Mardie Project

Marine Environmental Quality Monitoring & Management Plan

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O2 MARINE

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Acronyms and Abbreviations

Acronyms/Abbreviation	Description
ANZG	Australian and New Zealand Guidelines
BCH	Benthic Communities and Habitat
EPA	Environmental Protection Authority
EQC	Environmental Quality Criteria
EQIs	Environmental Quality Indicators
EQMF	Environmental Quality Management Framework
EQOs	Environmental Quality Objectives
ESD	Environmental Scoping Document
EVs	Environmental Values
GLpa	Gigalitre per annum
ktpa	kilo tonnes per annum
LEPs	Levels of Ecological Protection
MEQ	Marine Environmental Quality
MEQMMP	Marine Environmental Quality Monitoring & Management Plan
MEQP	Marine Environmental Quality Plan
MS	Ministerial Statement
MTs	Management Targets
Mtpa	Million tonnes per annum
NaCl	Sodium chloride, commonly known as salt.
SOP	Sulphate of potash
SWQMS	State Water Quality Management Strategy

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1. Introduction

1.1. Project Description

1.1.1. Proposal Summary

Table 1-1 Proposal Summary

Proposal Title	Mardie Project
Proponent Name	Mardie Minerals Pty Ltd
Short Description	Mardie Minerals Pty Ltd is seeking to develop a greenfields high quality salt and sulphate of potash (SOP) project and associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of WA. The Proposal will utilise seawater to produce a high purity salt product, SOP and other products derived from sea water. The Proposal includes the development of a seawater intake, concentrator and crystalliser ponds, processing facilities and stockpile areas, bitterns disposal pipeline and diffuser, trestle jetty export facility, transhipment channel, drainage channels, access / haul roads, causeway, desalination (reverse osmosis) plant, borrow pits, pipelines, and associated infrastructure (power supply, communications equipment, offices, workshops, accommodation village, laydown areas, sewage treatment plant, landfill facility, etc.).

1.1.2. Proposal Description

Mardie Minerals Pty Ltd (Mardie Minerals) seeks to develop the Mardie Project (the Proposal), a greenfields high-quality salt project in the Pilbara region of Western Australia (**Figure 1-1**). Mardie Minerals is a wholly-owned subsidiary of BCI Minerals Limited.

The Proposal is a solar salt project that utilises seawater and evaporation to produce raw salts as a feedstock for dedicated processing facilities that will produce a high purity salt, industrial grade fertiliser products, and other commercial by-products. Production rates of 4.0 Million tonnes per annum (Mtpa) of salt (NaCl), 100 kilotonnes per annum (ktpa) of Sulphate of Potash (SoP), and up to 300 ktpa of other salt products are being targeted, sourced from a 150 Gigalitre per annum (GLpa) seawater intake. To meet this production, the following infrastructure will be developed:

- Primary seawater intake pump station;
- Concentrator ponds;
- Crystalliser ponds;
- Processing facilities and stockpiles;
- Causeway, trestle jetty and transhipment berth/channel;
- Bitterns disposal pipeline, seawater intake (for dilution) and diffuser;
- Drainage channels and flood protection levees;
- Administration buildings;
- Accommodation village;
- Access / haul roads;
- Desalination plant for freshwater production;

- Boat launching facility and port stockyard; and
- Associated infrastructure including power supply, communications, workshop, laydown, landfill facility, sewage treatment plant.

Seawater for the process will be pumped from a large tidal creek into the concentrator ponds. All pumps will be screened and operated accordingly to minimise entrapment of marine fauna and any reductions in water levels in the tidal creek.

Concentrator and crystalliser ponds will be developed behind low permeability walls engineered from local clays and soils and rock armoured to protect against erosion. The height of the walls varies across the project and is matched to the storm risk for the area.

Potable water will be required for the production plants and the village. The water supply will be sourced from desalination plants across the Proposal. The high salinity brine output from the plants will be directed to concentrator ponds or a lined process pond.

A trestle jetty will be constructed to convey salt (NaCl) from the salt production stockpile to the transhipment berth pocket, approximately 2.2 km offshore. The jetty will not impede coastal water or sediment movement, thus ensuring coastal processes are maintained.

Dredging of up to 800,000 m^3 will be required to ensure sufficient depth for the transhipper berth pocket at the end of the trestle jetty, as well as along a 4.5 km long channel out to deeper water. The average depth of dredging is approximately 1 m below the current sea floor. The dredge spoil is inert and will be transported to shore for use within the development.

The production process will produce a high-salinity bittern that, prior to its discharge through a diffuser at the far end of the trestle jetty, will be diluted with seawater to bring its salinity closer to that of the receiving environment.

Access to the project from North West Coastal Highway will be based on an existing public road alignment that services the Mardie Station homestead and will require upgrading..

The majority of the power required for the project (i.e. approximately 95%) is provided by the sun and the wind, which drives the evaporation and crystallisation processes. In addition, the Proposal will require diesel and gas to provide additional energy for infrastructure, support services and processing plant requirements.

The Proposal will be developed within three development envelopes. The boundaries of these development envelopes are shown in **Figure 1-2** and described in **Table 1-2**.

Table 1-2 Location and proposed extent of physical and operational elements

Element	Ref.	Proposed Extent
Physical Elements		
1. Ponds & Terrestrial Infrastructure Development Envelope – concentrator and crystalliser ponds, processing plant, access / haul road, desalination plant, causeway, administration, accommodation village, laydown, other infrastructure.	Fig. 2	Disturbance of no more than 11,142 ha within the 15,667 ha Ponds & Terrestrial Infrastructure Development Envelope.
2. Marine Development Envelope – trestle jetty, seawater intake and pipelines.	Fig. 2	Disturbance of no more than 7 ha within the 53 ha Marine Development Envelope.
3. Dredge Channel Development Envelope – berth pocket, channel to allow access for transhipment vessels, bitterns outfall diffuser.	Fig. 2	Disturbance of no more than 55 ha within the 304 ha Dredge Channel Development Envelope.
4. Mangrove Disturbance	Fig. 2	Disturbance of mangrove communities limited to 20 ha of Scattered Canopy mangroves and no Closed Canopy mangroves
Operational Elements		
Desalination Plant discharge	Fig. 2	Discharge to ponds or bitterns stream
Dredge volume	Fig. 2	Dredging is only to occur within the Dredge Channel Development Envelope. Dredging of no more than 800,000 m3 of material from the berth pocket and high points within the dredge channel, with the material to be deposited within the Ponds & Terrestrial Infrastructure Development Envelope.
Bitterns discharge	Fig. 2	Discharge of up to 3.6 gigalitres per annum (GLpa) of bitterns with a specific gravity of no more than 1.25 via a diffuser within a Low Ecological Protection Area. Bitterns will be diluted prior to discharge.
Pond seawater intake		Up to 150 GL per annum, from a screened intake with a maximum average intake flow rate at the screen of less than 0.15 m/s. Seawater abstraction will only occur when water levels are at mean sea level or higher.

