

DevelopmentWA
Ocean Reef Marina

Abalone Habitat and Biomass Monitoring Plan
(Public Version)

7 April 2021

56726/124304 (Rev 4)

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Summary

Proposal detail	Description	
Title of Proposal	Ocean Reef Marina	
Proponent	DevelopmentWA	
Ministerial Statement number	1107	
Purpose of monitoring plan	To address requirements of Condition 9 Social Surroundings (Abalone monitoring and management) as set out in Condition 9-1 to 9-8 of MS 1107.	
Key environmental factor/s and objective/s	<u>Key environmental factor/s:</u> <i>Social Surroundings (Abalone monitoring and management)</i> <u>Objective/s:</u> <i>To protect social surroundings from significant harm</i>	
Condition clause/s	9-1	Prior to the commencement of construction, the proponent shall prepare and submit, an Abalone Habitat and Biomass Monitoring Plan to the requirements of the CEO in consultation with the Department of Primary Industries and Regional Development and the Department of Biodiversity, Conservation and Attractions.
	9-2	The Abalone Habitat and Biomass Monitoring Plan required by condition 9-1 shall: 1. identify options for translocating abalone from within the Development Envelope to other suitable habitat, including consideration of timing, biosecurity and genetic differences between the population relocated and the population and environment at the receiving location, and monitoring program to confirm outcomes from any translocation; 2. describe the area (being an area extending not less than 1500 metres from northern boundary of the Development Envelope) within which monitoring will be undertaken to: a. demonstrate impact to abalone habitat and biomass up to 500 metres north of the northern boundary of the Development Envelope is minimized; and b. confirm no direct or indirect impacts to abalone habitat and biomass beyond 500 metres north of the northern boundary of the Development Envelope; 3. describe the method, including the development of monitoring criteria, to demonstrate that the actual indirect impacts to abalone habitat and biomass are within those set in condition 9-2(2); 4. identify and spatially define the proposed survey locations within the abalone monitoring zone described in condition 9-2(2) and reference/control sites; 5. detail the proposed frequency and timing of ongoing monitoring within the abalone monitoring zone described in condition 9-2(2); 6. detail the proposed frequency and timing of reporting of ongoing monitoring within the abalone monitoring zone described in condition 9-2(2); 7. contingency management actions that will be implemented in the event that monitoring indicates that the indirect impacts to abalone habitat or biomass are beyond those set in condition 9-2(2); 8. complement the monitoring program required by condition 6-4(3); and 9. mechanisms to provide the public with details of any exceedances of management triggers and contingency actions as soon as practicable.
	9-3	After receiving notice in writing from the CEO that the Abalone Habitat and Biomass Monitoring Plan meets the requirements of condition 9-2, the proponent shall implement the plan.
	9-4	The proponent shall continue to implement the Abalone Habitat and Biomass Monitoring Plan, or any subsequent revisions as approved by the CEO, for a period of not less than five (5) years after the completion of the construction of the outer breakwaters or until the CEO has confirmed by notice in writing that the implementation of the management plan is no longer required.

Proposal detail	Description
	9-5 The proponent shall not undertake: 1. construction of the outer breakwaters within seventy (70) metres of the existing abalone habitat during the abalone spawning period between 1 June and 31 October; 2. dredging during the abalone spawning period unless construction of the outer breakwaters are completed.
	9-6 In the event that monitoring indicates that the indirect impacts to abalone habitat or biomass are beyond those set in condition 9-2(2), the proponent shall: 1. immediately implement the contingency management actions specified in the approved Abalone Habitat and Biomass Monitoring Plan; 2. continue to implement the approved Abalone Habitat and Biomass Monitoring Plan until the CEO has confirmed by notice in writing that it has been demonstrated that the completion criteria in the Abalone Habitat and Biomass Monitoring Plan have been met and therefore the implementation of the contingency management actions are no longer required; and 3. report any impacts identified in the area specified in condition 9-2(2)(b), along with measures taken and/or proposed to be taken, and strategies to be implemented in response to the impact, to the CEO within twenty-one (21) days of the non-achievement being identified.
	9-7 The proponent: 1. may review and revise the Abalone Habitat and Biomass Monitoring Plan; or 2. shall review and revise the Abalone Habitat and Biomass Monitoring Plan as and when directed by the CEO.
	9-8 The proponent shall implement the latest version of the Abalone Habitat and Biomass Monitoring Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 9-2.
Key provisions in the plan	This plan provides for the monitoring relevant to the potential impacts to abalone, associated with the Ocean Reef Marina development, in accordance with MS 1107.

1. Introduction

1.1 Proposal Background

DevelopmentWA (the Proponent) proposes to develop a world class recreational, residential, boating and tourist development, within the City of Joondalup at Ocean Reef, Western Australia and referred to as the Ocean Reef Marina Development. The Ocean Reef Marina Development is within the Ocean Reef locality, approximately 29 km north of the Perth Central Business District.

The Ocean Reef Marina Development will involve the upgrade and expansion of the existing Ocean Reef Boat Harbour. The preferred Concept Plan for the development identifies:

- a mixed use 'working marina' including club, service commercial and marine industrial uses, boating precinct including ramps, coastal amenities and parking in the south;
- a central retail, tourist and high-density residential precinct;
- a northern low to medium density residential precinct;
- capacity for up to 550 boat pens and 200 boat stackers; and
- civic and community uses, including Public Open Space (POS).

The marine component of the development (the Proposal) was assessed by the Environmental Protection Authority (EPA) at a Public Environmental Review (PER) level under Part IV of the *Environmental Protection Act 1986*. Ministerial Statement No. 1107 (MS 1107) was issued on 7 August 2019.

During a review of the detailed design aspects of the Proposal, safety and navigational issues associated with the original entrance channel configuration were highlighted which necessitated a change to the entrance channel configuration, and subsequently resulted in an application to change the Proposal under Section 45C of the EP Act. Approval of these changes was granted on 6 January 2020.

Table 1.1 provides a summarised description of the Proposal.

Table 1.1: Proposal Summary

Proposal Title	Ocean Reef Marina
Short description	The proposal is for the redevelopment and enlargement of the existing Ocean Reef Boat Harbour, located at Ocean Reef, approximately 29 km north of the Perth central business district. The Ocean Reef Marina proposal will provide accommodation for up to 750 vessels. The Proposal includes: • construction of two new outer breakwaters • removal of existing breakwaters from the boat launching harbour • dredging of sand and rock inside the new outer breakwaters • disposal of dredge spoil into land reclamations inside the breakwaters • construction of jetties to support piled boat mooring pens • piling works for new boat mooring pens. The proposal also includes the ongoing management and maintenance of the marina water body.

Table 1.2 Shows the key characteristics of the physical and operational elements of the Proposal.

Table 1.2: Physical and Operational Proposal Elements

Element	Location	Authorised Extent
Development Envelope	Refer to Figure 1 of MS 1107	61.9 ha
Marine construction activity		
Dredging	Refer to Figure 1 of MS 1107	No more than 3.5 ha within the Indicative Dredging Area

Element	Location	Authorised Extent
Reclamation and construction of breakwaters	Refer to Figure 1 of MS 1107	No more than 28.5 ha within the Development Envelope
Removal of existing breakwaters	N/A	Within the Proposal Footprint
Physical marine infrastructure		
Proposal footprint	Refer to 'Development Envelope' in Figure 1 of MS 1107	Not more than 28.5 ha within the Development Envelope
Jetties and associated structures	Within marina	No more than 750 boat pens within the marina in the Development Envelope

1.2 Purpose and Objective

This Abalone Habitat and Biomass Monitoring Plan (AHBMP) addresses the requirements of Condition 9-1 to 9-8 of MS 1107.

Table 1.4 provides references to the relevant sections of the AHBMP which have addressed each part condition.

This AHBMP has been developed with technical inputs from BMT (BMT 2020), Department of Primary Industries and Regional Development (DPIRD 2020) and Department of Biodiversity, Conservation and Attractions (DBCA).

