5	0	**27**
16/17	14	1	0	**15**
17/18	No Survey	-	-	**-**
18/19	No Survey	-	-	**-**
19/20	No Survey	-	-	**-**
Totals:	**166**	**48**	**0**	**214**

3.1.4 Monitoring Data from Legendre Island

Recorded nightly Flatback emergences along the north-eastern beach on Legendre Island ranged between 12 and 39 in the November/December 2008 survey, from 5 to 37 in the January 2009 survey (Table 3.8 and 3.9). A total of 473 emergences was recorded across the two surveys, with a small decrease from November/December 2008 to January 2009 (due to reduced monitoring duration).

Table 3.8 **Nightly emergence of Flatbacks on Legendre Island during the November/December 2008 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
24/25	16	0	0	**16**
25/26	15	5	0	**20**
26/27	No Survey	-	-	**-**
27/28	23	9	0	**32**
28/29	13	12	0	**25**
29/30	7	8	0	**15**
30/1	13	6	0	**19**
1/2	22	17	0	**39**
2/3	17	9	0	**26**
3/ 4	No Survey	-	-	**-**
4/5	10	2	0	**12**
5/6	9	5	0	**14**
6/7	26	7	0	**33**
Totals	**171**	**80**	**0**	**251**

Table 3.9 **Nightly emergence of Flatbacks on Legendre Island during the January 2009 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
7/8	14	3	0	**17**
8/9	17	10	0	**27**
9/10	14	20	0	**34**
10/11	22	15	0	**37**
11/12	14	17	0	**31**
12/13	15	2	0	**17**
13/14	15	11	0	**26**
14/15	14	6	0	**20**
15/16	3	2	0	**5**
16/17	4	4	0	**8**
17/18	No Survey	-	-	**-**
18/19	No Survey	-	-	**-**
19/20	No Survey	-	-	**-**
Totals	**132**	**90**	**0**	**222**

3.1.5 Monitoring Data from Dixon Island

Dixon Island was visited across seven nights during the January 2009 survey, during which 18 Flatbacks were tagged (Table 3.10). Nightly emergences ranged from nil animals to nine individuals and totalled 28 across the seven nights.

Table 3.10 **Nightly emergence of Flatbacks on Dixon Island during the January 2009 survey** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
7/8	No Survey			
8/9	No Survey			
9/10	5	0	0	**5**
10/11	5	1	0	**6**
11/12	4	5	0	**9**
12/13	3	4	0	**7**
13/14	0	0	0	**0**
14/15	1	0	0	**1**
15/16	No Survey			
16/17	No Survey			
17/18	No Survey			
18/19	No Survey			
19/20	No Survey			
Totals	**18**	**10**	**0**	**28**

3.2 Cape Lambert Track Counts Program

Track count data were also collected at Cape Lambert by the West Pilbara Community Turtle Program (WPCTP) during the 2008-09 nesting season (Salinovich 2009). Consistent with the tagging data collected here, and with previous years findings, the great majority of nesting activity was recorded at Bells Beach. Table 3.11 summarises the track count data across the total duration monitored by the WPCTP (from the end of October 2008 to March 2009; Salinovich 2009).

Table 3.11 Summary of WPCTP track count data from the 2008-09 season (source: Salinovich 2009).

Beach	Species	Nests	False Crawls
Bells Beach	Flatback	216	64
	Hawksbill	1	
Cooling Water Beach	Flatback	14	4
Boat Beach	Flatback	5	1
Wickham	Flatback	4	0

Over 90% of the 239 total nest events inferred from track counts were recorded from Bells Beach. The peak of this activity at Bells Beach was in December, with 83 nest events recorded during that month, followed by January with 71 events (Salinovich 2009). Almost all records were of Flatback turtles, with a single Hawksbill recorded from Bells Beach (Table 3.11).

3.3 Hatchling Orientation

None of the observed hatchlings or inspection of their tracks showed any evidence of misorientation. Due the time required for tagging and other components of the field monitoring programme, there was insufficient resources to undertake any trials of the more detailed hatchling monitoring approaches that were discussed in Biota (2008b). This will require consideration for future survey phases (see Section 4.4).

3.4 Regional Tagging Programmes

All data presented below were forwarded by Dr Dorian Moro of Chevron Australia.

3.4.1 Barrow Island

Nightly emergences of Flatback turtles on Barrow Island increased significantly between the November/December 2008 survey and the January 2009 survey. For example, on the 8/1/09, 188 Flatback emergences were recorded compared with the highest tally during the November/December 2008 survey period of 93 (on the 3/12/08) (Table 3.12 and Table 3.13).

Table 3.12 Nightly emergence of Flatbacks on Barrow Island during the November/December 2008 survey dates (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
24/25	4	4	22	**30**
25/26	3	8	20	**31**
26/27	3	14	37	**54**
27/28	3	7	30	**40**
28/29	2	6	29	**37**
29/30	1	5	10	**16**
30/1	2	10	24	**36**
1/2	3	6	11	**20**
2/3	6	11	28	**45**
3/4	11	33	49	**93**
4/5	5	9	59	**73**
5/6	No Survey	-	-	**-**
6/7	6	0	7	**13**
Totals	**49**	**113**	**326**	**488**

Table 3.13 **Nightly emergence of Flatbacks on Barrow Island during the January 2009 survey dates** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
7/8	7	53	14	**74**
8/9	28	124	36	**188**
9/10	16	80	22	**118**
10/11	4	32	7	**43**
11/12	17	73	27	**117**
12/13	No Survey	-	-	**-**
13/14	No Survey	-	-	**-**
14/15	4	17	4	**25**
15/16	4	27	3	**34**
16/17	No data	-	-	**-**
17/18	No data	-	-	**-**
18/19	No data	-	-	**-**
19/20	No data	-	-	**-**
Totals:	**80**	**406**	**113**	**599**

3.4.2 Munda (Cowrie Beach)

Tagging at Munda was only conducted during December in the current 2008/09 season and commenced on the 5/12/08. Table 3.14 summarises the data that were available at the time of preparing this report, which represents three evenings.

Table 3.14 **Nightly emergence of Flatbacks on Munda (Cowrie Beach) during the November/December 2008 survey dates** (re-sightings include animals tagged during the current season irrespective of whether it was earlier in the night, the previous night or on a previous trip).

Tide Cycle	New	Re-sighting	Re-migrant	Total
24/25	No survey	-	-	**-**
25/26	No survey	-	-	**-**
26/27	No survey	-	-	**-**
27/28	No survey	-	-	**-**
28/29	No survey	-	-	**-**
29/30	No survey	-	-	**-**
30/1	No survey	-	-	**-**
1 /2	No survey	-	-	**-**
2/3	No survey	-	-	**-**
3/ 4	No survey	-	-	**-**
4/5	No survey	-	-	**-**
5/6	8	0	11	**19**
6/7	18	0	34	**52**
7/8	36	0	30	**66**
Totals	**62**	**0**	**75**	**137**

A total of 137 Flatback Turtles were recorded at Munda over the three evenings from 5th to the 7th December 2008, 62 of which were new turtles and 75 were re-migrants (Table 3.14).

3.5 Beach Temperature Measurement

Although all of the temperature loggers were buried to a depth of 50 cm, several of the loggers became exposed or partially uncovered during the logging period. This is reflected in the relatively erratic temperature profiles (and relatively high standard deviation (SD)) for disturbed loggers. Table 3.15 summarises the data from the temperature loggers deployed on the five study beaches. The data is the average temperature for a 26-day period from 1/12/08 to 26/12/08. Those loggers where the SD exceeds 1°C (e.g. BEL03 and BEL04) were exposed to near surface or surface temperatures for at least some period of the logging duration (indicated by erratic temperature changes: those consistently at depth showed steady values). On average the temperatures recorded at a depth of 50 cm were 1°C to 3°C warmer on mainland beaches compared to the island beaches.

Table 3.15: Average (± SD) temperature across the logged period for each iButton temperature logger.

Islands	
Logger Code	**Temp (mean ± SD)**
Delambre Island	
DEL3	28.9±0.5°C
DEL4	28.8±0.4°C
DEL5	28.1±0.3°C
DEL6	28.6±0.4°C
DEL7	28.6±0.4°C
DEL8	28.6±0.4°C
DEL9	28.2±0.3°C
Legendre Island	
LEG1	28.2±0.3°C
LEG2	29.1±0.2°C
LEG4	28.0±0.2°C

Mainland	
Logger Code	**Temp (mean ± SD)**
Cleaverville Beach	
CL4	30.7±0.3°C
CL5	30.6±0.3°C
Cooling Water Beach	
CWB1	31.3±0.4°C
CWB2	31.4±0.5°C
CWB3	31.8±0.5°C
CWB4	31.5±0.4°C
CWB5	31.6±0.3°C
CWB7	31.8±0.4°C
CWB8	32.8±0.6°C
CWB9	32.9±2.6°C
CWB10	32.0±0.4°C
Bells Beach	
BEL2	30.6±0.4°C
BEL3	32.3±1.4°C
BEL4	32.4±1.3°C
BEL6	31.0±0.4°C
BEL7	30.8±0.3°C
BEL8	31.1±0.3°C
BEL10	32.4±0.4°C

For a smaller subset of loggers a more consistent temperature profile was obtained over a longer duration (1/12/08 to 7/1/09). Data from these loggers indicated that the initial logged temperatures on the two island beaches was around 28°C compared to 30.5°C for the three mainland beaches. At the completion of the logging period, temperatures from the island beaches had increased by around 3°C to 31°C, whilst temperatures from mainland beaches had increased by around 2.5°C to 33°C. Representative temperature profiles from eight of the most stable loggers are shown in Figure 3.2.