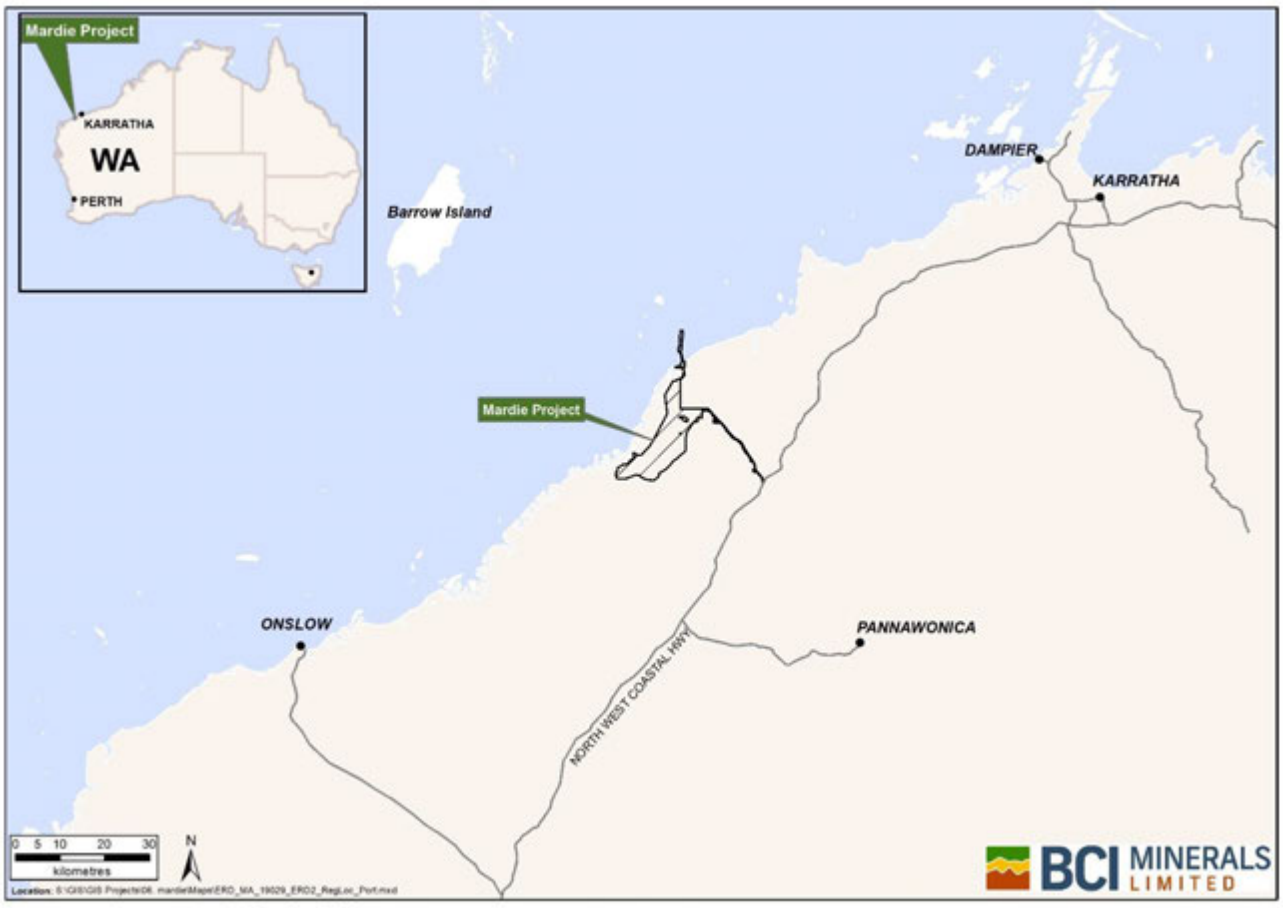

Figure 1-1 Mardie Project Regional Location

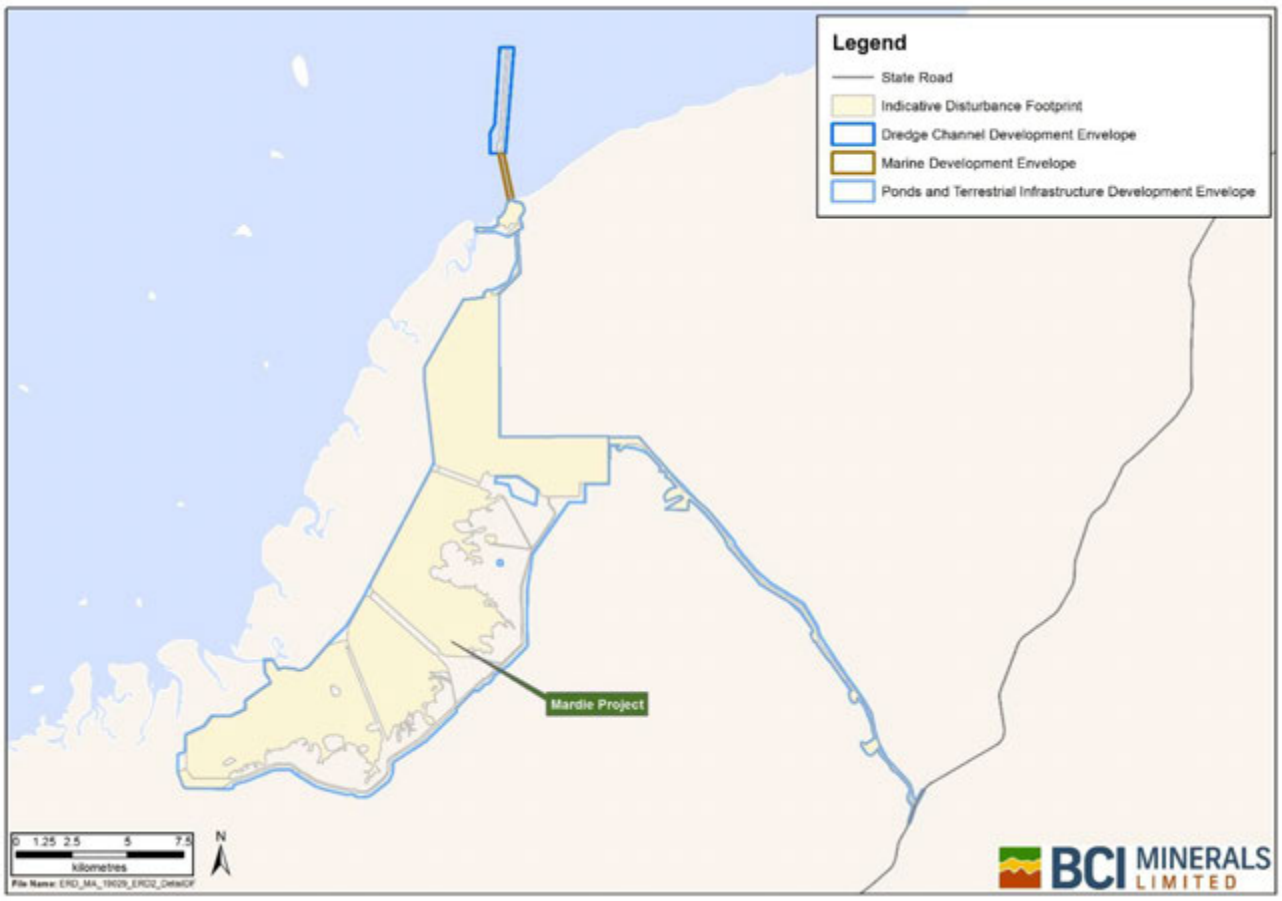

Figure 1-2 Mardie Project Development Envelopes

1.2. Scope

The purpose of this Marine Environmental Quality Monitoring and Management Plan (MEQMMP) is to establish a framework to ensure that the implementation of the Project does not compromise the Environmental Values (EVs) and Environmental Quality Objectives (EQOs) of the Mardie coastal area. The framework relies on establishing EVs and EQOs, spatially defining the Levels of Ecological Protection (LEPs) for the Project area, and applying a risk-based, adaptive approach to monitoring and management.

The MEQMMP applies to the following project activities that have the potential to impact on the environmental quality of the marine environment at Mardie:

- the discharge of waste bitterns;
- day-to-day port operations; and
- the storage and handling of potentially contaminating materials.

Project activities associated with off-shore dredging and on-shore construction are managed through their respective, specialised environmental management plans.

The MEQMMP sets out a process for monitoring and reporting to allow residual impacts to be assessed against acceptable limits of ecological change during the lifecycle of the Proposal. Where results outside the limits of acceptable change are reported, a pre-determined risk-based response is triggered to ensure the EVs and EQOs are not compromised.

Specifically, the objectives of this MEQMMP are to:

- Identify EVs and clearly define EQOs relevant to the Proposal area;
- Spatially define LEPs relevant to the Proposal area;
- Establish Environmental Quality Criteria (EQC) to provide measurable levels of acceptable change to Environmental Quality Indicators (EQIs) for each EV;
- Establish protocols and procedures for the monitoring, management and reporting regarding the achievement of EQOs and protection of EVs;
- Provide a framework to guide management response and required actions in the event established EQC are exceeded; and
- Ensure the collection, analysis and reporting of marine environmental quality (MEQ) data occur in a consistent and robust manner.

This MEQMMP applies to each of the key project phases. The Plan also details the process for routine review and continual improvement of the Plan as the Proposal progresses, or at any time key processes alter and new risks are identified.

To ensure the objectives of the MEQMMP are achieved the following key processes have been defined:

1. Pre-Project Baseline Data Collection;
    - Derive locally relevant EQC from baseline data to inform ongoing monitoring and management.
2. Commissioning and Validation;
    - Undertake further whole of effluent toxicity (WET) of the final bitterns during the commissioning phase to ensure the species protection levels (SPL) within the outfall mixing zone and the designated LEPs are appropriate;

- Validate the accuracy of numerical modelling in predicting the extent of the mixing zone; and
- Validate performance of the bitterns outfall diffuser during both commissioning and operational phases of the Proposal.

3. Ongoing MEQ Monitoring;
   - Monitor and mitigate potential impacts to MEQ throughout the life of the Proposal.

2. Environmental Quality Management Framework

2.1. Background

The Environmental Quality Management Framework (EQMF) was developed to implement the National Water Quality Management Strategy Guidelines No. 4 and 7 (ANZG 2018). In Western Australia the EQMF process has been utilised as a guide to implement water quality monitoring and management after being incorporated into the State Water Quality Management Strategy No.6 (SWQMS 2004). The Environmental Protection Authority (EPA) provides further guidance for the development and application of the EQMF as a consistent and standardised approach for measuring and reporting on marine environmental quality (MEQ) across other areas of Western Australia's marine environment (EPA 2016). The key structural elements of the EQMF are shown in **Figure 2-1**.