1.2.1 Relationship to Other Plans/Programs

This plan provides for the collection of monitoring data and information to enable the Proponent to demonstrate impacts from the Proposal are as predicted. This Plan will therefore be complemented by the following plans also required by MS 1107:

- Condition 6-3 - Marina Construction Monitoring and Management Plan (MCMMP);
- Condition 6-4 – Marine Operations Management Plan (MOMP), including specific reference that the plan complements both the Abalone Habitat and Biomass Baseline Survey (AHBBS) Plan (Condition 8-1) and the ABHMP;
- Condition 8-1 - Abalone Habitat and Biomass Baseline Survey (AHBBS) Plan (Strategen-JBS&G 2020); and
- Condition 10-2 – Offset Strategy (Benthic Communities and Habitat).

Additionally, it is anticipated that data collected by DPIRD as part of an ongoing Fishery Independent Survey (FIS) monitoring program, which advises the annual fishery Total Allowable Catch (TAC) setting process and informs the Voluntary Fisheries Adjustment Scheme (VFAS), will be utilised in the AHBMP.

1.2.1.1 Abalone Habitat and Biomass Baseline Survey

The AHBBS was approved on 7 February 2020 and is being implemented in accordance with Condition 8-3 of MS 1107. This AHBMP will utilise the baseline survey data obtained through the implementation of the AHBBS and as such, the monitoring described is aligned with the approved baseline survey program.

In addition to Condition 8-2, the AHBBS also addressed Condition 9-2(1) of MS 1107 relating to the translocation of abalone biomass from within the Development Envelope prior to commencement of construction:

identify options for translocating abalone from within the Development Envelope to other suitable habitat, including consideration of timing, biosecurity and genetic differences between the population relocated and the population and environment at the receiving location, and a monitoring program to confirm outcomes from any translocation.

The baseline survey of abalone biomass and the commencement of the translocation program occurred in Q1, 2020 to ensure collection and translocation occurred during favourable weather conditions (and prior to proposed commencement of construction in late 2020). The results of that program are to be reported separately but have informed the preparation of the AHBMP.

For completeness, details of the translocation program are included in this plan. Ongoing monitoring of the outcomes of the translocation program are also described (Section 4).

1.3 Key Environmental Factors

In its assessment of the Proposal, the EPA identified the following key environmental factor relevant to AHBMP:

- Social Surroundings – impacts to the abalone fishery (commercial and recreational) associated with direct and indirect impacts to abalone.

1.3.1 Overview of Predicted Impacts to Roe's Abalone

The Proposal will impact up to 18 ha of nearshore reef habitat (abalone habitat) that supports Roe's abalone (*Haliotis roei*). This is comprised of loss of 12.4 ha within the Development Envelope. Of the predicted loss within the Development Envelope, 5.8 ha is a direct result of the construction of the breakwaters, reclamation and dredging in the marina water body, and a further 6.6 ha is indirect impacts due to the 'halo' effect as a result of changes to sedimentation and wave energy adjacent to the breakwater. In addition, as a result of changes to reef scale hydrodynamics north of the Development Envelope (which could affect sediment deposition, wrack deposition, drift algae load and abalone larvae dispersion) the changes may result in a further indirect loss of up to 100% of abalone biomass up to 500 m north of the Development Envelope. This equates to an additional 5.6 ha area of abalone habitat. There is no predicted direct or indirect impacts to abalone habitat or biomass beyond 500 m north of the Development Envelope.

The potential impacts to Roe's abalone associated with changes in reef scale hydrodynamics, sediment deposition and nutrient concentrations are listed in Table 1.3 and are discussed in further detail within the technical note prepared by BMT (BMT 2020).

Table 1.3: Potential Indirect Impacts to Roe's Abalone

Parameter	Potential Changes to Natural Reef System
Reef scale hydrodynamics	Shift in distribution of: • Sediment deposition • Wrack deposition • Drift algae load • Abalone larvae dispersion
Sediment deposition	• Loss of cryptic microhabitats for abalone • Smothering of non-geniculate coralline algae
Nutrient concentration	• Shift in algae community structure • Increased growth of turfing algae • Seawater surface layer concentrations of algae

1.4 Condition Requirements

Conditions of MS 1107 applicable to the AHBMP and in-plan section references are outlined in Table 1.4 below.

Table 1.4: Condition Requirements and In-plan Section References

Condition No.	Condition	Section in this Plan
9-1	Prior to the commencement of construction, the proponent shall prepare and submit, an Abalone Habitat and Biomass Monitoring Plan to the requirements of the CEO in consultation with the Department of Primary Industries and Regional Development and the Department of Biodiversity, Conservation and Attractions.	Not applicable.
9-2	The Abalone Habitat and Biomass Monitoring Plan required by condition 9-1 shall: 1. identify options for translocating abalone from within the Development Envelope to other suitable habitat, including consideration of timing, biosecurity and genetic differences between the population relocated and the population and environment at the receiving location, and monitoring program to confirm outcomes from any translocation;	Section 4.
	2. describe the area (being an area extending not less than 1500 metres from northern boundary of the Development Envelope) within which monitoring will be undertaken to: a. demonstrate impact to abalone habitat and biomass up to 500 metres north of the northern boundary of the Development Envelope is minimized; and b. confirm no direct or indirect impacts to abalone habitat and biomass beyond 500 metres north of the northern boundary of the Development Envelope;	Section 2.1.
	3. describe the method, including the development of monitoring criteria, to demonstrate that the actual indirect impacts to abalone habitat and biomass are within those set in condition 9-2(2);	Section 2.2; Section 3
	4. identify and spatially define the proposed survey locations within the abalone monitoring zone described in condition 9-2(2) and reference/control sites;	Section 2.1.1; Figure 2.1
	5. detail the proposed frequency and timing of ongoing monitoring within the abalone monitoring zone described in condition 9-2(2);	Section 2.5; Table 3.1
	6. detail the proposed frequency and timing of reporting of ongoing monitoring within the abalone monitoring zone described in condition 9-2(2);	Section 7 ; Table 3.1
	7. contingency management actions that will be implemented in the event that monitoring indicates that the indirect impacts to abalone habitat or biomass are beyond those set in condition 9-2(2);	Section 3
	8. complement the monitoring program required by condition 6-4(3); and	Section 1.2.1
	9. mechanisms to provide the public with details of any exceedances of management triggers and contingency actions as soon as practicable.	Section 7.2
9-3	After receiving notice in writing from the CEO that the Abalone Habitat and Biomass Monitoring Plan meets the requirements of condition 9-2, the proponent shall implement the plan.	Section 6.
9-4	The proponent shall continue to implement the Abalone Habitat and Biomass Monitoring Plan, or any subsequent revisions as approved by the CEO, for a period of not less than five (5) years after the completion of the construction of the outer breakwaters or until the CEO has confirmed by notice in writing that the implementation of the management plan is no longer required.	Section 6.
9-5	The proponent shall not undertake: 1. construction of the outer breakwaters within seventy (70) metres of the existing abalone habitat during the abalone spawning period between 1 June and 31 October;	Will be addressed in the MCMMP
	2. dredging during the abalone spawning period unless construction of the outer breakwaters are completed.	Will be addressed in the MCMMP
9-6	In the event that monitoring indicates that the indirect impacts to abalone habitat or biomass are beyond those set in condition 9-2(2), the proponent shall: 1. immediately implement the contingency management actions specified in the approved Abalone Habitat and Biomass Monitoring Plan;	Section 3

Condition No.	Condition	Section in this Plan
	2. continue to implement the approved Abalone Habitat and Biomass Monitoring Plan until the CEO has confirmed by notice in writing that it has been demonstrated that the completion criteria in the Abalone Habitat and Biomass Monitoring Plan have been met and therefore the implementation of the contingency management actions are no longer required; and	Section 6
	3. report any impacts identified in the area specified in condition 9-2(2)(b), along with measures taken and/or proposed to be taken, and strategies to be implemented in response to the impact, to the CEO within twenty-one (21) days of the non-achievement being identified.	Section 7.2.
9-7	The proponent: 1. may review and revise the Abalone Habitat and Biomass Monitoring Plan; or	Section 8
	2. shall review and revise the Abalone Habitat and Biomass Monitoring Plan as and when directed by the CEO.	Section 8
9-8	The proponent shall implement the latest version of the Abalone Habitat and Biomass Monitoring Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 9-2.	Section 6

2. Monitoring Locations

2.1 Abalone Monitoring Zone (Condition 9-2(2))

Monitoring will occur within an Abalone Monitoring Zone which comprises an area not less than 1500 m north of the Development Envelope. The Abalone Monitoring Zone is made up of two sub-zones from the northern extent of the Development Envelope:

- Zone A: 0-500 m; and
- Zone B: 500-1500 m.