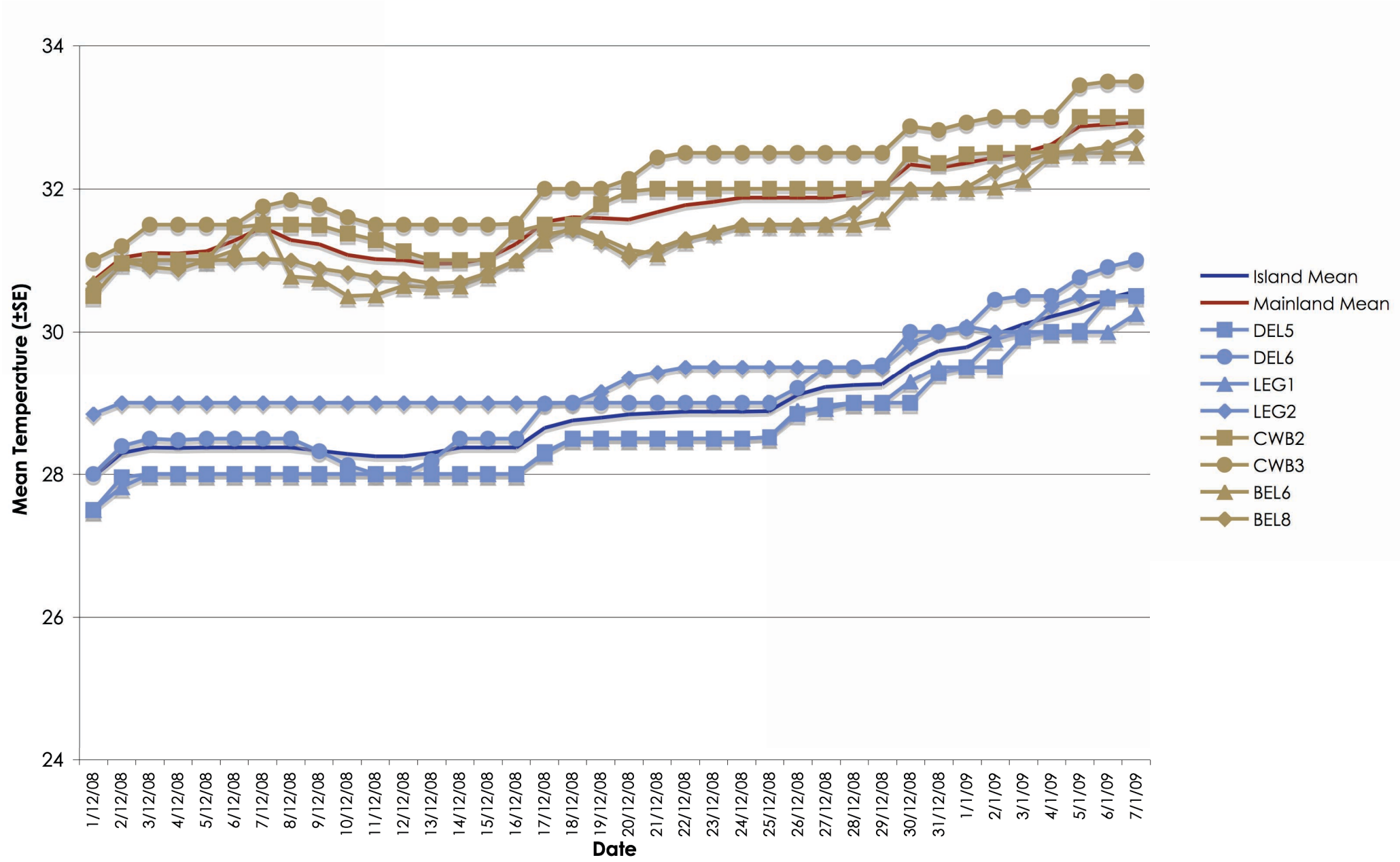

Figure 3.2 **Temperature profiles from iButton Temperature Loggers installed at a depth of 50 cm on beaches at Legendre Island (LEG1 and LEG2), Bells Beach (BEL6) and Cooling Water Beach (CWB3) for the period 1/12/08 – 7/1/09 (values are mean temperature for each 24 hour period).**

Figure 3.3: Locations where temperature loggers were installed at Bells Beach.

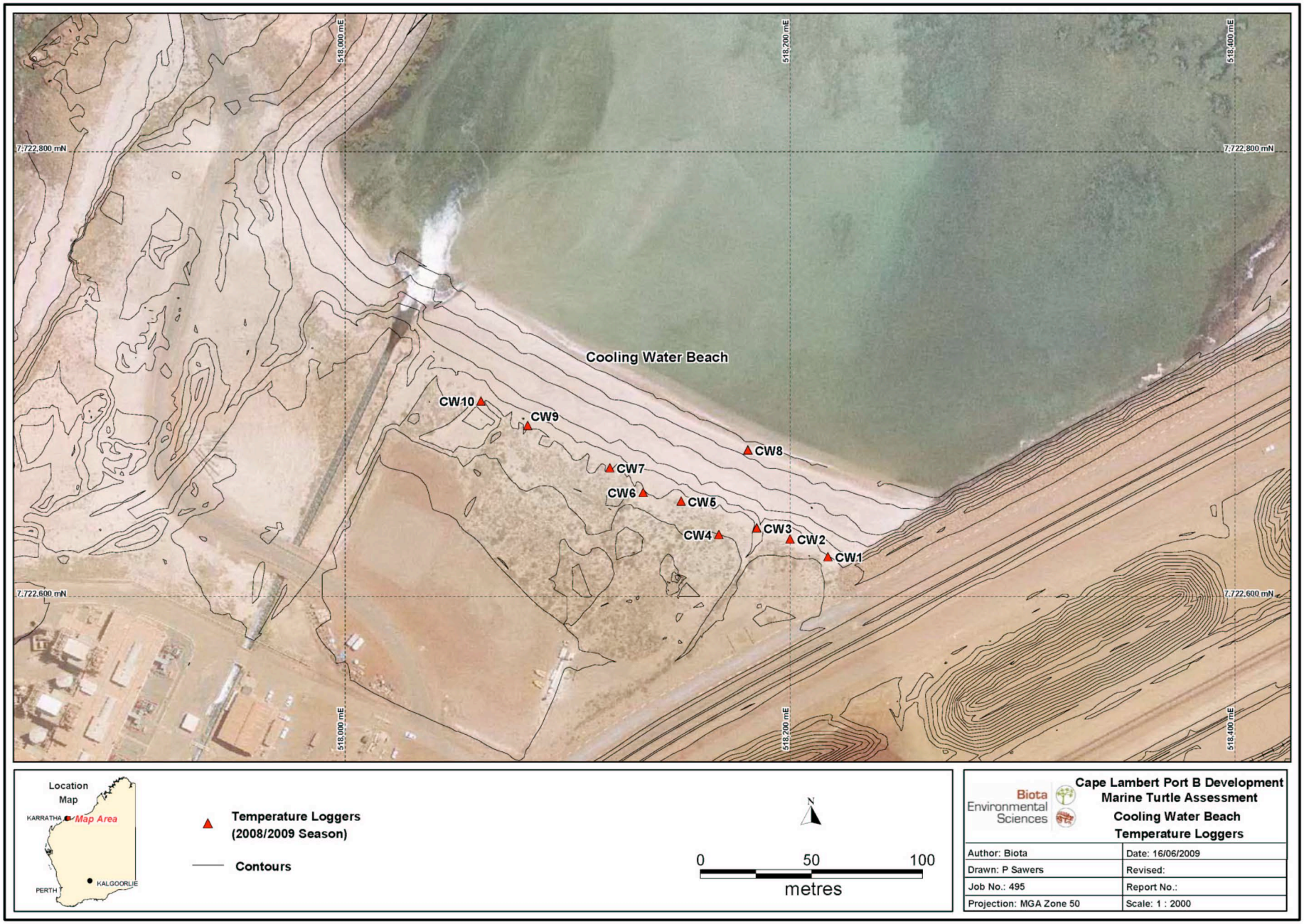

Figure 3.4: Locations where temperature loggers were installed at Cooling Water Beach.

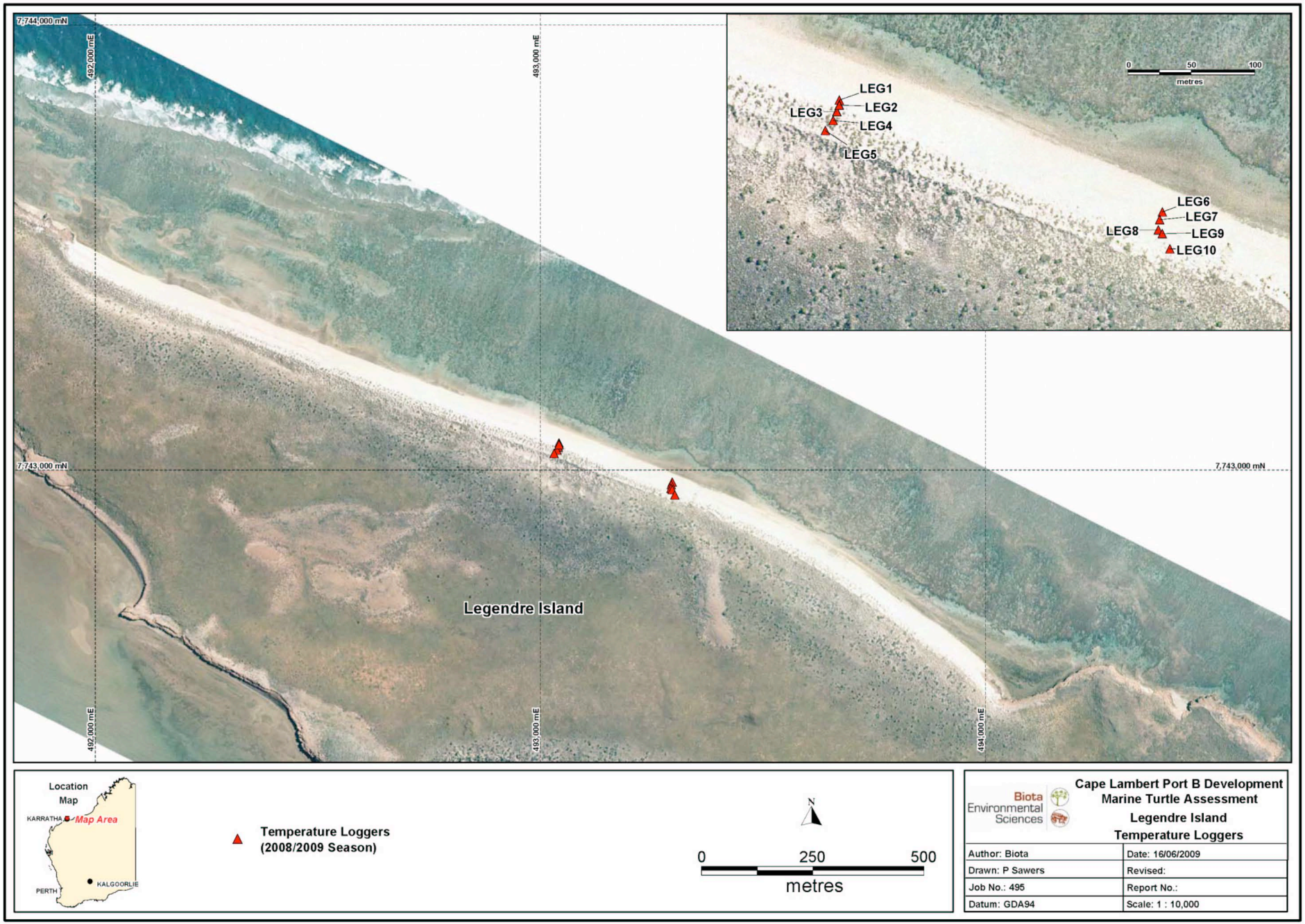

Figure 3.5: Locations where temperature loggers were installed on Legendre Island.