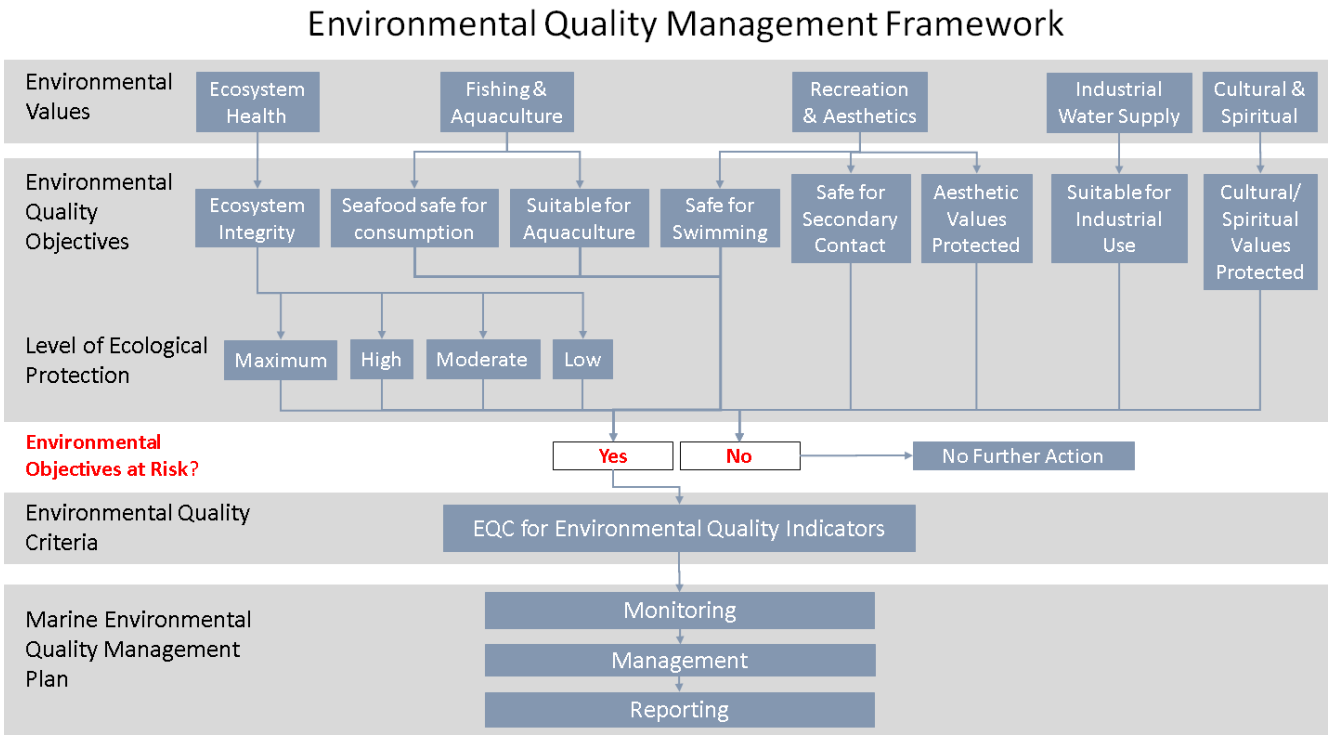

Figure 2-1 Environmental Quality Management Framework

The following sections outline how the EQMF framework has been applied to define the Environmental Values (EVs), Environmental Quality Objectives (EQOs) and spatial Levels of Ecological Protection (LEPs) for the Mardie Project area.

2.2. Environmental Values & Environmental Quality Objectives

Environmental Values (EVs) are defined as "P*articular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharges and deposits"* (ANZG 2018). EQOs are high level management objectives that describe what must be achieved to protect each EV (EPA 2016).

The EVs and associated EQOs for the Pilbara marine environment are already well established in Pilbara Coastal Waters Consultation Outcome (DoE 2006). Five EVs and eight corresponding EQOs apply to the Mardie Project area. These EVs and corresponding EQOs are presented in **Table 2-1**.

Table 2-1 Environmental Values and Environmental Quality Objectives applicable to the Mardie Project area

Environmental Values	Environmental Quality Objectives
Ecosystem Health	EQO1: Maintenance of ecosystem integrity. EQO1 is split into four sub-objectives, being: Maximum, High, Moderate and Low Levels of Ecological Protection (LEPs) (Refer Section 2.3 below).
Fishing and Aquaculture	EQO2: Seafood (caught) is of a quality safe for human consumption. EQO3: Water quality is suitable for aquaculture purposes.
Recreation & Aesthetics	EQO4: Water quality is safe for primary contact recreation (e.g. swimming and diving). EQO5: Water quality is safe for secondary contact recreation (e.g. fishing and boating). EQO6: Aesthetic values of the marine environment are protected.
Cultural & Spiritual	EQO7: Cultural and spiritual values of the marine environment are protected.
Industrial Water Supply	EQO8: Water quality is suitable for industrial supply purposes.

Site-specific features of the EVs identified through various investigations undertaken for the Mardie Project are summarised in **Table 2-2**.

Table 2-2 Specific features of EVs identified through Mardie Environmental Investigations

Ecosystem Health	Fishing & Aquaculture	Recreation & Aesthetics	Cultural & Spiritual	Industrial Water Supply
> Water quality (O2 Marine 2020a) > Sediment quality (O2 Marine 2019a) > Ecological processes > Benthic Communities and Habitat (O2 Marine 2020b/2020c): o Corals o Macroalgae o Filter feeders o Seagrass) o Mangroves o Samphires o Algal mats > Marine Fauna (O2 Marine 2020d): o Turtles o Fish o Shore birds o Sea birds o Sea Snakes o Whales o Dolphins o Dugong	> Shore-based fishing > Boat-based fishing > Crabbing is popular in the tidal creeks > Onslow Prawn Managed Fishery – Fortescue Nursery Area > No aquaculture operations undertaken at present	> Recreational fishing > Free diving > Scuba diving > 4WD Vehicles / Quad bikes > Access to the Project area	> Hunting > Mud crabbing > Fishing > Maceys Shipwreck > Recognition of traditional owner rights to access & usage of country	> Proposed Mardie Project seawater intakes

2.3. Levels of Ecological Protection

In accordance with EPA (2016), the objective for 'Ecosystem Health' is spatially allocated into four Levels of Ecological Protection (LEPs): Maximum, High, Moderate and Low. Each LEP area is assigned an acceptable limit of change as shown in **Table 2-3**. The spatial distribution of the LEPs enables measurable EQOs to be allocated for areas in accordance with expectations for ecosystem health condition. For example, important areas for conservation are assigned a Maximum LEP and maintained within the limits of natural variation, whereas large changes from natural variation may be allowed in small areas assigned a Low LEP around a bitterns discharge where EVs may not be protected.

Table 2-3 Limits of acceptable change in the key elements of ecosystem integrity for the four levels of ecological protection (Source: EPA, 2016).

Key elements of ecosystem integrity and their limits of acceptable change		Level of protection for maintenance of ecosystem integrity			
Key elements	**Limits of acceptable change**	**Maximum**	**High**	**Moderate**	**Low**
Ecosystem processes (e.g. primary production, nutrient cycles, food chains)	Ecosystem processes are maintained within the limits of natural variation (no detectable change)	✓	✓		
	Small changes in rates, but not types of ecosystem processes			✓	
	Large changes in rates, but not types of ecosystem processes				✓
Biodiversity (e.g. variety and types of naturally occurring marine life)	Biodiversity as measured on both local and regional scales remains at natural levels (no detectable change)	✓	✓	✓	
	Biodiversity measured on a regional scale remains at natural levels although possible change in variety of biota at a local scale				✓
Abundance and biomass of marine life (e.g. number or density of individual animals, the total weight of plants)	Abundances and biomasses of marine life vary within natural limits (no detectable change)	✓	✓		
	Small changes in abundances and/or biomasses of marine life			✓	
	Large changes in abundances and/or biomasses of marine life				✓
The quality of water, biota and sediment (e.g. types and levels of contaminants such as heavy metals, dissolved oxygen content, water clarity)	Levels of contaminants and other measures of quality remain within limits of natural variation (no detectable changes)	✓			
	Small detectable changes beyond limits of natural variation but no resultant effect on biota 99% Species Protection Limits (SPL) Applies		✓		
	Moderate changes beyond limits of natural variation but not to exceed specified criteria 90% SPL Applies			✓	
	Large changes from natural variation 80% SPL Applies				✓

LEP boundaries have been previously described for the Mardie Project area in the *Pilbara Coastal Water Quality Consultation Outcomes* (DoE 2006). These existing LEP boundaries were reviewed and

updated in the context of the proposed Mardie waste bitterns outfall and Port facility, to spatially define proposed LEPs around the project infrastructure.