Monitoring within and up to 500 m is for the purpose of demonstrating impacts to abalone habitat and biomass is minimised. Monitoring within Zone B is to confirm no direct or indirect impacts to abalone habitat and biomass beyond 500 m from the northern boundary of the Development Envelope have occurred.

It is noted that for the purpose of demonstrating compliance with Condition 9-2(2), it has been assumed that “impact to abalone habitat” means a statistically significant change in abalone habitat parameters, attributable to the development, and resulting in a statistically significant reduction of abalone biomass (beyond natural variation values).

For the purpose of demonstrating compliance with Condition 9-2(2), it has been assumed that “impact to abalone biomass” means a statistically significant reduction¹ in abalone biomass, attributable to the development.

Should monitoring results indicate a significant change in abalone habitat parameters or biomass, contingency measures will be implemented, as detailed in Section 3.

2.1.1 Monitoring Locations (Condition 9-2(4))

A total of nine (9) monitoring locations have been selected², comprising:

- one (1) control site (outside of the local reef system);
- two (2) reference sites (outside the Abalone Monitoring Zone); and
- six (6) sites within the Abalone Monitoring Zone.

Four (4) of these sites form part of DPIRD’s long-term FIS monitoring program for the Perth Metropolitan Roe’s abalone Fishery.

An additional site, AB1 (Resolute) was also selected to quantify abalone numbers and calculate biomass within the Development Envelope (refer to Section 4). This site has been monitored by DPIRD for three out of the four years since the 2015 abalone habitat and abundance baseline survey was conducted by BMT to inform the Public Environmental Review (PER) for the Proposal, providing an existing baseline dataset that can be drawn on in estimating abalone biomass.

All monitoring sites are shown in Figure 2.1. These sites are consistent with the sites established and approved in the AHBBS (noting that sites AB1A and AB1B were subject to in-field confirmation).

¹ “statistically significant” means statistically determined significance when compared to reference and control sites, based on advice from DPIRD, marine technical experts, and published studies (where relevant).

² Note: a tenth monitoring location was identified as part of the AHBBS for the purpose of quantifying biomass within the Development Envelope to inform the translocation as required by Condition 8-2(4) of MS 1107. Given this location was located in the Development Envelope, this site does not form part of the ongoing monitoring program described in this AHBMP.

Control Site

The Mindarie site has been selected as a control site to provide a regional baseline. Mindarie is a long-term DPRID FIS monitoring site which is located at the next reef platform unit that supports abalone biomass north of Burns Beach Reef. This site is located about 7 km north of the Development Envelope. DPRID also have sites throughout the fishery and can draw on this information if required.

2.1.1.1 Reference Sites

An abalone habitat and abundance baseline survey was previously conducted by BMT in 2015 (BMT 2015) to inform the PER for the Proposal. In order to provide continuity in data, site AB4 used in the 2015 baseline monitoring program, located 2.15 km north of the Development Envelope has been selected as a reference site.

DPRID conduct annual monitoring of abalone populations at various locations in the Perth Metropolitan Roe's abalone Fishery. The existing FIS monitoring site at Burns Beach, located 1.8 km north of the Development Envelope has also been selected as a reference site.

Burns Beach and AB4 are > 1500 m from the Development Envelope, but are located at the northern end of the Burns Beach Reef complex. These sites have also been selected due to known populations of abalone and suitable habitat occurring at these locations, as well as the availability of existing comparable baseline data.

It is not expected that any potential changes in parameters would occur beyond 500 m and very unlikely to exceed 1500 m. As such these two (2) sites make good reference sites which are within the local unit but outside the 'zone of influence' from the Development Envelope. These reference sites will assist with identifying impacts to abalone and abalone habitat which are not associated with the Ocean Reef Marina. In the event that abalone and abalone habitat loss is detected at the reference sites, there may be causes beyond those associated with the development that could explain potential loss within the 1500 m monitoring zone.

2.1.1.2 Abalone Monitoring Zone Sites

Zone A (0-500 m)

Beaumaris and AB1A sites are within the 0-500 m zone (Zone A).

Beaumaris is one of the existing DPIRD FIS monitoring sites along Burns Beach Reef. This site has also been selected due to known populations of abalone and suitable habitat occurring at these locations, as well as the availability of existing comparable baseline data.

One new site, AB1A, has been identified within Zone A as close as possible to the 500 m boundary line north of the Development Envelope to assist in confirming that impacts to abalone habitat and biomass do not extend more than 500 m from the Development Envelope. The exact location of this site was determined in-field by DPIRD. This identification involved ground truthing over 300 m (parallel along the shore) of nearshore reef traversing the 500 m boundary line north of the Development Envelope by DPIRD Mollusc Section staff with substantial experience in Roe's abalone FIS in the Perth Metropolitan Fishery.

Site AB1A is approximately 50 m south of the 500 m boundary line (i.e. 450 m north of the Development Envelope) within Zone A (0-500 m). During ground truthing no surveyable quantity of Roe's abalone were found within Zone A closer to the 500 m boundary line, and therefore AB1A is as close as practicable to the 500 m boundary line.

In the event that changes attributable to the development are detected at AB1A, monitoring of other parameters will be undertaken at the 500 m boundary line to assist in determining compliance with the condition requirements (Condition 9-2(2)(b)). This monitoring will be outlined in the MCMMP and the MOMP.

Zone B (500-1000 m)

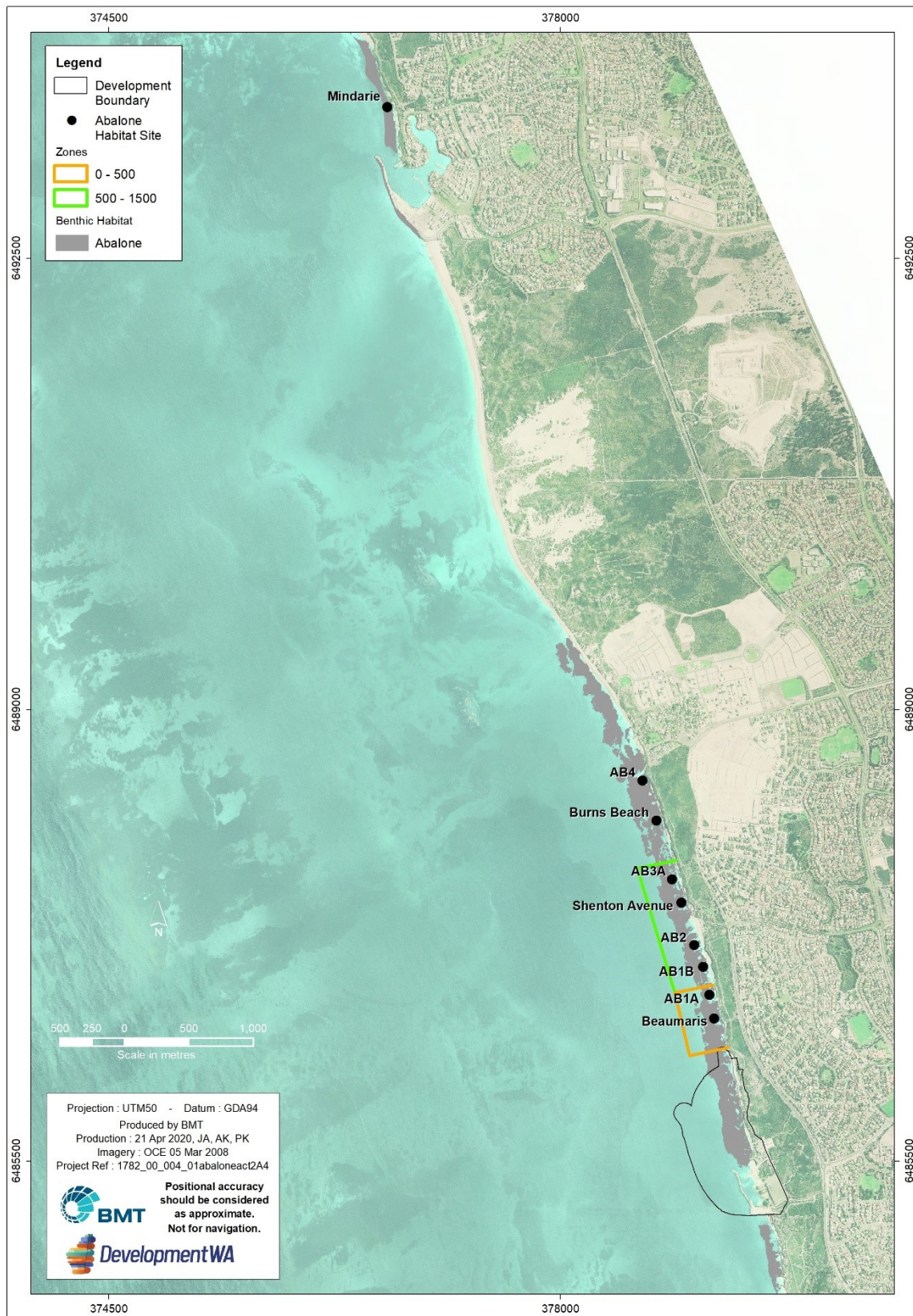
AB1B, AB2, Shenton Avenue and AB3A are located within the 500-1500 m zone (Zone B).