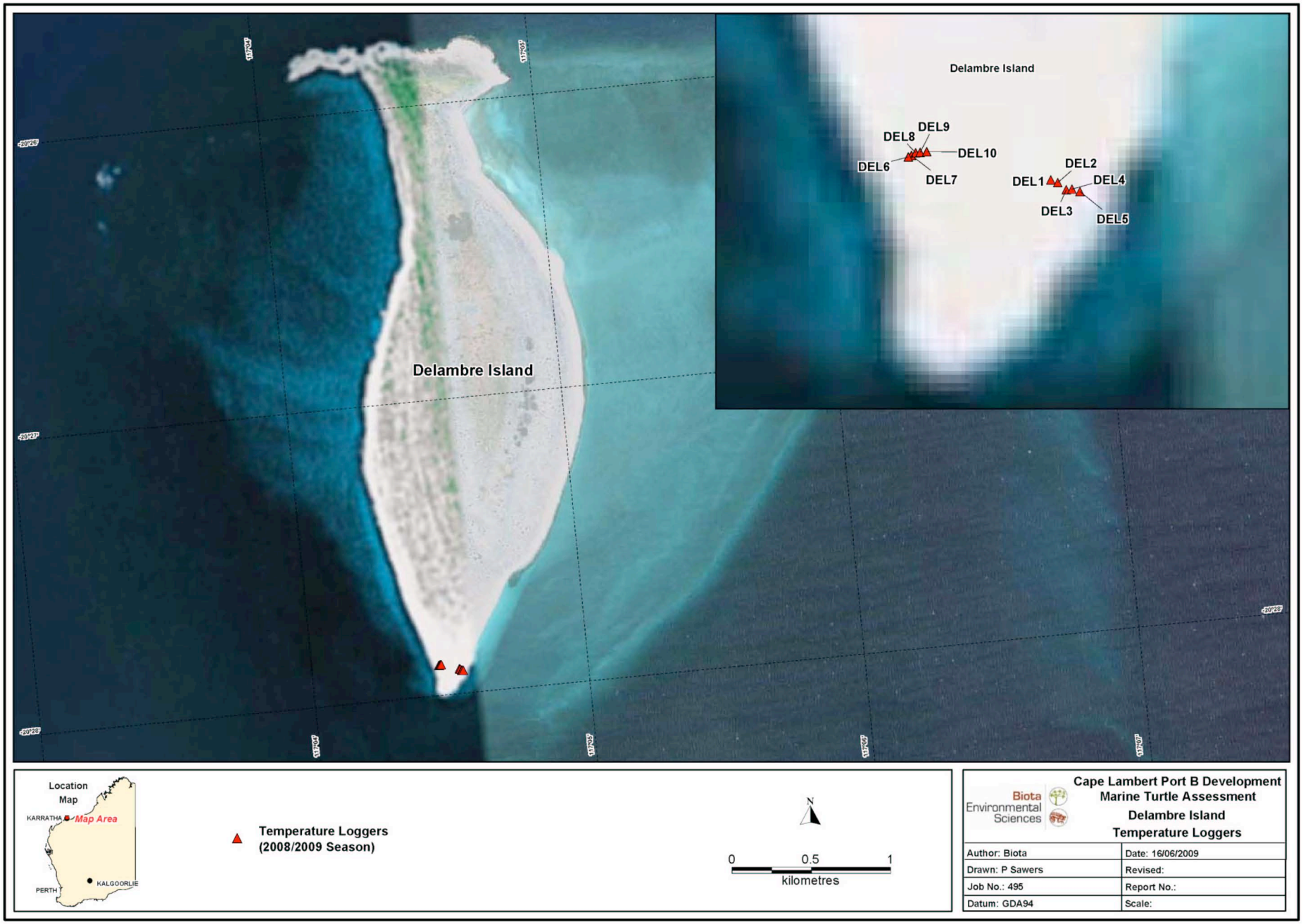

Figure 3.6: Locations where temperature loggers were installed on Delambre Island.

3.6 Incident Light Monitoring

Light falling directly on Bells beach was negligible throughout the survey period. Lux values recorded at 10 locations on Bells beach were effectively zero (Table 3.16; Figure 3.7), with lux values recorded at individual nesting sites also recording zero values.

However, Cooling Water Beach is located effectively within existing industry at Cape Lambert and measurable incidental light readings were recorded here (Table 3.17; Figure 3.8). It should be noted that on Cooling Water Beach, the main light sources originated from mobile lights near the ore stockpile, the power station and jetty mounted lights. For comparison purposes, bright moonlight is approximately 0.2 lux (Biota 2008a).

Table 3.16 Lux values at data logger locations on Bells Beach.

			Lux	
			24/11/08	28/11/08
Site	Lat	Long	10:00pm	00.35am
BB1	515877	7720640	0.00	0.00
BB2	515927	7720669	0.00	0.00
BB3	515969	7720686	0.00	0.00
BB4	516037	7720726	0.00	0.00
BB5	516076	7720749	0.00	0.00
BB6	516122	7720781	0.00	0.00
BB7	516170	7720816	0.00	0.00
BB8	516237	7720866	0.00	0.00
BB9	516266	7720908	0.00	0.00
BB10	516306	7720951	0.00	0.00

Table 3.17 Lux values at data logger locations on Cooling Water Beach.

			Lux		
			26/11/08	27/11/08	28/11/09
Site	Lat	Long	10:40pm	01.25am	01.45am
CW01	518217	7722618	0.01	0.37	0.05
CW02	518200	7722626	0.01	0.04	0.08
CW03	518185	7722631	0.02	0.05	0.13
CW04	518168	7722628	0.03	0.11	0.14
CW05	518151	7722643	0.03	0.07	0.14
CW06	518134	7722647	0.03	0.06	0.11
CW07	518119	7722658	0.03	0.02	0.11
CW08	518181	7722666	0.02	0.03	0.1
CW09	518082	7722677	0.02	0.03	0.09
CW10	518061	7722688	0.02	0.03	0.09

Figure 3.7: Light level monitoring locations at Bells Beach.

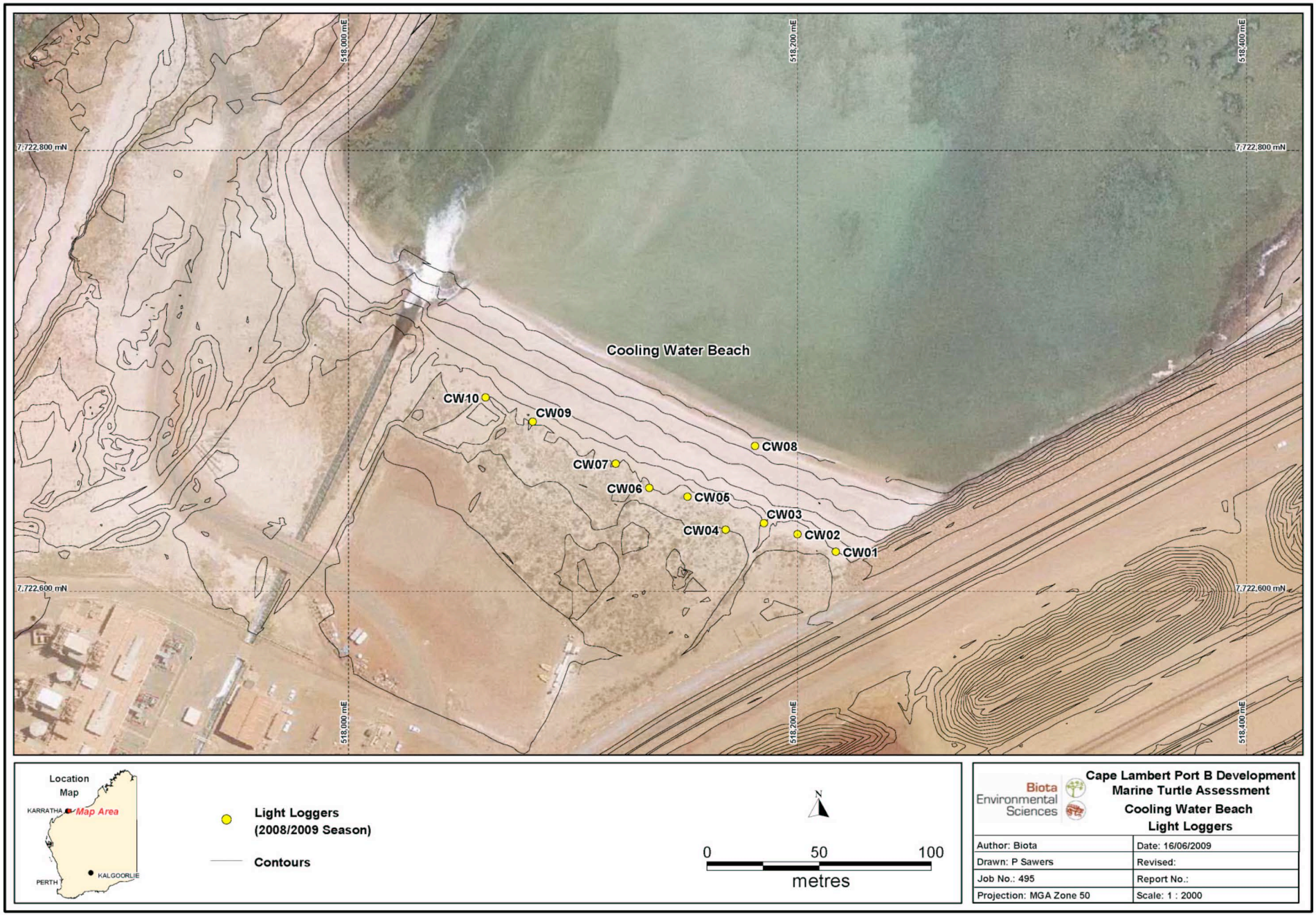

Figure 3.8 Light level monitoring locations on Cooling Water Beach.

4.0 Discussion

4.1 Tagging Data

Tagging provided the opportunity to quantify the number of female turtles emerging on Bells and other beaches over two two-week periods near the start and end of the nesting season respectively (see James (2004) for a summary of the merits of tagging). Whilst the Bells data are likely to be very accurate with respect to the total number of turtles utilising the beach during these periods, the data from both Legendre and Delambre will be underestimates due to tagging saturation and the fact that islands were not visited on several nights across both surveys.