The LEP boundaries were defined and mapped in consideration of the following key elements:

- A Low LEP area (LEPA) was designated based on modelled predictions of the bitterns plume which determined that a 90% SPL would be achieved at the LEPA/MEPA boundary (Baird 2020). Whole of effluent toxicity (WET) testing results presented in O2 Marine (2019b) were used to inform the number of dilutions required to meet the 90% SPL used by Baird (2020);
- A Moderate LEP area (MEPA) was designated for all waters (excluding the LEPA areas) based on modelled predictions of the bitterns plume which determined that a 99% SPL would be achieved at the MEPA/HEPA boundary (Baird 2020). WET testing results presented in O2 Marine (2019b) were used to inform the number of dilutions required to meet the 99% SPL used by Baird (2020);
- Two small HEPAs were designated within adjacent to proposed small vessel launching and retrieval ramp and the seawater abstraction pipeline in the northern and southern creeks respectively. These were both based upon a 250 m buffer around proposed infrastructure; and
- Existing LEPs as presented in the Pilbara Coastal Water Quality Consultation Outcomes (DoE 2006) were retained for all other areas which includes a High LEP area (HEPA) and a Maximum LEP area (XEPA). Based on WET testing results presented in O2 Marine (2019b), Baird (2020) determined that a 99% SPL would be achieved at the MEPA/HEPA boundary.

The proposed spatial designation of LEPs for the Mardie Proposal area is presented in **Figure 2-2**.

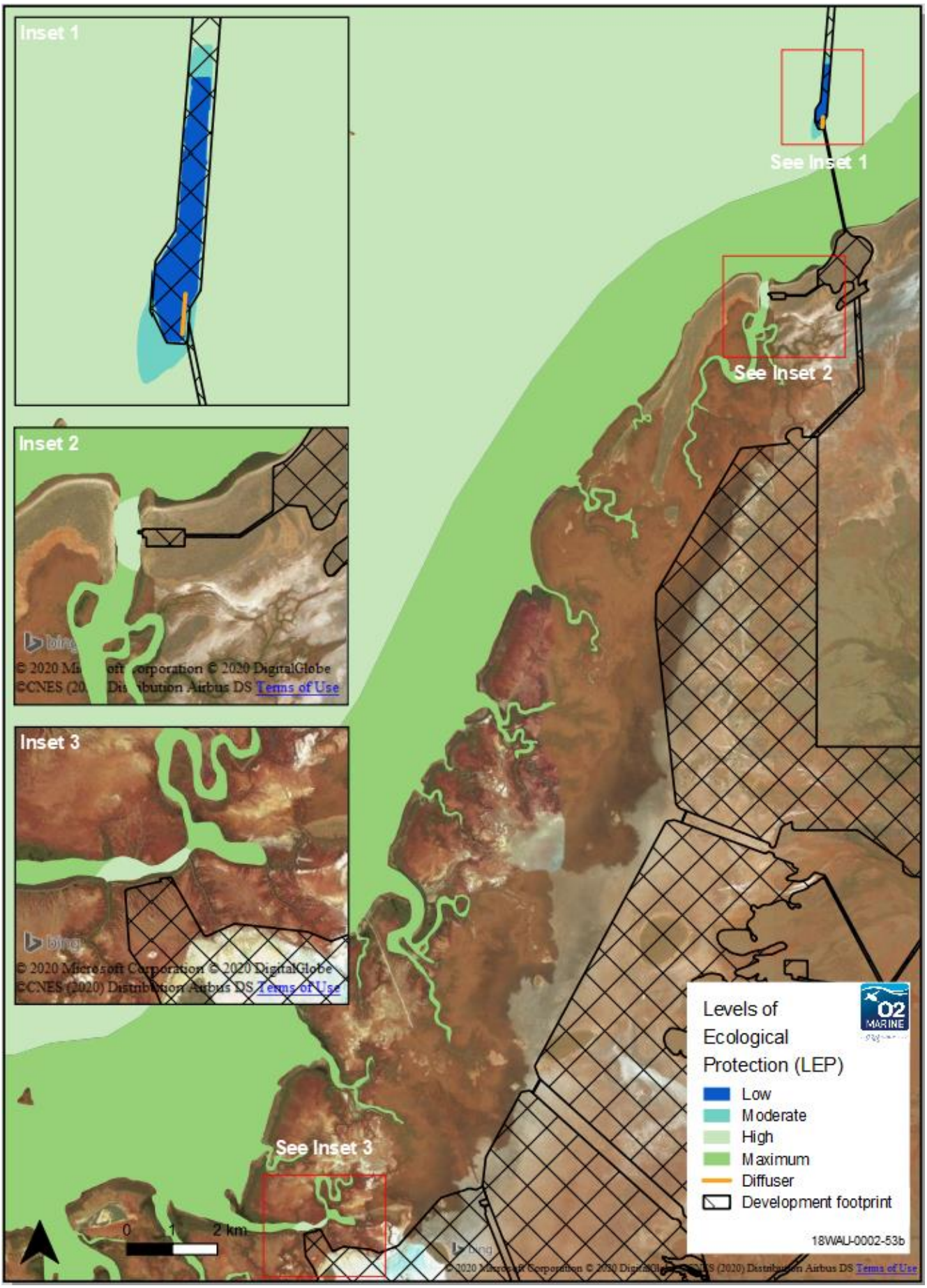

Figure 2-2 Levels of Ecological Protection for the Mardie Proposal

3. Operational Pressures and Threats to Marine Environmental Quality

3.1. Relevant Operational Activities

The following three key operational elements of the Mardie Proposal were identified in the Environmental Scoping Document (ESD) (Preston 2018) as posing a potential risk to MEQ:

- Waste bitterns discharge operations;
- Port operations; and
- Product processing and storage

The key aspects of these operational elements are discussed below in the context of risks to MEQ.

3.1.1. Waste Bitterns Discharge Operations

The production process will produce a high-salinity bittern (i.e. salinity ~325 ppt) that will be discharged into the marine environment through a diffuser at the end of the trestle jetty.

Whole of Effluent Toxicity (WET) testing results (O2 Marine 2019b) determined that the following dilutions of the waste bitterns would need to be achieved in order to meet the required Species Protection Levels (SPL) for each of the designated LEPs:

- 90% SPL requires 263 dilutions (LEPA/MEPA Boundary); and
- 99% SPL requires 417 dilutions (MEPA/HEPA Boundary).

In order to reach the required levels of dilution within each of the zones, the raw bitterns will be prediluted five-fold with seawater prior to being discharged through the diffuser (Baird 2020).

Prior to commencing full discharge operations, a diffuser commissioning phase will occur to allow initial validation of the outfall modelling and make final adjustments to the diffuser configuration (e.g. port spacing, port angle, etc.) and discharge operations (e.g. discharge rate, discharge velocity, pre-dilution rate, etc.) to ensure that the required no. of dilutions are met at the LEP boundaries specified above. Key elements of the preliminary diffuser design and configuration are provided in **Table 3-1**.

Table 3-1 Preliminary Diffuser Design and Configuration (Source Baird 2020)

Design Parameters	Details
Location:	Outfall is attached to the trestle jetty and discharges into the dredged berth pocket
Discharge Regime:	Constant
Water Depth:	6.45m MSL
No. of Ports:	Maximum 8 Ports
Port Spacing:	10.5 m apart
Port Diameter:	0.13 m
Port Angle:	90° to dominant current, 45° up towards surface
Total Diffuser Length	200 m
Discharge Velocity:	2.5 m/s
Discharge Flow Rate:	0.69 m^3/s
Discharge Volume:	3.6 GLpa
Raw Bitterns Salinity:	325 ppt
Diluted 1:5 Outfall Effluent Salinity	85.4 ppt
Whole Effluent Toxicity Results	99% SPL requires 417 dilutions – target bitterns concentration 0.24%
	90% SPL requires 263 dilutions – target bitterns concentration 0.38%
	80% SPL requires 227 dilutions – target bitterns concentration 0.44%

3.1.2. Port Operations

The Proposal includes the export of bulk salt. The salt will be loaded onto a transhipper barge using typical conveyors and ship-loading infrastructure, then the barge will travel offshore and re-load the salt onto an ocean-going vessel anchored offshore.

Some product spills may occur during the loading of vessels, however these volumes will be relatively low and intermittent. A risk area for Port Operations would be maintenance activities along the conveyor system where product has built up over time and requires removal, resulting in hypersaline runoff water to the receiving environment.

Vessel bunkering of the transhipper and support vessels is likely to be undertaken alongside the trestle jetty, within the berth pocket and the proposed LEPA/MEPA zone. Therefore, whilst hydrocarbon spills to the marine environment are possible in this area, they will be managed in accordance with leading industry operating procedures and as such represent a relatively low risk.