Sites AB2 and AB3A were included in the 2015 baseline sites and Shenton Avenue is one of the DPIRD FIS monitoring sites along Burns Beach Reef. These sites have also been selected due to known populations of abalone and suitable habitat occurring at these locations, as well as the availability of existing comparable baseline data.

One new site, AB1B, has been identified within Zone B as close as possible to the 500 m boundary line north of the Development Envelope to assist in confirming that impacts to abalone habitat and biomass do not extend more than 500 m from the Development Envelope. The exact location of this site was determined in-field by DPIRD. This identification involved ground truthing over 300 m (parallel along the shore) of nearshore reef traversing the 500 m boundary line north of the Development Envelope by DPIRD Mollusc Section staff with substantial experience in Roe's abalone FIS in the Perth Metropolitan Fishery.

Site AB1B is approximately 170 m north of the boundary line (i.e. 670 m north of the Development Envelope) within Zone B (500-1500 m). During ground truthing no surveyable quantity of Roe's abalone was found within Zone B, closer to the 500 m boundary line, and therefore AB1B is as close as practicable to the 500 m boundary line.

Figure 2.1: Monitoring Locations



2.2 Monitoring Parameters

This section outlines the parameters that will be monitored.

Condition 9-2(2) requires DevelopmentWA to:

- *demonstrate impact to abalone habitat and biomass up to 500 m north of the northern boundary of the Development Envelope is minimised; and,*
- *confirm no direct impacts to abalone habitat and biomass beyond 500 metres north of the northern boundary of the Development Envelope.*

Additionally, Condition 9-2 (8) requires that the monitoring program complements Condition 6-4(3)(b). Condition 6-4(3)(b) of MS 1107 requires DevelopmentWA to:

characterise any changes within the abalone monitoring zone as defined in condition 8-2(2)), in the cover and composition of macroalgal communities, including non-geniculate coralline algae, as well as changes in the abundance of key invertebrate grazers including abalone, limpets and chitons, having regard to any changes in hydrodynamics.

Based on the potential indirect impacts associated with the Ocean Reef Marina development and in alignment with the approved AHBBS, the following key parameters will be measured:

1. Abalone population structure (to enable biomass calculations) and numbers.
2. Benthic habitat (including non-geniculate coralline algae (NCA)).
3. Sedimentation of microsites and cryptic habitats.
4. Water quality (as part of the MCMMP and MOMP).
5. Key grazing invertebrates (abalone, limpets, chitons).

These parameters are discussed further in the following sections.

2.2.1 Abalone Population Structure and Numbers

The number and population structure of the abalone are important as this shows the different age classes of the population and therefore demonstrates the level of annual recruitment occurring and potential predation of juvenile abalone. This information is used to calculate abalone biomass.

2.2.2 Benthic Habitat Key Components

The benthic habitat of Burns Beach Reef differs between the platform and subtidal reef portions. The platform section is a shallow (<2 m deep), relatively flat and high energy section of the limestone reef with crevices, multiple channels and 'pot' marks. Three zones of algae support abalone populations on the platform:

1. Inshore portion of platform.
2. *Sargassum* zone.
3. Bare (or barren) zone.

The sub-tidal section is deeper (2–6 m) and rises abruptly to the platform section. The topography is much more tortuous than the platform reef, with caves and deep ledges. It is dominated by large canopy forming algae such as *Ecklonia* and *Sargassum*. Wave energy is reduced in this section of the reef.

The recruitment and juvenile stages of abalone are dependent on settling mechanisms (influenced by NCA), food supply (bacteria and microalgae), and stratified and limited by canopy of the macroalgal community associated with the platform reef.

NCA induce settlement of invertebrate larvae such as soft octocorals, scleractinian corals, polychaetes, limpets, chitons, asteroids, sea urchins and abalone. It has been shown that crustose coralline algae cover was positively correlated with abalone abundance.

As the abalone mature, a proportion of them may move to the subtidal reef, but it is not known how important the composition of the macroalgal community is at this stage. Canopy structure is likely a key component of the macroalgal community. *Ecklonia* movement is thought to increase NCA coverage because it shades out turf algae (which causes accumulation of sediments that smothers NCA).

Changes to macroalgae composition and cover may therefore affect abalone populations and numbers and may be an early indicator of population change for abalone.

2.2.3 Sedimentation

Availability of cryptic / microsites is essential during the early life stages of abalone when their small size makes them susceptible to predation by fish and crabs. These sites are particularly utilised on the platform reef portion as this is typically where settlement occurs and the juveniles are most susceptible. Sedimentation may smother NCA, leading to a decline in abalone numbers and a subsequent decrease in recruitment of larvae in following years. The loss of critical microsite habitat for abalone or the smothering of NCA may be early indicators of abalone population change.

2.2.4 Water Quality

Elevated nitrogen, phosphorus and resulting elevated concentrations of chlorophyll-a in the water column near abalone habitat may be an early indicator of additional inputs of nutrients above the background concentrations. These nutrients may also cause an increase in algae such as *Ulva* or turfing algae. It is likely that significant increases in either of these types of algae may alter surface conditions which would have an adverse effect on the abalone and / or NCA. Elevated chlorophyll-a concentrations may be early indicator of elevated nutrients along the reef which could alter key macroalgal components over time and thus may be an early indicator of potential abalone population change. Suspended sediments in the water column may also be an early indicator of increased sedimentation along the reef.

2.2.5 Key Grazing Invertebrates

Key grazing invertebrates on Burns Beach Reef (abalone, limpets and chitons) may control the macroalgal community composition on the platform section of the reef and to some extent canopy cover through their grazing activities. If there are large changes in grazing invertebrates this may represent a counter to increases in turfing algae or may represent a natural variation in the population that may temporarily affect the macroalgal community. The potential for key grazing invertebrates to control the macroalgal cover is most significant along the bare platform reef where there is a prominent zonation of macroalgal communities. As changes in grazing invertebrate abundance may affect key macroalgal components over time this may be an early indicator of potential abalone population change.

2.3 Survey Design and Implementation

The abalone biomass survey design is based on the methods used by DPIRD (Hancock 2004 and Hart *et. al* 2018), as summarised in the sections below. There are two key subsections of reef which support Roe's abalone: the platform section and the sub-tidal section. At each site, each of these reef sections will be monitored. To assess changes in the sedimentation of cryptic sites and cover and composition of the key components of the macroalgal community, within the abalone habitat zone, video transects will be completed by divers. To assess changes in abundance of key invertebrate grazers, counts within random quadrats along the bare platform sections will be sampled. These surveys will be completed during the summer months, preferably between January and May to coincide with DPIRD abalone biomass surveys. The abalone biomass surveys will be

completed by DPRID divers. Assessments of sedimentation, invertebrate grazers and macroalgae communities will be completed by commercial scientific divers.

2.3.1 Transect Placement and Replication

Surveys for abalone biomass, and associated macroalgal benthic habitat will be conducted on both the reef platform and sub-tidal reef at each of the sites. Surveys for sedimentation and invertebrate grazers will be conducted on the platform section of the reef only. For the abalone biomass surveys the methods are as per established DPIRD procedures (Hancock 2004; Hart *et al.* 2018). For the macroalgal benthic habitat, sedimentation and grazing invertebrates a flat circular weight will be placed at the starting point of each transect. The transect tape is attached to this weight and adjusted to start at the edge of the platform reef; however, for the sub-tidal reef the 0 m mark will be considered to be at the edge of the weight. On the platform portion of the reef a transect will be laid to the extent of abalone presence (or a maximum of 20 m) along the appropriate bearing for both transects. Five replicate video transects will be completed on both the platform and subtidal sections at each site. At the completion of each site a waypoint will be taken. All weights used to mark the starting point of each transect will be removed after the completion of each sites survey.