During the November / December 2008 period, 29 different Flatbacks emerged on Bells Beach and three on Cooling Water Beach, with no other turtle species recorded. These data compare to 158 and 171 different Flatbacks recorded on Delambre and Legendre Island respectively. In addition, three other marine turtle species (Green Turtles, Hawksbill Turtles and Loggerhead Turtles) were recorded from the island beaches.

During the January 2009 survey, 19 different Flatbacks emerged on Bells Beach and just a single animal was recorded on Cooling Water Beach. Of those that emerged on Bells Beach, eight were re-sightings from the November/December 2008 survey. On Delambre Island, 206 different Flatbacks emerged to nest over a ten-night period compared to 163 on Legendre Island. These tallies included 20 re-sightings from the November/December 2008 trip on Delambre and 31 re-sightings on Legendre Island. A seven-night tagging effort on Dixon Island yielded 18 individuals; one shy of the total recorded from Bells Beach.

In summary, of the 709 Flatbacks tagged across all beaches just two (0.3%) were recorded from Cooling Water Beach and 40 (5.6%) from Bells Beach. The majority 341 (48%) were recorded from Delambre Island, whilst 303 (43%) were recorded from Legendre. These two island rookeries therefore accounted for 91% of the Flatbacks tagged in this study. Whereas very few turtles were missed on Bells Beach, many more were missed on the section of beach monitored on Delambre Island. In addition, turtle tracks were noted during the January 2009 survey on all sandy sections of Delambre Island during daily helicopter flights. It is the author's opinion that the number of Flatbacks utilising Delambre Island could conservatively be two or three times that recorded by the current surveys.

The beach on Legendre Island is clearly a mixed species rookery, though mostly utilised by Flatbacks late in the turtle nesting season. Given that 90 Hawksbills were recorded during late November / early December 2008, it is likely that the beach is also an important Hawksbill rookery but visits would be required earlier in the turtle nesting season to confirm this. Delambre Island is predominantly a Flatback rookery, though it is occasionally visited by both Greens and Hawksbills. Again, the extent to which Hawksbills use the island is undoubtedly an underestimate as the two visits were conducted late in the nesting season for this species.

This current season's (2008/09) data suggest that a smaller population of nesting turtles is utilising Bells Beach than was recorded during the 2007 / 08 season. Last season, 73 different females were recorded over 13 nights during the mid December survey (Biota 2008a). This contrasts to the 40 individuals tagged across both phases (26 nights) of the current program. Fluctuation in the nesting population size is a common feature of sea turtles and has been well documented for Flatbacks (Limpus et al. undated). More accurate estimates of the Bells Beach nesting population will be possible as additional seasons' tagging data are accumulated and re-migrants are recorded.

4.2 Comparisons with Track Count and Regional Data

As the data provided in Salinovich (2009) are summarised to monthly and season totals, a direct comparison with individual evenings or the two-week tagging periods of this programme cannot readily be carried out. However, some broad comparisons can still be made.

During 2007/2008 season, a total of 79 Flatback Turtles emergences was recorded at Bells Beach over the two two-week monitoring periods (Biota 2008a). Only half this number (40 individuals; Section 3.1.1) were recorded during a similarly timed period of equivalent duration during the current 2008/2009 season study.

Consistent with this, the data from the tagging work completed by the WPCTP also show a marked decline in numbers from 2008/09 season compared to the previous year, particularly at Cooling Water Beach (see Table 4.1 and Table 4.2). Just four individual turtles were tagged at Cooling Water Beach during the two two-week periods of monitoring completed for the work documented in this report (Section 3.1.2), which is proportional with the total number of emergences recorded over the approximately 20 week season by the WPCTP track counts (Table 4.2; Salinovich 2009). The track count data from Bells Beach also show a decline from 2007/2008 to 2008/2008 (Table 4.1).

Table 4.1: Previous years WPCTP track count data on Flatback Turtle Nesting activity on Bells Beach compared to 2008-2009 (shown in bold) (data sourced from Salinovich 2007-2009).

Season	Nests	False Crawls	Total Emergences
2005/2006	185	204	389
2006/2007	149	67	216
2007/2008	245	144	389
2008/2009	**216**	**64**	**280**

Table 4.2: Previous years WPCTP track count data on Flatback Turtle Nesting activity on Cooling Water Beach compared to 2008-2009 (shown in bold) (data sourced from Salinovich 2007-2009).

Season	Nests	False Crawls	Total Emergences
2005/2006	17	21	38
2006/2007	43	60	103
2007/2008	36	28	64
2008/2009	**14**	**4**	**20**

Consistent with these trends, numbers were also reduced compared to the previous season at the only regional site where full concurrent comparison data were available at the time of preparing this report (Barrow Island; Section 3.4.1). A total of 1,617 Flatback emergences were recorded at Barrow Island during the 2007/2008 monitoring period (Biota 2008a), compared to a lower total of 1,087 over a similarly timed and equivalent duration monitoring period during the 2008/2009 season (Section 3.4.1).

4.3 Beach Temperature Profiles

The data collected from the temperature loggers suggest that the target mainland beaches are consistently 2 – 3°C warmer at a depth of 50cm than the target island beaches throughout the season. On the 1st of December all loggers from mainland beaches yielded temperatures in excess of 29.5°C: the quoted pivotal temperature for sex determination in Flatbacks (James 2004). In contrast, all loggers from island beaches yielded temperatures 1°C to 2°C below this pivotal temperature at the beginning of the season. However by January 7th all loggers at both island and mainland beaches had exceeded 29.5°C by at least 1°C.

These data are preliminary, but if these trends are maintained over multiple seasons then it would suggest that the mainland sites are female biased rookeries. The bias, if any, of the island sites is impossible to establish from these data alone.

4.4 Potential Refinements

The current tagging program was developed with two primary objectives:

1. Accurately establish the number of individuals emerging on Bells and Cooling Water Beaches during peak periods of the nesting season, and compare these to numbers emerging on key reference beaches.
2. To identify any movement of individual turtles between beaches.

Given these primary objectives, all turtles were identified with a single tag, typically located in the left front flipper. Flatbacks tend to shed tags more readily than other turtle species and missing tags are not uncommon even after a single season. If a key future objective of the study is to examine long term trends in population size (such as may be required for Bells and Cooling Water Beaches) then the tagging and marking methodology will need to reflect this objective. For example, it may be appropriate to apply two tags to all Flatbacks and / or consider the use of transponders.

Given that monitoring teams are missing turtles on both of the primary island beaches, it may be useful to focus efforts on a single reference island in an attempt to more accurately quantify levels of use. Delambre Island is perhaps the best candidate for this approach, given the high number of Flatbacks (the focal species of the program) potentially utilising this island. The island could be divided amongst four teams of two or alternatively each of the four teams could be given a 1 km stretch of beach to monitor.

As many of the temperature loggers were difficult to relocate and apparently dislodged by nesting turtles, it would be worth revisiting the method to secure and relocate these before continuing this work. Given the time, effort and resources required to implement the base monitoring components of this program, it will be necessary to have at least one additional team member dedicated to monitoring hatchling movement patterns and testing monitoring devices should this be pursued in the 2009/10 season.

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5.0 References

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Appendix 1

Scope of Work

Biota Environmental Sciences

Biota (n): The living creatures of an area; the flora and fauna together

27 October 2008

Mr Peter Royce
Principal Adviser Environmental Approvals
Approvals and Risk Management Division
Rio Tinto Iron Ore
Central Park, 152 - 158 St Georges Terrace
Perth WA 6000

Dear Peter

Proposed Scope for Cape Lambert Port B Marine Turtle Monitoring 2008-09 Season

Further to our recent discussions, please find following a proposed scope of work, methodology and budget for the planned Cape Lambert Port B marine turtle monitoring surveys for the 2008-09 nesting season.

1.0 Background and Context

The proposed Cape Lambert Port B Development is in the process of being formally assessed by the Environmental Protection Authority (EPA) at the level of Public Environmental Review (PER). The proposal is also being assessed by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) which is charged with focussing on Matters of National Environmental Significance, especially Scheduled flora and fauna species (including marine turtles).

One of the key factors for this assessment is the presence of turtle nesting beaches in the vicinity of the planned development areas for the Port B proposal. Bells Beach, immediately adjacent to the planned Port B site, is the larger of the two rookeries, with approximately 100 turtles nesting per season. Cooling Water Beach is less significant at only 10-15 animals per season, and is also subject to pre-existing disturbance from the current port facilities.

A Marine Turtle Management Plan (MTMP) was prepared by Biota (2008a) as a technical supporting document for the Port B Development PER. A parallel plan had earlier been prepared for the Cape Lambert CLU80 upgrade, and was appended to the Biota (2008a) plan. In addition to management procedures, the Port B MTMP sets out the framework for monitoring of potential impacts on marine turtles at Bells and Cooling Water beaches. The monitoring approach was targeted to the potential impacts identified as relevant in the earlier marine turtle assessment completed for the proposal (Biota 2008b). This latter study also yielded the first substantive data identifying the relatively low level of turtle nesting activity at the key mainland beaches compared to nearby islands in the Dampier Archipelago (Biota 2008b).

2.0 Requirement for the Work

2.1 Purpose

Given the current status of the Port B proposal, the planned work meets two key purposes of benefit to Rio Tinto Iron Ore (RTIO):

1. As the PER has yet to be considered by the EPA, the development of Port B is still some way from conditional approval. The results from the planned 2008-09 monitoring surveys are anticipated to strengthen the initial findings of the original assessment of Biota (2008b): that is, that there is a relatively low level of use of Bells and Cooling Water beaches compared to other local rookeries in the Archipelago. We have already seen preliminary comments from elements of the Department of Environment and Conservation (DEC) that suggest this could prove to be very important data affecting EPA's final consideration of the proposal. In addition, it is expected that the DEWHA comments on the draft PER will focus on the significance of the turtle population and the potential impacts of the development on the turtle population. We therefore believe that it is strongly in RTIO's interests to progress with this work while the opportunity is available to capture the 2008-09 nesting season prior to the completion of the EPA assessment.
2. From the statutory, regulatory and approvals context, it is clear that an ongoing turtle monitoring programme will be required for the Cape Lambert Port B Development. The existing Cape Lambert Operation will be an important component, due to its cumulative impact effect, in combination with Port B. A common challenge for ecological monitoring programmes is the collection of quantitative baseline data prior to the commencement of perceived impacts. This is particularly the case when the monitored systems are seasonal in nature (as is the case with nesting turtles here). The 2008-09 work will enable RTIO to commence quantitative monitoring of turtle nesting activity ahead of construction commencing at Port B. These baseline data will be important in placing any perceived future changes into the proper context, and providing a defensible position when dealing with regulators. The opportunity will also be taken to field trial some of the adjunct monitoring techniques identified in the Port B MTMP ahead of impact monitoring. This will include the use of illuminance meters, capture and analysis of digital viewshed photographs to measure sky glow, and field trials of devices to monitoring hatchling dispersal patterns in near-shore waters. This will be informative to RTIO going forward in regards to the usefulness and practicality of these aspects of the programme.