Vessel movements within the Port area are also likely to continually mobilise and redistribute fine sediments in the vicinity of the berth pocket.

3.1.3. Storage and Processing Facilities

Concentrator and crystalliser ponds will be developed behind low permeability walls engineered from local clays and soils and rock armoured to protect against erosion. The height of the walls varies across the project and is matched to the flood risk for the area.

A spill or leak of brine from the ponds or pipelines could result in impacts to MEQ within adjacent tidal creeks. However, brine is the resource for the Proposal, and as such the evaporation ponds and brine pipelines have been designed to minimise the risk of leaks, overflows and wall breaches. Pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further. Ponds have been designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches.

3.2. Potential Impact Pathways

The operational activities and associated potential impact pathways are summarised in **Table 3-2**.

Table 3-2 Operational Activities and Potential Impact Pathways

Facilities	Operational Activities	Potential Environmental Impact Pathway	EQO (EV) at Risk
Waste Bitterns Discharge Operations	Discharge of waste bitterns (i.e. 3.6 GLpa) to the marine environment.	Localised impact to water/sediment quality due to changed water quality conditions down-current from the bitterns outfall. Risks to water quality are primarily associated with diffuser not operating as expected or modelling predictions being incorrect.	EQO1 (Low/Moderate/High LEP) (Ecosystem Health)
Port Operations	Storage and handling of hydrocarbons and chemicals.	Contamination of water/sediment/biota resulting from a chemical/hydrocarbon spill/leak.	EQO1 (Low/Moderate LEP) (Ecosystem Health)
	Vessel bunkering operations.	Contamination of water/sediment/biota resulting from a chemical/hydrocarbon spill/leak.	EQO1 (Low/Moderate/High LEP) (Ecosystem Health)
	Product loading operations.	Changed physico-chemical conditions (i.e. salinity) of water/sediment resulting from a product spill.	EQO1 (Low/Moderate LEP) (Ecosystem Health)
	General vessel and barge operations	Contamination of water/sediment/biota resulting from vessel antifoulant.	EQO1 (Low/Moderate/High LEP) (Ecosystem Health)
		Continual re-suspension of fine sediments resulting from vessel and barge movements may impact on BCH in the immediate vicinity.	EQO1 (Low/Moderate LEP) (Ecosystem Health)
Product Storage and Processing	Storage and handling of hydrocarbons and chemicals.	Contamination of water/sediment/biota resulting from a chemical/hydrocarbon spill/leak.	EQO1 (Maximum LEP) (Ecosystem Health)
	Product storage and processing	Changed physico-chemical conditions (i.e. salinity) of water/sediment resulting from a product spill or washdown of conveyor systems.	EQO1 (Low/Moderate LEP) (Ecosystem Health)
	Bund walls	Direct impacts to water/sediment/biota resulting from leakage or failure of a pond bund wall.	EQO1 (Maximum LEP) (Ecosystem Health)

3.3. Environmental Quality Indicators

EQIs are measurable parameters selected to monitor changes in each EQO. The EQIs for the Mardie Project are listed in **Table 3-3**.

Table 3-3 Environmental Quality Indicators selected for the Mardie Project

Stressor	Environmental Quality Indicators[1]	
	Ecosystem Health (EQO1)	Recreation and Aesthetics (EQO4, EQO5 & EQO6)

< Physicochemical constituents, particularly:
  ○ salinity
  ○ dissolved oxygen
  ○ pH
  ○ water temperature
< Toxicants
< Habitat removal or disturbance
< Aquatic sediment
< Marine Pest Species
< Fauna removal or disturbance
< Freshwater flow regime
	< Toxicants in sediment
	< Toxicants in water
	< Toxicants in Biota
	< Physico-chemical constituents in water
	< Condition of Benthic Communities and Habitat
		< Nuisance Organisms
		< Faunal Deaths
		< Oil/Debris/Wrack

3.4. Environmental Quality Criteria

EQC are generally quantitative and are usually described numerically. They are comprised of Environmental Quality Guidelines (EQG) and more robust Environmental Quality Standards (EQS).

> ***Environmental Quality Guidelines*:** EQG are threshold numerical values or narrative statements which if met, indicate that there is a high degree of certainty that the associated EQO has been achieved. If the EQG is not met, then there is uncertainty as to whether the associated EQO has been achieved, and a more detailed assessment against an 'Environmental Quality Standard' (EQS) is triggered. This assessment is risk-based and investigative in nature.
>
> ***Environmental Quality Standards*:** EQS are threshold numerical values or narrative statements that indicate a level beyond which there is a significant risk that the associated EQO has not been achieved and a management response is triggered. The response would normally focus on identifying the cause/source of the exceedance and eradicating or reducing the contaminant of concern.

As identified within the Monitoring and Management Section below, it is proposed that a minimum of two years baseline data will be collected prior to commissioning through which site specific Marine Environmental Quality EQC will be derived.

The adopted approach to be used to derive EQG and EQC for the EQIs is presented within **Figure 3-1** and **Figure 3-2**.

For the purposes of assessing baseline conditions, data collected will be compared against the ANZG (2018) or relevant regional guideline (i.e. DEC 2006; CSIRO 2006) in accordance with **Figure 3-1**.

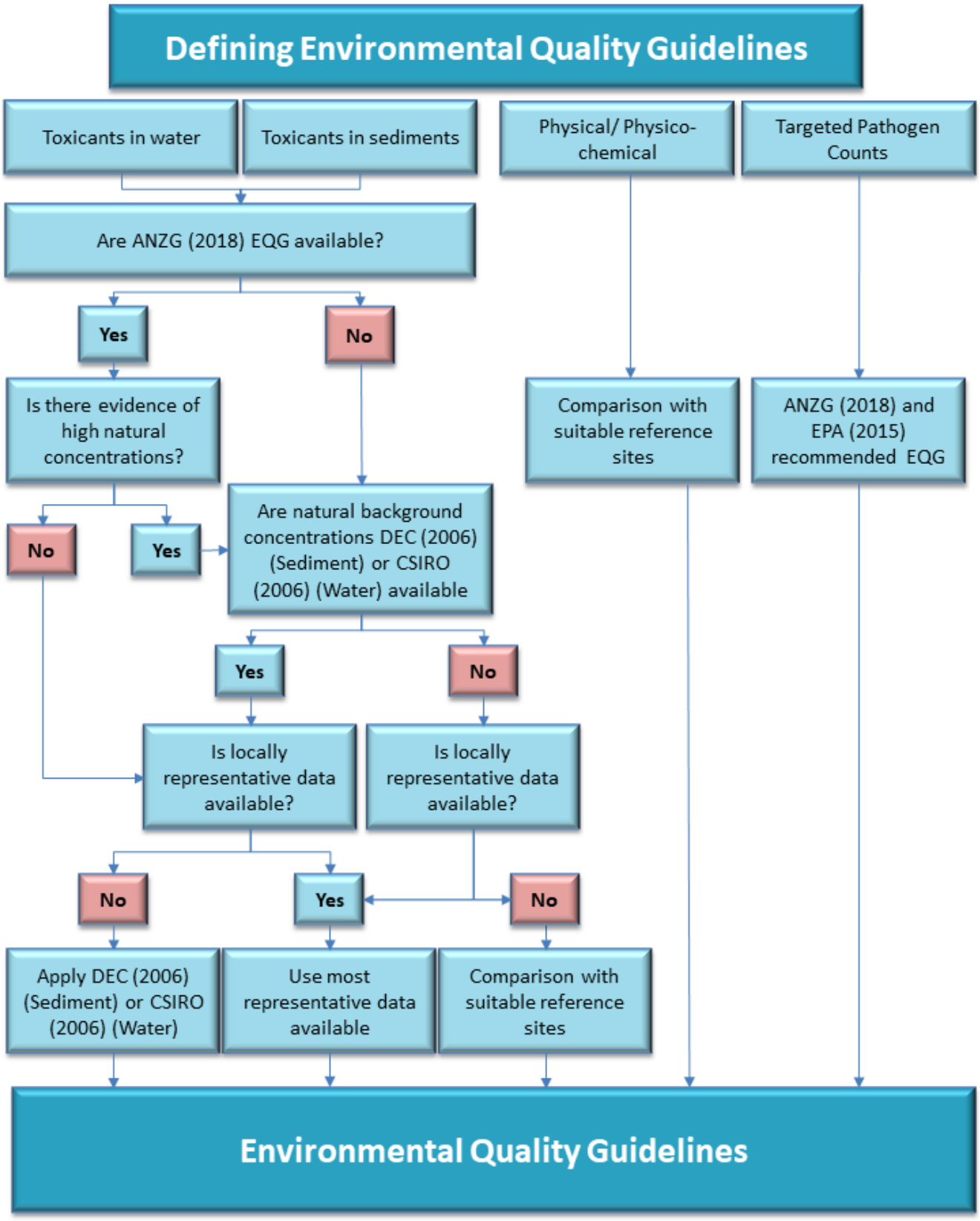

Figure 3-1 Summary of the approach used to define Environmental Quality Guidelines