2.3.2 Quadrat Placement for Grazing Invertebrates

At each site 10 quadrats (0.25 x 0.25 m) will be placed randomly within the bare section of the platform reef. Quadrats will be placed at least 1 m from the platform reef edge.

2.3.3 Data Collection

Abalone data collection will be undertaken in accordance with the established DPIRD procedures (Hancock 2004, Hart *et al.* 2018). Platform and sub-tidal reef abalone habitat data will be collected and processed individually by separate divers.

Video footage will be collected along each transect and used in a point count analysis to determine benthic habitat percentage cover (including NCA) and percentage cover of sediment. Along the bare platform reef section random quadrats will also be used to determine the abundance of key invertebrate grazers (abalone, limpets and chitons).

2.3.4 Abalone Population Structure and Number

Surveys for abalone numbers and population structure will be conducted on both the reef platform and sub-tidal habitats at each of the monitor sites. Abalone population structure and numbers will be surveyed using DPIRD's transect and quadrat methods based on Hancock (2004) and as described in Hart *et al.* (2018).

Divers will record on waterproof paper the maximum length of each abalone within each quadrat of each site. Within each of the quadrats, abalone which have the tip of their swirl within the quadrat will be considered to be 'in' and will be measured for maximum length. Platform and sub-tidal habitat abalone count data will be collected and processed individually by separate divers.

Summary statistics of the relevant abalone density parameters (minimum, maximum, mean and standard deviation) will be calculated for each site and for each habitat type (platform or sub-tidal) within each site.

Collected abalone data will be separately processed for the platform and sub-tidal habitat to determine:

- total Roe's abalone count per transect;
- abalone density (m²) (converted from counts per quadrat);
- size classes and designated age classes (Hancock 2004) and legal and sublegal classifications (based on the length of each abalone); and

- total counts and percentage per age and per legal classification.

Age class distribution will be determined based on the abalone size (shell length) and the maximum length for each size class in Table 2.1.

Table 2.1: Roe's abalone age classes based on maximum length

Age (years)	Size (mm) range
<1	<17
1-2	17-32
2-3	33-50
3-4	51-60
4-5	61-70
5+	>70

The recreational legal-size limit for fishing Roe's abalone is 60 mm. Abalone <60 mm will be designated as sub-legal and abalone 60 mm or greater will be designated as legal size.

2.3.5 Benthic Habitat Key Components

Surveys for macroalgal benthic composition will be conducted on both the reef platform and sub-tidal habitats at each of the sites.

To assess cover of the key component of the benthic habitat, within the abalone habitat zone, video transects will be completed by divers or snorkelers where practicable. For each transect (platform and sub-tidal separately) the length of the monitored abalone habitat will be analysed.

Video footage will be collected at each transect and used in a point count analysis to determine benthic habitat percentage cover (including NCA) and macroalgal composition. Video transects will be analysed using a computer point count program to determine the percentage cover and composition of the macroalgal assembly within the abalone zone. Ten random points will be overlaid on the 10 random images for a total of 100 identification points per transects. Five replicate transects will be completed per section for a total of 500 identification points. The percentage cover will be determined by the scientific analyst for each habitat identification within each image.

Macroalgal and habitat classifications were determined based on benthic habitat community composition identified within the abalone zone as per Hancock (2004).

To determine whether the benthic habitat percentage cover and composition is different across each habitat type, a multivariate analysis will be run. All statistical analyses will be undertaken using PERMANOVA (non-parametric analysis of variance, Version 1.0.1, Primer-E Ltd) (Anderson 2001a, b).

2.3.6 Sedimentation and Grazing Invertebrates

Surveys for sedimentation and invertebrate grazers will be conducted on the platform section of the reef only. Surveys for sedimentation will be undertaken using video transects as described in Section 2.3.3. Ten random quadrats within the bare section of the platform will be used to determine abundance of key invertebrate grazers (abalone, limpets and chitons).

To assess for spatial variation of key grazing invertebrate abundance (abalone, chitons and limpets) across habitats (platform), a univariate analysis will be performed. All statistical analyses will be undertaken using PERMANOVA (non-parametric analysis of variance, Version 1.0.1, Primer-E Ltd) (Anderson 2001a, b).

2.3.7 Water Quality

Elevated nitrogen, phosphorus and subsequent elevated chlorophyll-a in the water column near abalone habitat may be an early indicator of additional inputs of nutrients above the background concentrations. These nutrients may have an effect on the benthic habitat as discussed above. Suspended sediments in the water column may also be an early indicator of sedimentation increase on the nearshore reef.

Baseline water quality monitoring was undertaken for the PER to inform the impact assessment process. A water quality monitoring program is a requirement of the MCMMP (Condition 6-3), and this program will include water quality sampling locations as close as practicable to the abalone habitat monitoring sites. Water quality monitoring will be undertaken approximately one month prior to the commencement of construction to provide a baseline of water quality immediately prior to the commencement of works. Water quality will be monitored at the abalone habitat monitoring sites during marine construction activities and continue for one month after the completion of construction (to demonstrate compliance with Condition 6-1(3)) as outlined in the approved MCMMP following which operational monitoring required under the approved MOMP will be implemented. The MCMMP will detail the methodology for water quality monitoring and is required to be submitted prior to construction and will be assessed and approved prior to implementation.

Following construction, the water quality monitoring will be completed as part of the operation monitoring requirements of the marina in accordance with Condition 6-4 of MS 1107, and thus the frequency of monitoring will be reduced to align with the operational water quality in the marina. Water quality monitoring will continue for at least three (3) years from completion of dredging activities and the construction of the marina breakwater as required by Condition 6-10, or as otherwise advised by the CEO.

Water quality monitoring will include:

1. Secchi depth - to determine underwater visibility.
2. Total suspended solids (TSS) – to determine sediment load in water column.
3. Chlorophyll-a – as an early indicator of nutrient loading and algae response (pre-Ulva or turfing algae).
4. CTD profiles – conductivity (salinity), temperature, depth, pH and dissolved oxygen as supplemental data or secondary investigation of chlorophyll-a, TSS or secchi depth.

2.4 Statistical Analysis

Summary statistics of the relevant abalone biomass parameters (minimum, maximum, mean and standard deviation) will be calculated for each habitat type (platform or sub-tidal) within sites and for each site.

Benthic habitat percentage cover of key components will be evaluated for each habitat (platform and sub-tidal) at each site. The abundance of key grazing invertebrates (abalone, chitons and limpets) will be determined for platform reef at each site. Percentage cover of sediment will be determined along each platform transect.

Data will be analysed using a beyond-BACI (Before, After, Control, Impact) design following Underwood 1991 which aims to detect a change at disturbed sites relative to appropriate reference sites.

2.5 Proposed Frequency and Timing of Monitoring

The monitoring surveys for abalone biomass and habitat will be completed once during construction during January thru May and then annually during January thru May to ensure it aligns with the DPIRD annual abalone biomass survey for five years after the completion of the construction of the outer breakwaters as per Condition 9-2(5).

3. Monitoring Criteria and Contingency Actions

Monitoring within and up to 500 m north of the Development Envelope (i.e. Zone A) is for the purpose of demonstrating impacts to abalone habitat and biomass are minimised. Monitoring within 500-1500 m north of the Development Envelope (i.e. Zone B) is to confirm no direct or indirect impacts to abalone habitat and biomass beyond 500 m from the northern boundary of the Development Envelope.

Monitoring trends within the abalone habitat sites will provide data which may be used as early indicators for potential abalone habitat loss and population decline (i.e. early response indicators).

Ecologically significant changes in key macroalgal components, key invertebrate grazers or sedimentation may lead to a subsequent decline in abalone recruitment. These indicators therefore provide a trigger to implement contingency management measures.

Additionally, abalone population numbers and biomass are a directly measurable monitoring criteria (outcome-based provision) to determine if any direct or indirect impact has occurred to abalone biomass.