2.1 Other Benefits

In addition to achieving the objectives outlined above, the work will also:

- demonstrate to EPA and other regulators that RTIO is adopting a best-practice approach to the issue of marine turtles for the Port B Development and associated with this, it is better to formulate and drive the monitoring program rather than have a more demanding and un-manageable program imposed through the condition setting process ;
- enable RTIO to respond to opinion-based comments or unfounded criticism that may arise from regulators or other stakeholders in the PER process and during the Operational phase from a position of strength based on quantitative data; and
- collect data that will allow for integration with other regional turtle programmes being conducted in the region by industry and government which is expected to have the additional benefit of setting the Cape Lambert turtle data into better regional context.

3.0 Survey Design

The overall approach and design of the field work is consistent with the Port B Development MTMP. Some monitoring components of the TMMP, particularly those associated with measuring construction phase impacts, will not be included in the 2008-09 field work. The monitoring aspects that are not due yet and have been excluded this year consist of:

- Bells Beach dune stability monitoring; and
- vibration and sand temperature monitoring at Cooling Water Beach.

These items are either not dependent on the presence of turtles to collect data, or are associated with construction activities that have not yet commenced. A summary of the planned approach to the monitoring that will be conducted this year follows.

3.1 Monitoring Sites

The primary focus for the monitoring programme will be the two beaches that may be impacted by the Port B Development: Bells Beach and Cooling Water Beach. Contextual monitoring data on selected aspects of turtle nesting activity will also be collected at key reference sites in the immediate locality, at Delambre, Legendre and Dixon Islands. The locations of the monitoring site are shown in Figure 1, with the extent of monitoring beaches detailed in Table 1.

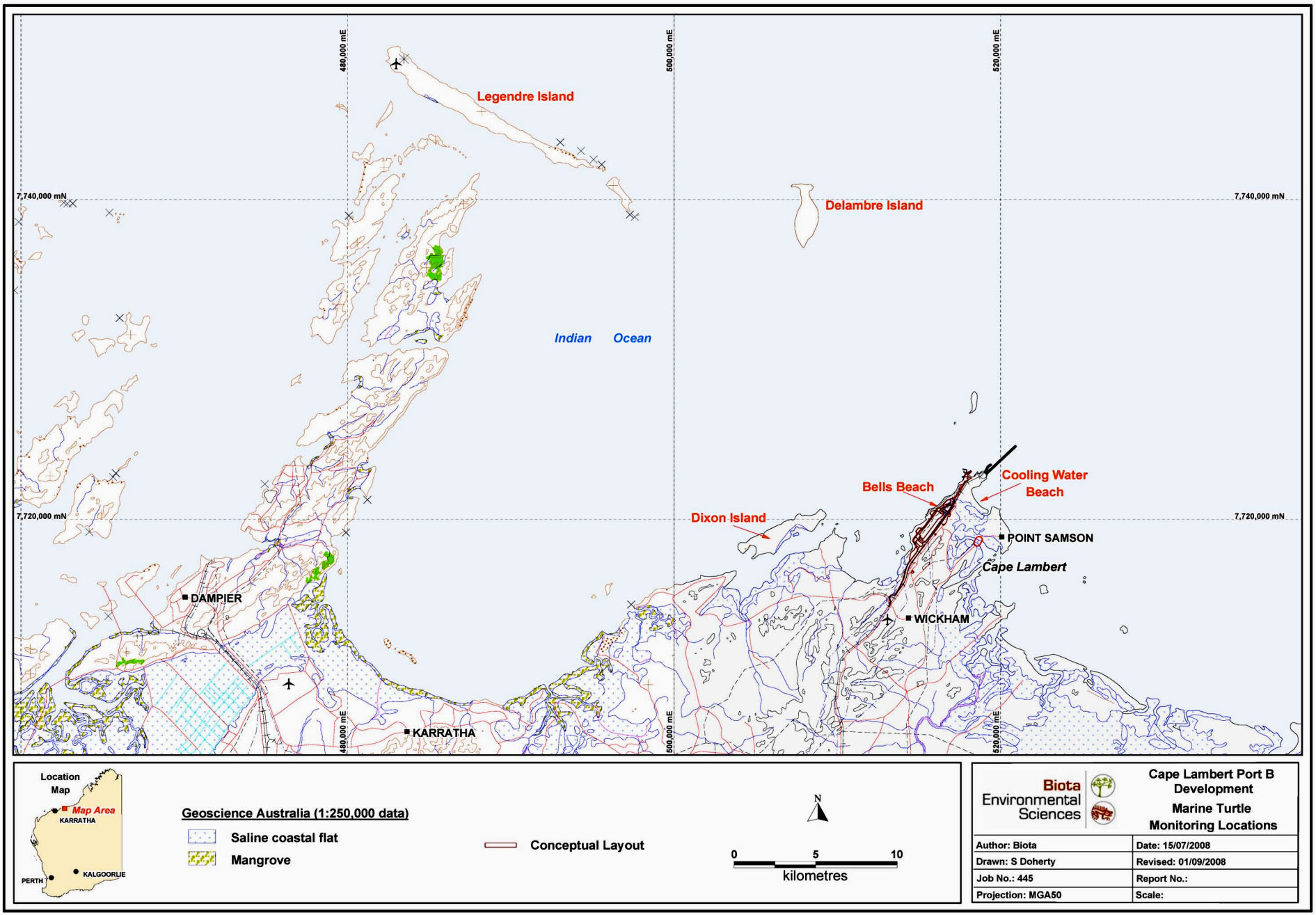

Figure 1: **Location of monitoring sites for 2008-09 surveys (labelled in red).**

Table 1: Extent of beaches planned for monitoring in 2008-09.

Monitoring Site	Status	Length of Beach
Bells Beach	Impact	550 m
Cooling Water Beach	Impact	200 m
Dixon Island	Reference	600 m
Delambre Island	Reference	2.5 km
Legendre Island	Reference	2.3 km

3.2 Timing of Monitoring Programme

We have reviewed the tide charts for November 2008 – January 2009, with the objective of picking two two-week periods when high tide timing in the evening will maximise turtle nesting activity (and thereby data collection for the programme). Based on this rationale, the work will be conducted in two phases:

- Phase I: 24th November – 8th December 2008; and
- Phase II: 7th – 20th January 2009.

Previous turtle population modelling studies have indicated that approximately 60% of the individuals in a season are detected by monitoring for peak activity two-week periods (M. Guinea, pers. comm.). It is therefore likely that the programme as planned will provide an accurate and representative measure of actual turtle nesting on the beaches in question.

3.3 Turtle Nesting Activity Monitoring

One of the key parameters for the monitoring programme will be the long-term quantification of turtle nesting activity at Bells Beach and Cooling Water Beach, relative to the monitored reference sites in the locality. This would build on historical data collected by the WPCTP and Biota (2008). Basic parameters to be recorded at Bells Beach and Cooling Water Beach would include:

- number of successful nests;
- spatial location of successful nest sites (recorded using a GPS);
- number of emergences (past high tide mark); and
- number of false crawls.

These exercises would involve a nightly presence of data collection teams on the monitored beaches, rather than basing monitoring on next-day track counts alone. This would also serve to maximise the value of the monitoring exercise, by allowing for data to be collected on:

- confirmed nest site locations (rather than being inferred from track counts and body hole inspections);
- field observations regarding weather conditions and lunar cycle; and
- nesting females to be tagged with uniquely coded titanium tags to begin building a data set that would allow for proportion of first-time nesting females and re-nesters to be identified.

Given the long life span and generational time of marine turtles (and the long-term presence of the Port B facility), there is value in collecting data on population trends at the management beaches. The most effective method of achieving this is via tagging of nesting females. The primary benefit of tagging as opposed to track counts or other indirect monitoring techniques, is that it allows for individual turtles to be identified and tracked over time. The approach of tagging turtles:

- enables individuals to be re-identified within different time scales, including animals that may be re-emergent within a season, and to identify the same individuals from year to year: this provides for a more accurate measure of actual number of nesting individuals and how frequently they return to the beach in question. The actual number of nesting turtles at Bells Beach is the primary parameter that RTIO will need to measure with the construction and operation of Port B;
- will allow for any use of other local or regional nesting sites by females previously tagged at Bells Beach or Cooling Water Beach to be identified;

- will yield other population information which may prove important, including long-term use and nest site fidelity of females from previous seasons; and
- is consistent with both the long-term DEC dataset from the Pilbara coast and other industry data being collected on off-shore islands (e.g. Barrow Island). This will facilitate the inclusion of the Cape Lambert data in any regional analysis that may be able to be agreed with DEC and other parties (see Section 4.0). This then enables the Cape Lambert rookeries to be placed into the correct context: that of the local breeding population in the Dampier Archipelago and the wider Pilbara coast and offshore islands

Track counts, while still a useful method to measure overall nesting activity, does not yield these types of data, and is perhaps best suited to community monitoring programmes. Given the presence of field data collection teams at the monitored beaches during the planned monitoring work, these potentially valuable data can be obtained for relatively little minimal additional effort involved in tagging.

The procedure for tagging Bells and Cooling Water Beach will be as follows:

1. Only custom-made titanium tags, designed specifically for turtle marking will be used. These have been uniquely coded to enable individual turtles to be identified, and also include contact information should the turtle be recorded as part of another regional programme.
2. To avoid any observer effect on nest success, tagging will be not be commenced until individuals have finished egg-laying. Turtles are typically engaged in stereotyped behaviour of re-filling the egg chamber (initially using the rear flippers) and tags can be applied at this stage without affecting nesting. Turtles can also be tagged during their return to the water, and can be halted by one team member covering their eyes.
3. The second team member then secures the front right flipper for tagging. Tags are self-piercing and are applied with a special applicator. The tag is inserted in the trailing edge of the front flipper, ensuring that the mechanism locks securely on application. The turtle is then released to return to the water.