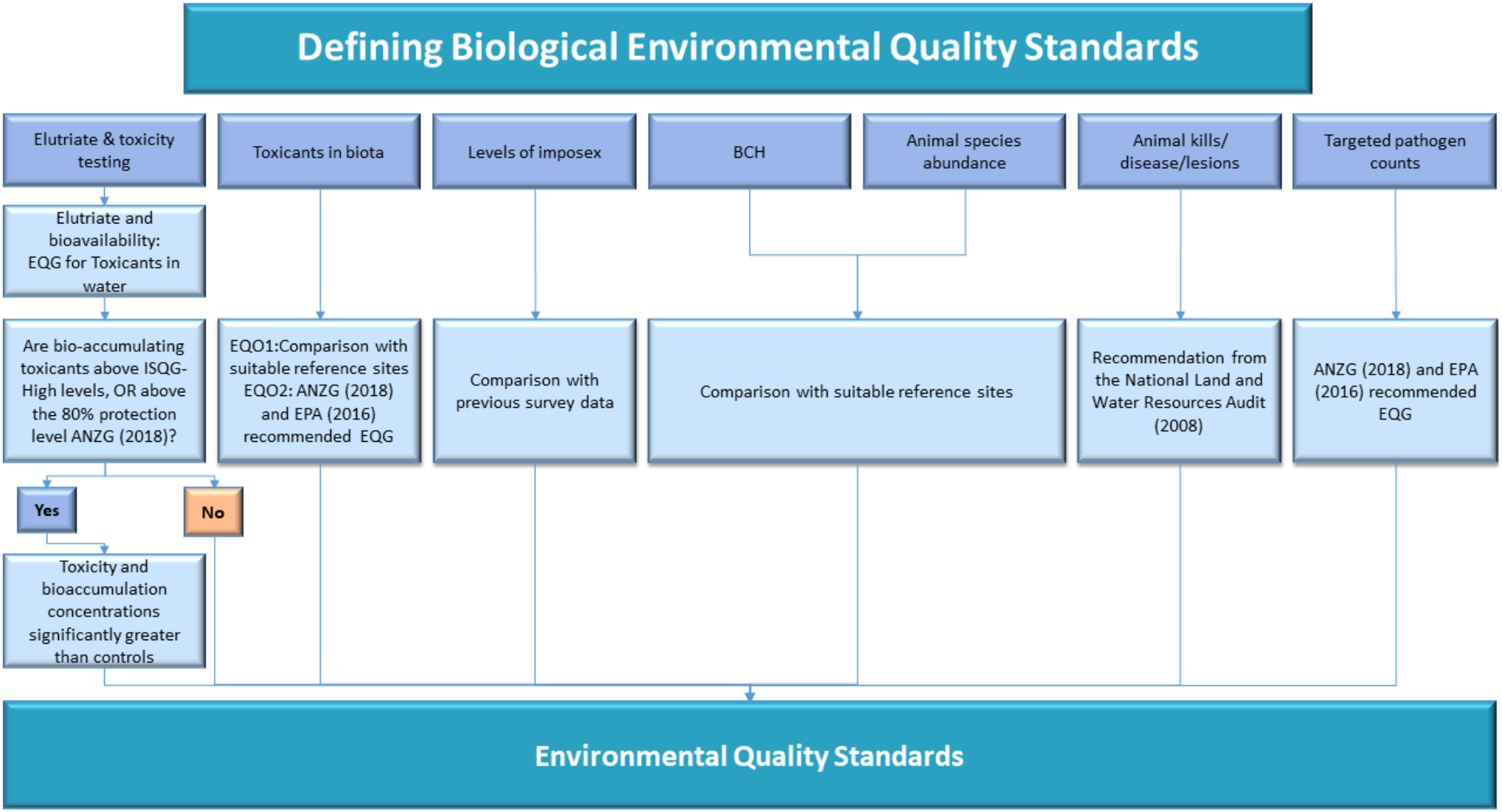

Figure 3-2 Summary of the approach used to define Environmental Quality Guidelines

4. Monitoring and Management

Monitoring and management actions proposed to mitigate potential operational impacts of the Mardie Project on MEQ are described in **Table 4-1**.

Table 4-1 Management Targets and Proposed Actions to Mitigate Operational Impacts on Marine Environmental Quality

Management Target	Management Actions		Environmental Performance		
	Item	Actions	Reporting / Evidence	Timing	Contingency
General: Maintenance of ecosystem integrity within each of the LEP areas.	1.1	Implement the Marine Environmental Quality Monitoring Program (Refer **Section 4.5.5**) to confirm the required EQOs and spatial LEPs are being achieved.	> Monitoring Program Implementation Reports	> Annually for the life of the Project.	> Implement reactive monitoring / management in the event that EQOs are determined to be at risk.
Manage waste bitterns discharge to achieve: > **A Low LEP within the nearfield mixing zone** > **A Moderate LEP within 70 m of the outfall diffuser; and** > **A High LEP within 250 m of the Port facility (i.e. Trestle Jetty, Berth Pocket and Turning Basin)**	2.1	Outfall diffuser to be designed and operated to achieve the required dilutions and associated SPLs: > At the LEPA/MEPA boundary (263 Dilutions; 90% SPL); and > At the MEPA/HEPA boundary (417 Dilutions; 99% SPL). *Note. Number of dilutions may require update to meet revised SPLs following completion of WET testing on actual bitterns sample as per Item 2.2.*	> Diffuser Basis of Design Report > Bitterns Outfall Management Plan (item 2.1) > Model Validation Study Report	> Ongoing for the life of Project.	> Revise outfall diffuser design to meet requirements.
	2.2	Undertake WET testing on the actual waste bitterns sample (refer to **Section 4.4.4**) and update modelling if appropriate to ensure that SPLs are achieved at each of the specified LEP boundaries.	> Bitterns Ecotoxicity Report > Updated Modelling Report (If required)	> During bitterns outfall commissioning phase, prior to commencement of operations. > Again during operations phase to evaluate the final discharge configuration. > Whenever changes to the product or bitterns occur during the life of the Project	> Update modelling and management plans as appropriate.

Management Target	Management Actions		Environmental Performance		
	Item	Actions	Reporting / Evidence	Timing	Contingency
	2.3	Implement the bitterns outfall model validation study as described in the MEQMMP (**Section 4.4.5**).	> Bitterns Outfall Model Validation Study Report	> During bitterns outfall commissioning phase, prior to commencement of operations. > Again during initial operations phase to evaluate the final discharge configuration. > Biannually (i.e. during winter & summer) for first 5 years > Whenever changes to the product or bitterns occur during the life of the Project	> Revise outfall diffuser design to meet requirements as appropriate.
Manage vessel bunkering, chemical storage and spill response to avoid release of contaminants to the marine environment	3.1	Develop and implement project specific management procedures: 1. Chemical Storage and Handling Procedure. 2. Bunkering Procedure. 3. Port Facility Oil Spill Response Plan. 3. Shipboard Oil Pollution Emergency Plan (SOPEP).	> Management Procedures > Audit records providing evidence of effective controls.	> Prior to commencement of any works onsite.	> Corrective actions should be applied where there is evidence that procedures have not been followed. > Update procedures as appropriate.
	3.2	All vessel equipment to be designed and operated to prevent spills and leaks through the provision of in-built safeguards including, but not limited to, relief valves, overflow protection, and automatic and manual shut-down systems.	> Inspection reports > Vessel management procedure	> Inspection reports required at least quarterly for the life of the Project.	> Rectify any equipment that is damaged or missing as soon as practicable. > Port operations not to commence prior to development and approval of vessel management procedures.
	3.3	In accordance with the Port Facility Oil Spill Response Plan (Item 3.1), Hydrocarbon spills will be reported to the Relevant Decision-making Authority (DMA). An incident report will be submitted for each spill to the marine environment.	> Verbal communication > Incident Report	> Immediate verbal communication. > Incident report submitted with 24 hrs of incident.	> Implement reactive sampling as appropriate.