Trigger criterion, rationale and contingency management measures are outlined in Table 3.1.

Table 3.1: Abalone Habitat and Biomass Triggers, Thresholds, Monitoring and Response Actions

Trigger / Threshold	Rationale	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
Abalone Habitat					
Trigger Criteria Median concentration of Chlorophyll-a at any monitoring site exceeds the 80th percentile concentration of the reference sites Threshold criteria Statistically significant³ increase (outside of natural variation) in turfing algae or Ulva AND Statistically significant changes in abundance of abalone, chitons and/or limpets	Increased Chlorophyll a is a potential indicator of elevated nutrient P and N, which may cause an increase in algae such as <i>Ulva</i> or turfing algae. Increases in turfing algae or Ulva may alter sedimentation on the platform section of the reef Decreases in key grazing invertebrates may allow turfing algae or Ulva to invade bare portions of the platform reef resulting in increased sedimentation	Trigger Criteria Action 1. Immediately investigate if the cause for change is due to the construction or operation of the proposal. If the exceedance is considered to be project attributable, the trigger criteria is considered to be exceeded. For project attributable exceedances of trigger criteria: 2. Increase frequency of monitoring to assess changes; 3. Complete investigation to determine the source of the nutrients; 4. Make necessary changes to eliminate the issue at the source or measures to improve water quality, such as encourage exchange of water quality in the marina waterbody, in consultation with DWER and DPIRD, including timeframes for implementation. 5. Continue monitoring until Chlorophyll-a achieves trigger criteria; and 6. Identify additional measures required to prevent the trigger level being exceeded in the future.	Indicators: Chlorophyll a Abalone habitat video transects Abundance of key invertebrate grazers Collected at: Zone A - AB1A and Beaumaris Zone B - AB1B, AB2, AB3A and Shenton Ave Reference – AB4 and Burns Beach Control – Mindarie	Monitoring of Chlorophyll a will start 1 month pre-construction, during construction and for five years after the completion of the construction of the outer breakwaters. Monitoring frequency as outlined in approved MCMMP and MOMP. Abalone habitat video transects and abundance of key invertebrate grazers will be undertaken annually between January – May once during construction and for five years after the completion of the construction of the outer breakwaters.	In the event of an exceedance of trigger or threshold criteria, DevelopmentWA will report the exceedances to the CEO and DPIRD within 21 days of the detected exceedance (as per Condition 9-6 (3)).

³ “statistically significant” means statistically determined significance when compared to reference and control sites, based on advice from DPIRD, marine technical experts, and published studies (where relevant).

Trigger / Threshold	Rationale	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
		Threshold Criteria Action As for Trigger Criteria Actions, plus the following: 1. Provide a report to the CEO and DPIRD within 21 days from the date of awareness of the exceedance. Document the threshold exceedance for later inclusion in the annual Compliance Assessment Report. 2. Continue to monitor abalone biomass to determine if changes to habitat result in statistically significant reduction in abalone biomass. This may include increasing monitoring frequency. 3. If a project attributed statistically significant reduction in biomass is detected within Zone B, implement contingency actions as outlined for Abalone Biomass Threshold Criteria action.			
Trigger criteria Total suspended solids (>2 mg L ⁻¹ above background) Threshold Criteria Statistically significant increases (outside of natural variation) in percentage cover of sedimentation on the platform section of the reef AND	Sedimentation may smother NCA, leading to a decline in abalone numbers and a subsequent decrease in recruitment of larvae in the following years. Increases in percentage cover of sediment on the platform section of reef may infill cryptic microsites used by juvenile abalone	Trigger Criteria Action 1. Immediately investigate if the cause for change is due to the construction or operation of the proposal. If the exceedance is considered to be project attributable, the trigger criteria is considered to be exceeded. For project attributable exceedances of trigger criteria: 2. Increase frequency of monitoring to further assess changes 3. Complete investigation to determine the source of the plume and make necessary changes to eliminate the issue at the source e.g. assess effectiveness of silt curtains, in consultation	Indicator: TSS Abalone habitat video transects Collected at: Zone A - AB1A and Beaumaris Zone B - AB1B, AB2, AB3A and Shenton Ave Reference – AB4 and Burns Beach	Monitoring of TSS will start 1 month pre-construction, during construction and for five years after the completion of the construction of the outer breakwaters. Monitoring frequency as outlined in approved MCMMP and MOMP. Abalone habitat video transects will be undertaken annually between January – May once during construction	In the event of an exceedance of trigger or threshold criteria, DevelopmentWA, will report the exceedances to the CEO and DPIRD within 21 days of the detected exceedance (as per Condition 9-6 (3)).

Trigger / Threshold	Rationale	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
Statistically significant decrease (outside of natural variation) in NCA on platform section of reef		with DWER and DPIRD including timeframes for implementation; - Assess extent of plume by reviewing plume sketches and remote imagery units at construction site; - Continue monitoring until TSS achieves trigger criteria; - Identify additional measures required to prevent the trigger level being exceeded in the future. Threshold Criteria Action As for Trigger Criteria Actions, plus the following: - Provide a report to the CEO and DPIRD within 21 days from the date of awareness of the exceedance. Document the threshold exceedance for later inclusion in the annual Compliance Assessment Report; - Continue to monitor abalone biomass to determine if changes to habitat result in statistically significant reduction in abalone biomass. This may include increasing monitoring frequency; - If a project attributable statistically significant reduction in biomass is detected within Zone B, implement contingency actions as outlined for Abalone Biomass Threshold Criteria action.	Control – Mindarie	and for five years after the completion of the construction of the outer breakwaters.	
Abalone Biomass					
Trigger criteria A statistically significant change in abalone population structure (i.e. age, class, density parameters as	A change in population structure may provide an early trigger or indicator of a reduction in biomass A reduction recorded during biomass survey may	Trigger Criteria Action - Investigate if the cause for change is due to the construction or operation of the proposal: - Compare changes in abalone population structure with reference sites and DPIRD FIS monitoring program sites	Indicators: Abalone population structure and number Collected at:	Annually between January – May once during construction and for five years after the completion of the construction of the outer breakwaters.	In the event of an exceedance of trigger or threshold criteria, DevelopmentWA will report the exceedances to the CEO and DPIRD within 21 days of the detected exceedance

Trigger / Threshold	Rationale	Response Actions	Monitoring	Timing / frequency of monitoring	Reporting
outlined in Section 2.3.3) Threshold Criteria A statistically significant reduction in abalone biomass within Zone B	indicate a declining trend in abalone numbers.	b. Investigate if the cause for change is due to the construction or operation of the proposal based on an assessment of all monitoring parameters, including those of the MCMMP and MOMP and identifying any activities associated with the marina development that may have resulted in the trigger criteria being met/ exceeded; c. If the exceedance is considered to be project attributable, the trigger criteria is considered to be exceeded. For project attributable exceedances of trigger criteria: 2. Implement controls to mitigate impacts to abalone habitat as a result of activities associated with the marina (i.e. refer to trigger criteria actions for abalone habitat) in consultation with DWER and DPIRD, including timeframes for implementation; 3. Continue monitoring to determine whether controls implemented are successful. This may include increasing monitoring frequency. Threshold Criteria Action As for Trigger Criteria Actions, plus the following: 1. Where project attributable impacts to abalone biomass within Zone B are identified and cannot be mitigated, the proponent will provide additional compensatory measures for stakeholders in consultation with DWER and DPIRD, including timeframes for implementation.	Zone A - AB1A and Beaumaris Zone B - AB1B, AB2, AB3A and Shenton Ave Reference – AB4 and Burns Beach Control – Mindarie		(as per Condition 9-6 (3)).

4. Translocation Program

As per Condition 9-2(1), the AHBMP required by Condition 9-1 shall:

“identify options for translocating abalone from within the Development Envelope to other suitable habitat, including consideration of timing, biosecurity and genetic differences between the population relocated and the population and environment at the receiving location, and monitoring program to confirm outcomes from any translocation”.

Options for translocation of abalone as required by Condition 9-2(1) were outline and approved as part of the AHBBS. The AHBBS addressed the following elements of Condition 9-2(1):

- Timing;
- Biosecurity; and
- biosecurity and genetic differences.

For completeness, details of the translocation program are outlined below. Information regarding the translocation program has been provided by DPIRD.