In order to place the data from the potential impact beaches into context, data on number of nests, emergences and false crawls will also be collected during the same monitoring periods at Delambre, Dixon and Legendre Islands for the first three years of the monitoring programme. Individual turtles will also be tagged at these other nearby rookeries, to allow for their identification in the event they subsequently utilise Bells Beach or Cooling Water Beach. Data will also be sought from other monitoring programmes currently being undertaken in the region (e.g. at Barrow Island and Mundabullangana Beach), with further context provided by data from other regional rookeries previously documented by DEC (e.g. Rosemary Island). This will be further supplemented by integration with the continued West Pilbara Community Turtle Program (WPCTP) track count monitoring of the Cape Lambert beaches. We have been in liaison with Peter Salinovich (Coordinator of the WPCTP) and Jason Rosendell (Pilbara Iron Ecosystems Monitoring Advisor) regarding this. The dataset collected by the WPCTP is compatible with the work proposed in this scope and the two programmes can be jointly implemented. We will continue to liaise with Peter Salinovich and Jason Rosendell in this respect.

3.4 Incident Light Monitoring

Field measurement of incident light levels will be conducted at both Bells Beach and Cooling Water Beach during the monitoring work. Illuminance data will be collected using a TopCon IM5 Lux Meter at each confirmed nest location. This will allow dataset to be assembled of current light levels at nest locations at these key beaches under the range of lunar cycle and under cloud-cover conditions that occur during the survey. Equivalent data on existing lighting levels will also be collected at regional monitoring sites for comparative purposes (Delambre, Dixon and Legendre Island). This will assist in addressing a concern voiced by DEC officers regarding light levels as a key potential impact.

3.5 Skyglow Monitoring

We will trial the use of digital analysis of sky glow photographs taken from fixed viewsheds on both the potential impact and reference monitoring beaches. The objective of this would be to utilise image analysis software in an attempt to quantify overall brightness and sky glow

under standardised exposures. Suitable sites will be selected in the field at each monitoring beach and spatially located using a GPS. Images of the horizon and adjoining sky will be captured using a digital SLR set to pre-defined aperture and shutter speed (to ensure consistent exposure), mounted on a tripod, under a range of lunar and cloud cover conditions.

3.6 Beach Temperature Measurement

Turtle hatchling sex is determined by environmental temperature cues, and it has been suggested by DEC that this is one factor they believe makes Bells Beach significant compared to island sites. To address this, we will install field data loggers at typical nest depth in a representative range of locations each both the mainland and island reference sites. Ten locations will be selected, with ibutton loggers buried at a depth of 40 cm (typical flatback nest depth) at each site (50 loggers in total). This will provide a preliminary dataset to begin establishing if there is any significant temperature difference between mainland and island beaches (currently stated by DEC, but no data exist to demonstrate this in Western Australia).

3.7 Hatchling Activity

Hatchling behavioural patterns on emergence from the nest and animal orientation will be measured by direct observation and mapping of a representative sample of hatchling tracks from emergent nests. This will enable the compilation of frequency data on the dispersal patterns of hatchlings at each monitored nest site under current conditions. We will also begin trialling the use of acoustic transmitters fitted to hatchlings prior to release into the water under a range of lunar conditions. It will be important to ensure that field trials are conducted to ensure the devices do not alter hatchling swimming success under current conditions, prior to monitoring once the Port B facility is operational.

4.0 Data Management and Reporting

Customised data sheets will be used to consistently capture all field data collected during the programme. These will be entered into spreadsheets on return to Perth and digitally supplied to RTIO.

As this programme has dual purposes (Section 2.0), a brief report will be produced based on the 2008-09 work for supply to RTIO. This will address:

- methodology employed and any refinements arising from the 2008-09 field work;
- summary descriptive statistics documenting the relative levels of turtle nesting activity at Bells Beach and Cooling Water Beach compared to the reference sites in the Archipelago;
- summary of number of individuals tagged on the various monitored beaches;
- GIS mapping of all nesting locations at all monitored beaches;
- comparative review of WPCTP track count monitoring data from the field survey periods and the balance of the season;
- field illuminance data and GIS mapping of relative light levels at nest sites;
- relevant observation data on adult and hatchling behaviour; and
- raw data appendices.

Our longer term view of data analysis is that there would be considerable value (and benefit to RTIO) in the completion of an integrated, regional analysis of turtle monitoring data from Cape Lambert and other sites in the region. This could include both other industry data from Barrow Island and Mundabullangana Beach, as well as long-term DEC datasets from Rosemary Island and other important turtle rookeries in the region. This is only likely to be achievable after considerable liaison with DEC and other industry groups. Biota understands that RTIO has commenced liaising with other industry parties on monitoring and data exchange, as has been requested by regulatory authorities We would suggest that a population ecologist experienced in analysing marine turtle data undertake the actual analysis. As this is likely to be a longer timeframe project (i.e. not required until at least 3 or 4 years of data has been collected from this current program), we have made no allowance for this in the current scope. At this stage, it is important that the methodology followed for the 2008-09 work is consistent with that being used for other regional programmes. We have ensured that this is the case.

5.0 Logistics and Safety

We have invested considerable time in planning and evaluating logistics for this work on RTIO's behalf. The most time and budget efficient approach to the work comprises:

- the charter of a 10-passenger in-survey vessel out of Dampier to service the offshore island sites (Dixon, Delambre and Legendre Islands); and
- vehicle and walking access to Bells Beach and Cooling Water Beach.

As the work will take place at night, the typical daily routine will comprise:

- Those working on offshore islands will depart Dampier in the late afternoon to be ferried to each island site by the charter vessel. These teams will overnight on each island and be collected by the charter vessel the next morning for return to Dampier. Monitoring work will occur for four hours either side of the high tide each evening, consistent with peak nesting activity.
- The team working at Bells Beach and Cooling Water Beach will drive to site in the late afternoon and spend the evening working the two beaches. Monitoring would again occur four hours either side of high tide consistent with peak turtle activity each evening. This team would be then return to accommodation at varying times of the morning.

We are in the process of assembling a detailed schedule for this work, mapping out the individuals in each team, timing and activities. Once details of all volunteer participation (to be provided by RTIO) are available, this will be finalised and supplied to you. Volunteers participating in the work will be provided with initial training and guidance from our staff on the commencement of their field work. We have also developed a checklist of requirements to inform all personnel of items to bring with them for this programme.

A comprehensive Job Hazard Analysis will also be completed for the work prior to commencement of the field survey. We expect this to be finalised approximately two weeks before the work commences. We will ensure that all personnel working on the project have participated in, and familiarised themselves with, the JHA and Biota's field safety requirements. As you are aware, our safety systems recently passed external audit by RTIO safety personnel.

6.0 Resourcing

Our planned team to complete this work comprises six zoologists that all have experience in marine turtle monitoring work. Many have previously worked on DEC or other monitoring and tagging programmes. The field programme will be coordinated and led by Roy Teale, who has worked on turtle monitoring surveys since 1989, including at Cape Range, the Muiron Islands, Mundabullangana Beach, Varanus Island and all the study sites in the current programme.

We will ensure that one or more of our zoologists works at each monitoring site to ensure volunteers are provided with appropriate guidance, methods are implemented correctly and that all data are properly captured. As you are aware, we will be involving volunteers from RTIO and members of the WPCTP as part of the field team. Our intention is to gear the number of people in each team to match the likely level of turtle activity and size of monitoring area as outlined in Table 2. No site will have less than two people working at any given time.

Table 2: Extent of beaches planned for monitoring in 2008-09.

Monitoring Site	Length of Beach	Likely Turtle Activity	Field Personnel
Bells Beach	550 m	Low	2 (1 zoologist, 1 volunteer) *
Cooling Water Beach	200 m	Moderate	2 (1 zoologist, 1 volunteer) *
Dixon Island	600 m	Moderate	2 (1 zoologist, 1 volunteer)
Delambre Island	2.5 km	High	3 (2 zoologists, 1 volunteer) **
Legendre Island	2.3 km	High	3 (2 zoologists, 1 volunteer) **

* Our intention is to have the same team monitoring Bells and Cooling Water Beach. We have discussed the site access issues with Jason Rosendell and this appears workable.

** Subject to the final number of volunteers, one of the zoologists planned for either Legendre Island or Delambre Island may need to be deployed to another site.

In addition to the above systematic monitoring, track counts will also be conducted at Cleaverville Beach each day. This will assist in confirming whether Cleaverville should be included in the overall programme. This latter component of the work may provide another aspect where the WPCTP can usefully integrate with the proposed work and we will discuss this further with the WPCTP coordinator.

As the field work is scheduled to commence in four weeks time from the date of this letter, we would appreciate your earliest confirmation of your acceptance of the above.

Please contact me, or Roy Teale, should you wish to discuss any aspect of this scope.

Yours sincerely,

Biota Environmental Sciences Pty Ltd

Garth Humphreys
Ecologist / Director

Appendix 2

Project Marine Turtle Tagging Methodology and Procedures

Biota Environmental Sciences

Marine Turtle Monitoring and Tagging Procedures

Prepared for Pilbara Iron Pty Ltd

November 2008

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Marine Turtle Monitoring Procedures

Contents

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1.0 Background and Overview

1.1 Purpose

The purpose of this document is to provide guidance for the Cape Lambert marine turtle monitoring program as outlined in the Marine Turtle Management Plan (MTMP) (Biota 2008). This is a live document and will be updated as new techniques are included through the course of the implementation of the MTMP.

This document anticipates that the reader will have a good understanding of the primary issues of concern in respect of working with marine turtles. If the reader is new to marine turtle work then they must also read the appended information provided by the WA Marine Turtle Program in Appendix 1.

The primary focus for the monitoring component of the MTMP will be the two beaches that may be impacted by the Port B Development: Bells Beach and Cooling Water Beach. Contextual monitoring data on selected aspects of turtle nesting activity will also be collected at key reference sites in the immediate locality: at Delambre, Legendre and Dixon Islands. A fourth site, Cleaverville Beach, will also be monitored via morning track counts to ascertain the usefulness of this beach for future monitoring. Morning track counts will also be conducted at a fourth site, Cleaverville Beach, to broadly quantify the number of nightly emergences.

1.2 Beach Activity

It is essential in all instances when working with marine turtles that the use of lights is kept to a minimum.

When on the beach waiting for turtles to emerge, all lights should be off. Where possible (eg. on moonlit nights), beach traverses should be undertaken without torches or with a shielded torch. Make sure to walk the beach in the daylight and make yourself aware of exposed rocky areas or any other features that may present a hazard.