Management Target	Management Actions		Environmental Performance		
	Item	Actions	Reporting / Evidence	Timing	Contingency
Manage operations to avoid release of any brine or product from the processing, storage or vessel loading facilities to the marine environment	4.1	Intake and outfall pipelines will utilise industry-standard materials to minimise the chance of leaks, and mitigation will be implemented to reduce this risk further.	> Pipeline Basis of Design Report	> Prior to pipeline installation	> Review pipeline design as required.
	4.2	Ponds will be designed with adequate freeboard and overflow features to minimise the risk of unplanned overflows and wall breaches.	> Pond Basis of Design Report	> Prior to pond construction	> Review pond design as required.
	4.3	Regular inspections to be undertaken on facilities to ensure: > Bund wall condition / integrity; and > Pipeline condition / integrity.	> Inspections reports	> At least quarterly for the life of the Project.	> Implement routine or reactive maintenance as required to rectify any observed defects.
	4.4	Routine maintenance procedures to be developed and implemented for all product storage and processing infrastructure.	> Maintenance Procedures	> Procedures to be developed prior to construction and updated as required for the life of the Project	> Corrective actions should be applied where there is evidence that procedures have not been followed. > Update procedures as appropriate
	4.5	Relevant Decision-making Authority (DMA) is to be notified immediately in the event of a critical asset failure to the marine environment. An incident report will be submitted for each spill.	> Verbal communication > Incident Report	> Immediate verbal communication. > Incident report submitted with 24 hrs of incident.	> Implement reactive sampling as appropriate.

4.1. Monitoring and Management Programs

To ensure that defined EVs and EQOs are not compromised through construction, commissioning and routine operation of the Mardie Project a comprehensive monitoring and management program is proposed. The elements of the monitoring and management program as they relate to potential MEQ impacts from the Project are defined in **Table 4-2**, whilst an overview of the monitoring requirements are presented in **Table 4-3**.

Table 4-2 Elements of the Marine Environmental Quality Monitoring and Management

Element	Sub-Elements	Rationale
Pre-Commissioning Baseline Monitoring	Water Quality Monitoring Sediment Monitoring Benthic Infauna Physical Observation	To collect sufficient spatial and temporal data with a high level of replication from which site specific EQGs and EQS will be derived. Potential Project impacts have been identified to water and sediment quality, so monitoring has been designed in accordance with ANZG (2018) protocols for monitoring and assessment of these values.
Bitterns Diffuser Outfall Commissioning	Bitterns Discharge Quality Bitterns Discharge Flowrate	To implement a monitoring and management program for bitterns outfall diffuser commissioning that meets MEQ expectations. This program targets the actual water quality being discharged to ensure that the design specifications are being achieved. If water quality of the discharge is achieved, then it is assumed through bitterns outfall modeling that the EQC within each LEP will be achieved (Note: the below program will validate this assumption)
Marine Environmental Quality Validation	Whole Effluent Toxicity Testing	To identify the actual toxicity of the bitterns discharge on local native species. These results will be used with other monitoring results to validate modelled impact predictions and verify the LEPs and EQCs.
	Bitterns Diffuser Outfall Validation Testing	To ensure that the specified bitterns discharge criteria are met once routine operations are established. These results will be used with other monitoring results to validate modelled impact predictions and verify the LEPs and EQCs.
	Model and EQC Validation	To provide an assessment of whether the defined EQCs are being met at their respective LEPs and determine if the discharged bitterns conform with WET testing and modelled predictions and required dilutions are being achieved at the LEPA/MEPA and MEPA/HEPA boundaries during routine operations. These results will be used with other monitoring results to validate modelled impact predictions and verify the LEPs and EQCs
Routine Operational Performance Assessment	Bitterns Diffuser Outfall Water Quality	To ensure that design specifications for bitterns discharge constituents, as defined by modelling and WET testing, are being achieved through the lifecycle of the Project.
	Ongoing Marine Environmental Quality	To verify that impacts from operational activities associated with the Mardie Project, such as ocean outfall, vessel operations stormwater runoff or groundwater flows, do not impact MEQ outside the limits of acceptable ecological change associated with the defined LEPs.

Table 4-3 Monitoring Program Overview

Element	Sub-Element	Sample Requirement	Parameters	Frequency	Duration	No. of Sites	No. Samples per site*
Pre-Commissioning Baseline Monitoring	Water Quality Monitoring	Physico-chemical in-situ data logging	Electrical conductivity Salinity Temperature Depth/Pressure Photosynthetically active radiation Temperature Turbidity	Continuous	2 years	3	NA
		Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity Dissolved oxygen	Six weekly	2 years	3	NA
		Water sampling	Alkalinity and hardness; Nutrients; Total recoverable hydrocarbons; Total petroleum hydrocarbons; BTEXN; Total organic carbon; Dissolved major cations and anions; Dissolved metals and metalloids; Fluoride, chloride, sulfate; Silicon anion, Calcium, magnesium, sodium, potassium cations; and Ionic balance	Six weekly	2 years	3	1

Element	Sub-Element	Sample Requirement	Parameters	Frequency	Duration	No. of Sites	No. Samples per site*
	Sediment Quality Monitoring	Sediment sampling	Particle size distribution; Total organic carbon; Moisture; Metals and metalloids; Organic compounds; Nutrients; Pesticides	Once only**	NA	10	1
	Benthic infauna	Sediment grab sample	Lowest taxonomic level	Annual	2 years	10	3
	Aesthetic Observation	Physical observations	Nuisance organisms Large-scale deaths Oil/Film Natural reflectance Objectionable odour Floating debris, rubbish, surface slicks	Six weekly	2 years	3	NA
Bitterns Diffuser Outfall Commissioning	Bitterns discharge quality	Water grab sample	Salinity	Weekly	TBD	3	2
		Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity	Weekly	TBD	2	NA
	Bitterns discharge flowrate	Flow rate measurement	Instantaneous flow rate – 0.69 m^3/s	Weekly	TBD	NA	NA
Marine Environmental Quality Validation	Whole Effluent Toxicity Testing	Actual bitterns sample	48-hour larval development test: Saccostrea echinate (Milky Oyster). 96-hr toxicity test: Melita plumulosa (Amphipod). 8-day Sea anemone pedal lacerate development test: Aiptasia pulchella	Once only***	NA	NA	1

Element	Sub-Element	Sample Requirement	Parameters	Frequency	Duration	No. of Sites	No. Samples per site*
			72-hr sea urchin larval development test: Heliocidaris tuberculata. 96-hr Fish Imbalance toxicity test: Lates calcarifer (Barramundi). 7-hr Fish Imbalance and biomass toxicity test: Lates calcarifer. 72-hr marine algal growth test: Nitzschia closterium.				
	Bitterns Diffuser Outfall Validation Testing	Grab Sample	Salinity	Weekly	6 Weeks	3	2
		Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity	Weekly	6 Weeks	2	NA
		Flow rate measurement	Instantaneous flow rate – 0.69 m^3/s	Continuous	6 Weeks	NA	NA
	Model and EQC Validation	Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity Dissolved oxygen	Weekly	6 Weeks	21	NA
		Water Sampling	Alkalinity and hardness; Nutrients; Total recoverable hydrocarbons; Total petroleum hydrocarbons; BTEXN; Total organic carbon; Dissolved major cations and anions;	Weekly	6 Weeks	21	1

Element	Sub-Element	Sample Requirement	Parameters	Frequency	Duration	No. of Sites	No. Samples per site*
			Dissolved metals and metalloids; Fluoride, chloride, sulfate; Silicon anion, Calcium, magnesium, sodium, potassium cations; and Ionic balance				
		Physical observations	Nuisance organisms Large-scale deaths Oil/Film Natural reflectance Objectionable odour Floating debris, rubbish, surface slicks	Weekly	6 Weeks	21	NA
Routine Operational Performance Assessment	Bitterns Diffuser Outfall Water Quality	Grab Sample	Salinity	Biannually	2 Years	3	2
		Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity	Biannually	2 Years	2	NA
		Flow rate measurement	Instantaneous flow rate – 0.69 m^3/s	Continuous	2 Years	NA	NA
	Ongoing Marine Environmental Quality	Physico-chemical water column profiling	Electrical conductivity Salinity Temperature Depth Temperature Turbidity Dissolved oxygen	Quartley	Ongoing	21	NA
		Water Sampling	Alkalinity and hardness; Nutrients; Total recoverable hydrocarbons;	Quarterly	Ongoing	21	1

Element	Sub-Element	Sample Requirement	Parameters	Frequency	Duration	No. of Sites	No. Samples per site*
			Total petroleum hydrocarbons; BTEXN; Total organic carbon; Dissolved major cations and anions; Dissolved metals and metalloids; Fluoride, chloride, sulfate; Silicon anion, Calcium, magnesium, sodium, potassium cations; and Ionic balance				
		Sediment Sampling	Particle size distribution; Total organic carbon; Moisture; Metals and metalloids; Organic compounds; Nutrients; and Pesticides	Annually	Ongoing	21	1
		Benthic Infauna	Lowest taxonomic level	Annual	Ongoing	10	3
		Physical observations	Nuisance organisms Large-scale deaths Oil/Film Natural reflectance Objectionable odour Floating debris, rubbish, surface slicks	Quarterly	Ongoing	21	NA

Notes:

** Excludes field QA/QC sample requirements*

*** Excludes previously undertaken investigation reported in O2 Marine 2019a*

**** WET testing also required at any time during which the Project process is altered in any way, thus potentially altering the levels of constituents and therefore possibly the toxicity within the discharge stream*

4.2. Pre-Commissioning Baseline Monitoring Program

4.2.1. Context

In order to be able to determine impacts upon MEQ from the Mardie Project a comprehensive set of EQCs needs to be defined that are specific to the local area within which the Project will be situated. The pre-commissioning baseline monitoring program aims to collect data from the local marine environment with which to derive site specific EQCs for which actual Project impacts can be measured against during commissioning and ongoing routine operations. This program is typically comprised of the following sub-monitoring elements:

- Marine water quality monitoring;
- Physical observations;
- Sediment monitoring; and
- Benthic infauna.