The baseline survey of abalone biomass and the commencement of the translocation program occurred in Q1, 2020 to ensure collection and translocation occurred during favourable weather conditions (and prior to proposed commencement of construction in late 2020). The results of that program are to be reported separately but have informed the preparation of the AHBMP.

Ongoing monitoring of the outcomes of the translocation program as required by Condition 9-2(1) are described in this AHBMP.

4.1 Baseline survey

Condition 8-2(4) requires DevelopmentWA to; *characterise and quantify abalone numbers and biomass within the Development Envelope to inform the translocation investigations referred to in condition 9-2(1).*

Abalone numbers and population structure were recorded in accordance with Section 2.2.1.

Historical information from DPIRD’s annual FIS program carried out within the Development Envelope and the survey of AB1 was utilised to determine abalone numbers and population structure (used to calculate biomass) within the Development Envelope.

An estimation of total abalone numbers and population structure within the Development Envelope was calculated in accordance with Hancock (2004) based on:

- the total anticipated area of abalone habitat
- densities historically recorded by DPIRD
- densities recorded during the baseline survey.

4.2 Translocation Release Locations

Release locations were identified through consultation between DPIRD and the West Coast Abalone Divers Association (WCADA). The release locations are a representation of the Perth Metropolitan Roe’s abalone Fishery and include a component of both platform (recreational) and subtidal (commercial) habitats, given the Fishery’s formal catch allocation between sectors. The relocated Roe’s abalone were distributed throughout the nearshore reef habitat at each release location (between the northern and southern boundary).

Approximately 100,000 adult Roe's abalone (10-12 tonnes) tonnes of adult biomass within the Development Envelope are likely to be translocated.

4.3 Translocation Methodology

The translocation program was designed and executed by DPIRD with assistance from the WCADA on behalf of DevelopmentWA. Adult Roe's abalone (> 40 mm, size at which Roe's abalone reach sexual maturity) will be harvested by licenced commercial fishers (WCADA) from within the Development Envelope using current collection techniques (chipping). Given the logistics and number of abalone available animals smaller than this size were not targeted for translocation.

For translocations occurring in the Perth Metropolitan Roe's abalone Fishery, harvested abalone were transported by boat (under wet hessian to remain cool and moist) from Burns Beach Reef to between Hillarys and Trigg Island (<45 min steam). The translocated abalone were released by divers onto both the platform and subtidal habitats at defined locations. Multiple release locations within this stretch of Roe's abalone habitat were selected based on several parameters:

- the total amount of abalone to be translocated as part of this program;
- the potential receiving locations topography and abalone abundance;
- accessibility based on weather conditions; and
- ability to conduct monitoring surveys.

Information on the biomass and health of abalone removed from the Development Envelope by the commercial fishers and then released at each receiving location was recorded. Biomass was estimated by using individual average weight of the animal by the total weight harvested on any given translocation day.

Any translocations that release animals outside of the Perth Metropolitan Roe's abalone Fishery was carried out as per the methodology in Strain *et al.* (2019).

4.4 Biosecurity

Potential parasites in Roe's abalone in the Perth metropolitan area may include:

- shell boring polychaetes, sponges and bivalves (Jenkins 2004);
- boring whelks;
- boring sponge *Cliona* spp. (Shepherd 1972); and
- trematodes (Wells & Keesing 1989).

DPIRD is the authority responsible for regulating translocations of live fish under the *Fish Resources Management Act 1994* (FRMA). The translocation program was required to comply with DPIRD's *Policy for Managing Translocations of Live Fish into and within Western Australia*. The Department uses a risk-based assessment process to evaluate and regulate translocations of live fish in Western Australia (WA). In assessing translocation applications, the Department also takes into account other relevant legislation. Applications made under this policy include assessment of the biosecurity risk by the Aquatic Disease Specialist at DPIRD.

Abalone collected from AB1 was inspected for parasites prior to translocation in accordance with the DPIRD *Policy for Managing Translocations of Live Fish into and within Western Australia*.

4.5 Genetics

A comprehensive evaluation of Roe's abalone genetic population differentiation has been completed by Sandoval-Castillo *et al.* (2015). Through the screening of genome-wide variation, this study

showed the existence of one single abalone meta-population with high connectivity across the geographic range sampled. Only relatively small genetic differences exist in Roe's abalone in Western Australia.

Due to the widespread similarity in genetic populations, there are currently no genetic zones assigned for Roe's abalone. As such, translocation of Roe's abalone from within the Development Envelope to other suitable habitat within WA is unlikely to pose any significant risk to genetic contamination.

The translocation program complied with DPIRD's Translocation Policy.

4.6 Timing of translocation

The majority of the translocation program was completed from January to May 2020 to ensure it occurred during optimum weather conditions and to minimise translocation mortality. This timing also aligned with the baseline survey, DPIRD's annual FIS program and will be completed prior to construction being initiated. However, opportunities for additional translocation may be identified, such as releases of Roe's abalone north of Kalbarri and to other population locations within WA.

4.7 Translocation Monitoring Program

4.7.1 Monitoring Locations

Three release locations were surveyed prior to the translocation being undertaken to determine a baseline population structure. These sites will be surveyed post translocation for the length of the AHBMP.

4.7.2 Monitoring Parameters

The following key parameters will be measured:

1. Abalone population structure (to enable biomass calculations) and numbers.

Understanding the change in population structure over time is important to evaluate the translocation program and its effect on the receiving locations. This may include increases in spawning biomass and potential changes in recruitment into the future. This information is used to calculate abalone biomass.

Surveys for abalone numbers and population structure will be conducted on both the reef platform and sub-tidal habitats at each of the monitor sites. Abalone population structure and numbers will be surveyed using DPIRD's transect and quadrat methods based on Hancock (2004) and as described in Hart et al. (2018).

Divers will record on waterproof paper the maximum length of each abalone within each quadrat of each site. Within each of the quadrats, abalone which have the tip of their swirl within the frame will be considered to be 'in' and measured for maximum length. Platform and sub-tidal habitat abalone count data will be collected and processed individually by separate divers.

Summary statistics of the relevant abalone density parameters (minimum, maximum, mean and standard deviation) will be calculated for each site and each habitat type (platform or sub-tidal) within each site.

Collected abalone data will be separately processed for the platform and sub-tidal habitat to determine:

- total Roe's abalone count per transect
- abalone density (m²) (converted from counts per quadrat)
- size classes and designated age classes (Hancock 2004) and legal and sublegal classifications (based on the length of each abalone)
- total counts and percentage per age and per legal classification.

Age classes will be determined based on the abalone size using the maximum length size classes in Table 4.1.

Table 4.1: Roe's abalone age classes based on maximum length

Age (years)	Size (mm) range
<1	<17
1-2	17-32
2-3	33-50
3-4	51-60
4-5	61-70
5+	>70

The legal-size limit for fishing Roe's abalone is 60 mm. Abalone <60 mm will be designated as sub-legal and abalone 60 mm or greater will be designated as legal size.

4.7.3 Monitoring Methodology

The survey method and analysis to assess the outcomes of the Translocation Program will be conducted using DPIRD's transect and quadrat methods based on Hancock (2004) and as described in Hart et al. (2018). Further detail is provided in Section 2.3.4.

4.7.4 Frequency

Translocation release sites will be surveyed within one (1) year of the translocation taking place and then annually for the length of the Abalone Habitat and Biomass Monitoring Plan (i.e. minimum of five years after the completion of construction of the outer breakwaters, or until the CEO has confirmed by notice in writing that the implementation of the management plan is no longer required [Condition 9-4]).

5. Quality Control and Assurance

Quality control and assurance will be completed by:

- Abalone surveys will be carried out by DPIRD scientific divers as per a long-term FIS program methodology.
- Commercial scientific divers being trained to AS2815.1 with divers having experience in video footage surveys in near shore reefs. Divers will receive additional informal training from DPIRD personnel in the field to ensure sampling methods are equivalent and directly comparable to DPIRD techniques.
- Photos of diver data slates will be taken prior to leaving bottom to ensure data is not accidentally lost.
- Sea conditions will be less than 1.0 m swell at the Rottnest Island buoy and winds will be from an easterly direction and less than 10-15 knots, where practicable.
- Speciality equipment will be used to help stabilise the diver on the platform transect to ensure accurate measurements of abalone maximum length.
- High definition video to be collected for point count analysis.
- Marine Scientists to complete point count analysis.
- Disease analysis will be completed by an Aquatic Disease Specialist at DPIRD.