On long beaches or beaches that receive a large number of turtles, it is often useful to mark the entire length of the beach by dragging a stick or your foot continuously through the sand above the high tide mark. This will enable you to establish whether new turtles have appeared on the beach that night. This technique is especially useful when working a rising tide and into spring tides. New tracks are much easier to identify on a falling tide, as they are distinctive in the wet sand below the previous high tide mark. All new tracks can likewise be marked once the animal has been tagged.

On Bells and Cooling Water Beach, it will be important to minimise disturbance to new tracks such that track count activities can be undertaken by volunteers on the following morning. It will still useful to mark the entire length of the beach by dragging a stick or your foot continuously through the sand above the high tide mark when you first arrive. But rather than cross off each track after the turtle has left the beach it is preferred that you walk up the centre of the track only, then place a long continuous line up the length of the track to indicate that the turtle has been tagged or identified.

1.2.1 Bells Beach and Cooling Water Beach

Given the relatively few turtles that will emerge to nest on these beaches at any given time, all turtles should be allowed to proceed up the beach slope and commence nesting activity. Tagging should only be attempted once turtles have completed laying and are covering over, or when they are returning to the water. Be mindful of any other turtles in the proximity and try and conduct tagging activities to minimise impacting on these other individuals.

The length of Bells Beach should be checked at least every 20 minutes. When working Bells Beach during quiet times, it is often best to position yourself midway along the beach and then team members walk in opposing directions. Walk to the end of the beach, wait 20 minutes, and then return to meet in the middle before repeating the activity again in another 20 minutes. Be sure to carry a two-way radio to enable communication with your team-mate. When the beach is busy, your movements will be determined by turtle activity.

1.2.2 Legendre and Delambre Islands

The nesting beaches here are quite long and can support very large numbers of turtles. The preference is still to tag turtles when they are returning to the water or once they have completed laying and are covering over. However, it may be necessary to tag turtles prior to nesting activities commencing eg when they are climbing the beach slope or just starting the body hole. Do not attempt to tag a turtle if she is excavating the egg chamber or laying eggs.

Ideally a team of 3 people or two teams of 2 people will be working the beaches on Delambre and Legendre Islands. In the event that three people are working a beach, the preference is to have a single person marking all turtles with a spray can and recording the numbers marked. The team of two people will then be responsible for tagging as many turtles as can be managed. At the end of the night, the total number of turtles can be estimated.

1.2.3 Dixon Island

A team of two people will work on Dixon Island, and given the relatively low numbers, will probably be able to tag turtles after they have completed nesting activities (ie. are covering over or returning to the water). However, these turtles can also be tagged before they have commenced nesting activities eg climbing beach slope or just started on the body hole.

1.3 Hatchling Emergences

It will be useful to record information about any hatchling emergences that occur on Bells or Cooling Water Beach. In this event, the data that should be recorded include:

- **Location of emergence**: record using a hand-held GPS (WGS84 datum);
- **Approximate number of hatchlings**: count the number of tracks to establish the number of emerged hatchlings;
- **Spread of tracks at waters edge**: at the waters edge, take a tape measure and record the width of the arc between the two outermost hatchling tracks;
- **Orientation of tracks**: make notes about any hatchling's misorientation and note direction of track (eg. directly to water; towards dunes).
- **Success rate**: excavate the nest and estimate the number of successful hatchings, moribund eggs and dead hatchlings.

1.4 Egg Counts

This is useful data to collect if you have sufficient time (ie. if there are few other turtles up on the beach and there is a low risk of one returning to the water untagged). Wait until the female has almost completed her egg chamber before approaching from behind, keeping a low profile. Be aware that if the egg chamber is unsuitable, she can quickly change behaviour back to excavating the body hole and will throw sand in your direction – make sure you are wearing clear safety glasses. When the female has finished the egg chamber, she will position both rear flippers over the hole. You can then carefully move aside a flipper and excavate some sand to as to get an unobstructed view of the egg chamber. Be careful not to allow sand to fall back into the egg chamber or startle the animal, as she can collapse the chamber if she moves suddenly.

2.0 Equipment List and Preparations

Prior to the nights activities, the following should be conducted:

1. Check the field kit to ensure all equipment is present and clean (see equipment list below).
2. Clean equipment as required. This will be particularly important after the final day of tagging to ensure that equipment does not rust.
3. Empty the kit of any sand, debris or rubbish.
4. Repair damaged tags and re-insert onto the ream for use that night.
5. Any tags damaged beyond repair must be handed back to the team leader. Any lost tags must also be reported to team leader.
6. Ensure that you have sufficient datasheets for the night, and that completed datasheets have been handed to the trip leader. No completed data sheets should be taken back out into the field.
7. Ensure you have all other essential items (see accessories list below).

Each kit should comprise

- Tagging pliers (marked with pink flagging tape).
- One set of long-nosed pliers (for extracting and straightening bent tags).
- Tags (sufficient for the nights tagging). Check that the tags are correctly aligned and in the correct sequence[1].
- Roll of electrical tape (re-secure loose tags to the strip should they become loose or dislodged).
- Two measuring tapes (one spare).
- Spare pencils.
- GPS unit.
- Clear safety glasses (2 spare). You should be carrying your own with you.
- Spare batteries for the GPS.
- Spare batteries for the light meter.
- Adhesive reflective tape. This will be used to mark hazards and key pieces of equipment.
- Aqualyte sachets.
- Spray paint

In addition, you should also be carrying:

- Head torch.
- Clipboard.
- Data sheets.
- Pencil.
- Clear safety glasses.
- Water bottle (10lt per person).
- Light meter.
- VHF Two-way radio for communicating with boat.

[1] Having the tags in the correct numerical sequence on the strip will help in validating data sheets, should transcribing errors occur.

- UHF radios for communication between team members
- Hikers First Aid kit (1 per team).
- Satphone: for those on Delambre, Dixon and Legendre Islands, and for those conducting track counts at Cleaverville Beach.
- Watertight bags for dinghy transfers.

If you are overnighting on the islands you should also consider.

- Snacks as required.
- Sleeping bag, sleeping mat, etc.
- Warm and/or windproof clothing.

3.0 Proposed Schedule

For those working on Bells Beach, below is the tide chart for the upcoming survey as well as the indicative times that you will probably spend on the beach. Timing is roughly four hours either side of the high tide.

Table 3.1: Tide chart for Cape Lambert Nov-Dec Survey (modified for daylight saving).

Monday 24th Nov 2008	Bells (CWB) Arrive	Bells (CWB) Depart
2.04m @ 3:38 AM 4.13m @ 9:44 AM 2.28m @ 1:45 PM 4.74m @ 9:47 PM	5 - 5:30pm	
Tuesday 25th Nov 2008 1.69m @ 4:27 AM 4.35m @ 10:31 AM 2.10m @ 4:34 PM 4.96m @ 10:26 PM	5 - 5:30pm	app. 2am
Wednesday 26th Nov 2008 1.40m @ 5:07 AM 4.56m @ 11:11 AM 1.95m @ 5:14 PM 5.13m @ 11:00 PM	6 - 6:30pm	app. 2:30am
Thursday 27th Nov 2008 1.17m @ 5:42 AM 4.71m @ 11:45 AM 1.83m @ 5:48 PM 5.23m @ 11:32 PM	6:30 - 7:00pm	app. 3:00am
Friday 28th Nov 2008 1.03m @ 6:15 AM 4.81m @ 12:16 PM 1.76m @ 6:20 PM 5.28m @ 12:04 AM	New Moon 7:30 - 8:00pm	app. 3:30am
Saturday 29th Nov 2008 0.96m @ 6:45 AM 4.85m @ 12:46 PM 1.73m @ 6:49 PM	8:00 - 8:30pm	app. 4:15am
Sunday 30th Nov 2008 5.28m @ 12:34 AM 0.96m @ 6:15 AM 4.85m @ 1:16 PM 1.75m @ 7:18 PM	8:30 - 9:00pm	app. 4:30am
Monday 1st Dec 2008 5.23m @ 1:04 AM 1.03m @ 7:45 AM 4.80m @ 1:45 PM 1.81m @ 7:46 PM	9:00 - 9:30pm	5:00am
Tuesday 2nd Dec 2008 5.13m @ 1:35 AM 1.16m @ 8:14 AM 4.72m @ 2:15 PM 1.93m @ 8:15 PM	9:30 - 10:00pm	Sunrise
Wednesday 3rd Dec 2008 4.98m @ 2:07 AM 1.33m @ 8:44 AM 4.62m @ 2:45 PM 2.08m @ 8:46 PM	10:00 - 10:30	Sunrise
Thursday 4th Dec 2008		Sunrise

4.78m @ 2:41 AM 1.55m @ 9:15 AM 4.49m @ 3:18 PM 2.27m @ 9:23 PM	Check Beach at 5:00pm 10:30 - 11:00pm	
Friday 5th Dec 2008 4.54m @ 3:18 AM 1.81m @ 9:49 AM 4.36m @ 3:58 PM 2.46m @ 10:09 PM	Check Beach at 5:00pm 11:00 - 11:30pm	Sunrise
Saturday 6th Dec 2008 4.26m @ 4:03 AM 2.09m @ 10:30 AM 4.23m @ 4:48 PM 2.61m @ 11:16 PM	Check Beach at 5:00pm 11:30pm - 12:00AM	Sunrise
Sunday 7th Dec 2008		Sunrise

4.0 Data Collection

This tagging protocol has been prepared as a guide to experienced taggers and provides guidance in relation to the specific objectives of the MTMP. As such, the protocol does not go into detail in respect of measurements etc, as it assumes that experienced taggers will already be aware of the requirements and pass them onto novices.

4.1 Species Preference

In this instance and in accordance with the aims of the MTMP, we are most interested in:

1. the total number of turtles emerging on the target beaches for the duration of the surveys[2]. and
2. whether turtles are moving between target beaches.

On Bells Beach and Cooling Water Beach, all turtles should be tagged.

On the islands, the target species for the tagging program is the Flatback. If there is sufficient time (and tags), then tagging can be extended to Hawksbills, and lastly Green Turtles.

4.2 What to Record

For each turtle (given comments in Section 1.2), you will be required to:

1. Obtain a GPS location;
2. Complete all sections of the DEC Marine Turtle Data Sheet;
3. Obtain measurements;
4. Take light reading (if you have a light meter);
5. Tag the turtle (see Section 4.4); and
6. Paint mark the turtle.

Note that on Bells Beach, all nesting – both failed and successful – must be recorded with the hand-held GPS, and a light reading taken using the light meter (see Section 4.6).

Before moving on the next individual, and before handing your datasheets to the team leader, please validate your datasheet to ensure all fields have been correctly completed.