6. Implementation

In accordance with Condition 9-3 of MS 1107, after receiving notice in writing from the CEO that the AHBMP meets the requirements of Condition 9-2, DevelopmentWA will implement the plan (the AHBMP).

As required by Condition 9-4, DevelopmentWA will continue to implement the AHBMP, or any subsequent revisions as approved by the CEO, for a period of not less than five (5) years after the completion of the construction of the outer breakwaters or until the CEO has confirmed by notice in writing that the implementation of the management plan is no longer required.

DevelopmentWA will have overall responsibility for the implementation of the monitoring program and compliance with MS 1107.

The monitoring described in this plan will be undertaken by DPRID and suitably qualified consultants on behalf of DevelopmentWA.

Table 6.1: Monitoring Summary and Implementation

Monitoring aspect	Monitoring Locations ¹				Frequency	Timing	Resources
	Zone A	Zone B	Control	Reference			
Abalone numbers and population structure	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	Once during construction and annually for five years following breakwater construction ¹	January – May	DPIRD
Benthic habitat	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	Once during construction and annually for five years following breakwater construction ¹	January – May	Suitably qualified consultants
Sedimentation of microsite and cryptic habitat	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	Once during construction and annually for five years following breakwater construction ¹	January – May	Suitably qualified consultants
Key grazing invertebrate population	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	Once during construction and annually for five years following breakwater construction ¹	January – May	Suitably qualified consultants
Water Quality							
Secchi depth	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	As outlined in approved MCMMP and MOMP At least annually between January – May for five years following breakwater construction		Suitably qualified consultants
Total Suspended Solids	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	As outlined in approved MCMMP and MOMP At least annually between January – May for five years following breakwater construction		Suitably qualified consultants
Chlorophyll a	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	As outlined in approved MCMMP and MOMP At least annually between January – May for five years following breakwater construction		Suitably qualified consultants

Monitoring aspect	Monitoring Locations ¹				Frequency	Timing	Resources
	Zone A	Zone B	Control	Reference			
CTD Profiles	AB1A Beaumaris	AB1B AB2 AB3A Shenton Ave	Mindarie	AB4 Burns Beach	As outlined in approved MCMMP and MOMP At least annually between January – May for five years following breakwater construction		Suitably qualified consultants

¹ Or until the CEO advises that implementation of the plan is no longer required.

7. Reporting

Reporting for the monitoring surveys for abalone biomass and habitat will be completed annually by 1 July as required by Condition 9-5(6).

The report will include:

- Abalone population structure (number per size class) for all sites, including translocation monitoring sites;
- Abalone density (number per m²) for all sites, including translocation monitoring sites;
- Percentage cover of macroalgae classification (including NCA) for sites within the Abalone Monitoring Zone;
- Percentage cover of sediments on platform section (surrogate for microhabitat and cryptic sites) for sites within the Abalone Monitoring zone;
- Abundance of key grazing invertebrates within the barren zone of the platform section of sites within the Abalone Monitoring zone; and
- statistical analysis results and discussion of whether there are differences in the key parameters between sites and years.

7.1.1 Index of Marine Surveys for Assessments requirements

The Index of Marine Surveys for Assessments (IMSA) project is a mechanism by which all marine survey information collected for environmental impact assessment under the EP Act will be captured and integrated into a consolidated, indexed and publicly available repository. IMSA is administered by Department of Water and Environmental Regulation. . Each time a marine survey report is submitted (at any point in the assessment and compliance processes under Part IV of the EP Act) it should be accompanied by an electronic IMSA package.

In accordance with the above requirements, an IMSA package will be prepared to accompany the results of monitoring undertaken in accordance with the approved AHBMP.

7.2 Reporting of Non-Achievement (Condition 9-6(3))

In accordance with Condition 9-6(3), DevelopmentWA will report any incidences of non-achievement (i.e. a trigger or threshold exceedance as per Table 3.1) of the monitoring criteria set out in Section 3 within twenty-one (21) days of the non-achievement being identified. The report will include:

- results from the monitoring;
- measures taken and/or proposed action to be taken;
- where possible, quantification of the nature and extent of the impact;
- contingency actions to be implemented in response to any impact identified; and
- ongoing reporting requirements.

Within three (3) days of receiving confirmation from the CEO that the proposed actions and strategies are acceptable, DevelopmentWA will notify the public via its website at:

<https://www.landcorp.com.au/Industrial-and-Commercial/Ocean-Reef-Marina/Latest-News/>

8. Review and Revision

As provided for under Condition 9-7 of MS 1107, DevelopmentWA:

- may revise the AHBMP, or
- will review and revise the AHBMP as and when directed by the CEO.

DevelopmentWA will implement an adaptive management system to provide a robust management plan, which effectively meets the environmental objectives. To achieve this, the AHBMP will be reviewed regularly (at least annually) to ensure that the plan takes into consideration:

- any revision or change to the Proposal approved under the EP Act;
- outcomes of ongoing consultation with DWER, DPIRD, WCADA and other relevant stakeholders (such as RecFishWest) results of monitoring;
- outcomes of compliance assessment reporting;
- continuous improvement; and
- changes in regulatory or corporate requirements.

If revised, a copy of the revised AHBMP will be provided to the CEO for approval prior to implementation. Any revised plan will not be implemented until such time the CEO has confirmed by notice in writing, that the revised plan satisfies the requirements of Condition 9-2.

In accordance with Condition 9-8 of MS 1107, DevelopmentWA will implement the latest approved version of the AHBMP.

8.1 Annual Reporting

DevelopmentWA shall submit to the CEO annual Compliance Assessment Reports in accordance with Condition 4-6 which include:

1. All monitoring data and reportable incidents;
2. An analysis and interpretation of monitoring data to demonstrate compliance with the requirements of conditions 9-2(2); and
3. An assessment of the effectiveness of monitoring, management and contingency measures implemented to ensure compliance with the requirements of condition 9.

8.1.1 Index of Marine Surveys for Assessments Requirements

The Index of Marine Surveys for Assessments (IMSA) project is a mechanism by which all marine survey information collected for environmental impact assessment under the EP Act will be captured and integrated into a consolidated, indexed and publicly available repository. IMSA is administered by Department of Water and Environmental Regulation. Each time a marine survey report is submitted (at any point in the assessment and compliance processes under Part IV of the EP Act it should be accompanied by an electronic IMSA package.

In accordance with the above requirements, an IMSA package will be prepared to accompany the results of monitoring undertaken in accordance with the approved AHBMP.

9. Stakeholder consultation

In accordance with Condition 9-1 of MS 1107, this plan has been prepared in consultation with DPIRD and DBCA. The following key elements of the plan are consistent with the AHBBP prepared in consultation with and input from both DPIRD and DBCA and approved in January 2020:

- monitoring locations;
- parameters to be monitoring; and
- monitoring methodology.

Consultation and input to the AHBBP is therefore relevant to this plan. In addition, specific technical input was sought from DPIRD on the translocation monitoring and in developing the monitoring criteria and contingency actions relating to abalone.

This plan was provided to both agencies for review, prior to submission to DWER.

Consultation also been undertaken with West Coast Abalone Divers Association (WCADA) and RecFishWest in relation to impacts of the Proposal on abalone biomass and associated concerns regarding catch allocations and recreational fishing experience. The Voluntary Fisheries Adjustment Scheme will address commercial compensation for licensed fishers impacted by the Proposal. DevelopmentWA will continue to work with DPIRD and RecFishWest in identify additional measures to mitigate impacts to the recreational sector which may include abalone restocking, stock enhancement and habitat enhancement. In this regard, it is also noted that the translocation program (refer to Section 4) was one of those initiatives.

10. Public availability

This version of the AHBMP has been made public in accordance with Condition 5 of MS 1107 which states:

“Subject to condition 5-2, within a reasonable time period approved by the CEO of the issue of this Statement and for the remainder of the life of the proposal the proponent shall make publicly available, in a manner approved by the CEO, all validated environmental data (including sampling design, sampling methodologies, empirical data and derived information products (e.g. maps)), management plans and reports relevant to the assessment of this proposal and implementation of this Statement.”

11. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

Strategen-JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by Strategen-JBS&G, and should not be relied upon by other parties, who should make their own enquiries.

12. References

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