4.3 Body Measurements

We will obtain the Curved Carapace Length (CCL) and Curved Carapace Width (CCW) for all tagged turtles. Though this is not essential for the purpose of the MTMP, it is useful data that takes little extra time to collect.

4.4 Tagging

4.4.1 Application of Tag

For the current proposed work, most turtles will receive just one tag.

[2] Track counts do not provide accurate numbers of individuals, and margins for error are even higher at smaller rookeries such as Bells Beach. Similarly paint marking, whilst better than track counts, is not as effective as tagging.

In the event that an individual is a re-migrant, it may receive up to two additional tags depending on the condition of the old tag ie each re-migrant must have two well positioned tags. Given that there is very little if any tagging history on the target beaches, we do not expect many re-migrants.

The new tag will be applied to the left front flipper. The tag position is critical to the long-term persistence of the tag. For Flatbacks, the tag should be inserted through the soft skin just inside the axial scale on the left front flipper (as has been suggested by Dr. Mick Guinea). For all other species, the tag will be applied *through* the axial scale on the trailing edge of the left front flipper. Make sure the tag is correctly inserted into the pliers: you should feel it "click" into place.

Once the tag has been applied, the tagger will call out the number sequence to the scribe. The scribe will then repeat the number sequence out loud so that the tagger can cross-check. The scribe will also cross-check the previous tag number from the datasheets to establish that the sequence is correct.

4.5 Paint Marking

On Legendre and Delambre Islands, there may be a requirement to paint mark those turtles which cannot be tagged (this will be done for all species). For example, if only three people are on the island, then one team member should walk the beach and mark all turtles, keeping a score. The tagging team will then tag as many as possible (focussing on Flatbacks), noting which have been sprayed and which haven't. This will enable the total emergences to be obtained for each beach on each night.

4.6 Incident Light Measurements

The aim of this work is to quantify any change in the artificial light spill associated with the Cape Lambert Port B Development and investigate whether there is a detectable change in turtle nesting activity.

Field measurements of incident light levels will be conducted at Bells Beach and Cooling Water Beach. These beaches are in close proximity to the existing Cape Lambert Port and the proposed Cape Lambert Port B Development. In addition, incident light levels will also be examined on reference beaches of Delambre and Legendre Islands.

The lighting characteristics of each beach will be recorded during each turtle monitoring assessment prior to commencement of the Cape Lambert Port B development and again after the development.

Illuminance data will be collected using a Yokogawa 510-02 Digital Illuminance Meter. The illuminance meter will be set to a response speed of 10mS, recommended for measuring continuous light sources such as fluorescent lamps and incandescent lamps. Measurements will consist of three elements:

1. Incidental light characteristics of the entire beach during a period of no moonlight (Section 4.6.1).
2. Continued light data collection in all conditions centred around high tide (Section 4.6.2).
3. Light data at each nest site on Bells Beach and CWB and as time permits on Delambre, Legendre and Dixon Islands.

4.6.1 Beach Light Characteristics with Absent Moonlight

Illuminance data will be collected during a period of no moonlight; either before the moon has risen or during a period of waned moon. At Bells Beach and CWB beach, illuminance data will be

collected at fix positions along the base of the dunes and along the Spring High Tide mark. Record the position using a GPS.

4.6.2 Continued Light Data Collection

Illuminance data will be collected each night regardless of climatic conditions and lunar cycle. At each survey beach, illuminance data will be collected at 10 locations along the beach coinciding with the Spring High Tide mark and at about 20m intervals. Data will be collected from the same 10 points on five occasions each night (four hours either side of high tide, two hours either side of high tide and on the high tide) where times occur after sunset and before sunrise. Use paint-marked rocks or pieces of coral to mark the location and use a GPS to obtain position data.

4.6.3 Incident Light Levels at the Nest

On Bells Beach and CWB, illuminance data will be collected at each nest location irrespective of nesting success. The Yokogawa 510-02 Digital Illuminance Meter should be placed at the same level as the turtle's head.

4.7 Skyglow Monitoring

We will trial the use of digital analysis of sky glow photographs taken from fixed viewsheds on both the potential impact and reference monitoring beaches. The objective of this would be to utilise image analysis software in an attempt to quantify overall brightness and sky glow under standardised exposures. Suitable sites will be selected in the field at each monitoring beach, and spatially located using a GPS. Images of the horizon and adjoining sky will be captured using a digital SLR set to pre-defined aperture and shutter speed (to ensure consistent exposure), mounted on a tripod, under a range of lunar and cloud cover conditions.

4.8 Beach Temperature Measurement

We propose to install field data loggers at typical nest depth in a representative range of locations at both the mainland and island reference sites. Ten locations will be selected, with ibutton loggers buried at a depth of 50 cm (typical Flatback nest depth) at each site (50 loggers in total). This will provide a preliminary dataset to begin establishing if there is any significant temperature difference between mainland and island beaches (as currently stated by DEC, although there is no data to demonstrate this in Western Australia).

The loggers have been set to record at 30 minute intervals and this will give 6 weeks of recording time. All loggers will be removed from the beaches at the completion of the January survey.

When installing loggers, note the number of the logger and tie the rope lead to a piece of coral or stick etc to assist with future retrieval and obtain a GPS reading. Write the locality data against the number on the logger.

5.0 Fatigue and Dehydration Management

5.1 Fatigue

It is extremely important that you manage your fatigue levels during the survey. If you are feeling fatigued, you *must* advise the team leader to discuss management options.

Those team members operating at Cape Lambert (ie. on Bells and Cooling Water Beaches) will be typically working 4 hours either side of the high tide and the following table has been prepared as a guide[3]. Following work on the beach, these team members will return to their accommodation at Cape Lambert or if during daylight then Karratha.

5.2 Dehydration

Although the majority of work will be carried out at night, dehydration is still a very real risk as the work will require extensive walking through soft beach sand in warm humid conditions. To help manage the risk of dehydration each team will be provided with sachets of Aqualyte. The benefits of Aqualyte include:

- Contains fewer calories than other fluid replacement fluids cordials and soft drinks;
- It is hypotonic so is absorbed rapidly;
- Maintains electrolyte balance;
- Prevents dehydration; and
- Offsets fatigue.

Further information on Aqualyte can be found at http://www.pointhealth.com.au/index.htm.

At least 10 litres of water will be provided per person. It is advised that 1 litre is consumed every hour, and it is anticipated that each team will work for eight hours per night. The 10 lt water bottles should be centrally located on the beach and their location noted with the GPS. Reflective tape will also be applied to the outside of the bottles so that they are easy to find. Each team member should also carry a small water bottle with them as they walk along the beach.

A spare 20 litre water jerry will be taken to the island at the commencement of the survey and left for the duration. The jerry will be clearly labelled as "emergency water for ongoing research program". Reflective tape will be placed around the jerry and it will be left at the proposed camp site along with the nights camping gear.

[3] Please use the table as a guide, it is not meant to be prescriptive. If turtles are coming onto the beach before or after these indicative times then you should adjust your schedule accordingly.

6.0 Communications and Medical Emergency

6.1 Communications

At least two forms of communication will be available to all teams. Each team working on the islands will carry a Satphone as well as a VHF hand-held two-way radio tuned to Channel 16 (Marine Rescue Channel). The hand-held can also be used to communicate with the Charter Vessel during pick-ups and drop-offs.

UHF hand-held radios will be available to each team member to allow communication on the beach. It will be the responsibility of each individual to re-charge the radio batteries as required.

Delambre Island is within mobile range and reception was available last year. It is likely that Dixon Island will have mobile coverage on the high points, given that Cleaverville Beach has coverage from the car park. Bells Beach has mobile coverage and is within range for radio contact with Cape Lambert Operations.

6.2 Medical Emergency

For emergency contact on site, the Cape Lambert EMO will be contacted by radio or telephone. Any medical emergency on the islands can be communicated to the site EMO at Dampier or Cape Lambert.

Medical emergency contacts:

- Cape Lambert EMOs
- Radio Channel 4: Verbal alert "Mayday, mayday, mayday"
- Telephone contact 08 9187 2222

Dampier EMOs

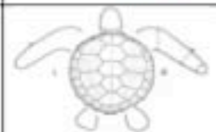
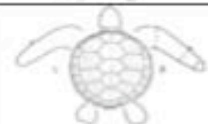
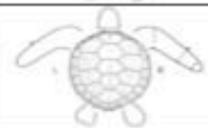
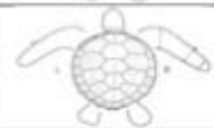
- Radio Channel 22, Verbal alert "Mayday, mayday, mayday"
- Telephone contact 08 9143 5333

The Port Walcott Volunteer Marine Rescue and West Pilbara VMR will be informed of the island teams' itinerary prior to commencing field work. The emergency VMR call out numbers and rosters are provided in Appendix 2.

Appendix 3

Data Sheets

Location:	**Beach:**	**Date:**	*Supervisor:*	**Page:** of
Team Members: *Measurer:*		*Recorder:*	*Tagger:*	

Species	Time (24hr clock)	Existing tag(s) *Note your evidence for any possible Lost tag. Enter Nil or strike through box if no tag sign evident.*		New tag(s)		Activity (Code) & Clutch Data	Nests: Position (Code)& Egg counts	Carapace: Measure-ments (mm)	Dam Please age: off mark turtle	Comments
		L	R	L	R	Clutch completed Yes ☐ No ☐ Not sure ☐	Egg count: No: Method:	*Length* *Width*		
		L	R	L	R	Clutch completed Yes ☐ No ☐ Not sure ☐	Egg count: No: Method:	*Length* *Width*		
		L	R	L	R	Clutch completed Yes ☐ No ☐ Not sure ☐	Egg count: No: Method:	*Length* *Width*		
		L	R	L	R	Clutch completed Yes ☐ No ☐ Not sure ☐	Egg count: No: Method:	*Length* *Width*		
		L	R	L	R	Clutch completed Yes ☐ No ☐ Not sure ☐	Egg count: No: Method:	*Length* *Width*		

Nest Location	Activity Codes	
A = Above H.W.	A = Resting at waters edge	F = Excavating egg chamber
B = At H.W.	B = Leaving water	G = Laying eggs
C = Below H.W.	C = Climbing beach slope	H = Covering eggs (filling in)
D = Edge spinifex	D = Moving over sand	I = Returning to water
E = In spinifex	E = Digging body hole	

Notes re Turtle *is/is not* New Tagged: If no prior tag signs detected - *Write **Nil** in Existing Tag box for side*. Where Lost tag indicators present: *Write **Lost** in Existing Tag box for side flipper(s) and note what signs you detected - eg:* information re tag scars, tissue thickening etc.

Appendix 4

Tagging Data