4.2.2. Purpose

The purpose of this element is to collect sufficient spatial and temporal data with a high level of replication from which site specific EQGs and EQS will be derived in accordance with ANZG (2018). Site specific EQGs and EQS will be used to define marine environmental performance during both the commissioning and routine operational phases of the Project lifecycle. In accordance with ANZG (2018) a two-year baseline monitoring period is proposed to provide a suitable data set for the intended purpose.

This phase will also allow the fine tuning of sampling methodology to ensure the described practices are effective when applied under field situations. Any lessons learnt, or alterations to the defined methodologies will need to be included into a revised version of this MEQMMP.

4.2.3. Sampling Design

Table 4-4 provides a summary of the proposed sampling frequency. Where practical, sampling should be undertaken on or near to the same date each month/year to allow for consistent comparison of seasonal trends. Sampling frequency has been determined based on the recommended number of samples and sample collection frequency specified in ANZG (2018).

Sediment and water quality investigation have previously been undertaken to assists with the environmental assess met for the proposed project. Data has been analysed and reported in the following project specific technical documents:

- Mardie Project Baseline Sediment Characterisation. Report prepared by O2 Marine for Mardie Minerals Ltd (O2 Marine 2019a); and
- Mardie Project Baseline Water Quality Monitoring. Report prepared by O2 Marine for Mardie Minerals Ltd (O2 Marine 2020a).

Whilst these studies were developed to specifically inform project environmental impact assessment, data collected will be pooled with data to be collected during the baseline water and sediment quality program to derive EQIs in accordance the process specified in **Section 3.4**.

Additional sediment and water quality data will be collected in accordance with this MEQMMP.

Table 4-4 Monitoring Frequency for the Proposed Phase I Baseline data collection

Monitoring Event	Frequency	Period	No. of Sampling Rounds*	No. of Samples Collected*
Physico-chemical Water Quality Profiling	Six weekly	2 years	17	52
In-Situ Physico-chemical Monitoring	Continuous	2 years	NA	NA
Benthic Infauna	Annual	2 years	10	60
Sediment Monitoring	Annual	2 years	10	10
Physical Observation	Six weekly	2 years	17	52
Water Samples	Six weekly	2 years	17	52

Notes:
** Excludes sampling previously undertaken as reported in O2 Marine 2019a or O2 Marine 2020a.*

The water quality monitoring program includes three (3) monitoring locations displayed in **Figure 4-1** and presented in **Table 4-5**. Sediment quality and infauna monitoring programs include 10 locations as displayed in **Figure 4-2** and presented in **Table 4-5**

Table 4-5 Baseline Water Quality Monitoring Locations and Routine Tasks

Site Name	Site Reference	Level of Ecological Protection	Easting	Northing	Routine Sampling Tasks					
					Physical Observations	Physico-chemical Water Column Profiling	In-situ Water Physico-chemical Monitoring	Water Sample Collection	Sediment Monitoring	Benthic infauna
MB1	This site is located adjacent to the proposed bitterns outfall diffuser allowing an assessment of the pre-project baseline conditions.	High	388382.2	7673404.0	X	X	X	X		
NC1	This site is located adjacent to the small vessel support infrastructure area within Mardie Creek allowing assessment of impacts associated with related activities.	High	388401.7	7668638.8	X	X	X	X		
MIC1	This site is located adjacent to the sweater abstraction intake within Peter's Creek allowing assessment of potential impacts related to this activity.	High	379199.1	7649389.6	X	X	X	X		
RF2 – RF5 OC1 – OC3	These sites have been carried over form O2 Marine 2019a and represent the proposed dredge footprint. These sites are suitable for further baseline data collection and represent seasonal variation.	High Moderate/High	389772.7 389735.9 389742.7 389942.7 389626.0 389577.9 389566.6	7674002.7 7674500.9 7675382.8 7676618.4 7673387.7 7673163.0 7672970.7	X				X	X

Site Name	Site Reference	Level of Ecological Protection	Easting	Northing	Routine Sampling Tasks					
					Physical Observations	Physico-chemical Water Column Profiling	In-situ Water Physico-chemical Monitoring	Water Sample Collection	Sediment Monitoring	Benthic infauna
RD1 – RD3	These sites are included to cover the revised berthing pocket preciously unsampled to date. These sites are new for this program	Low	389556.4 389567.6 389591.7	7672173.1 7672458.0 7672746.2	X				X	X

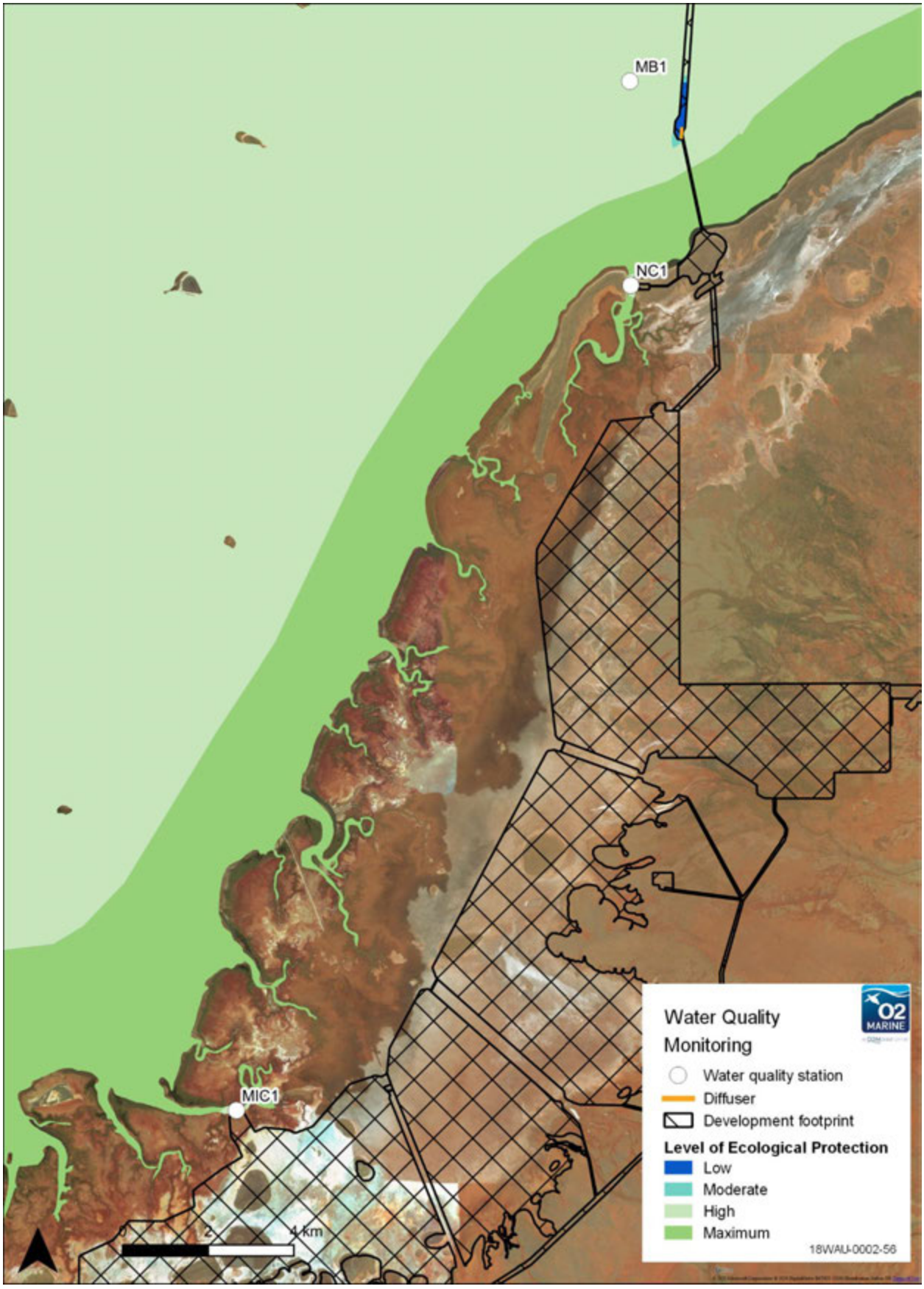

Figure 4-1 Baseline Water Quality Monitoring Locations

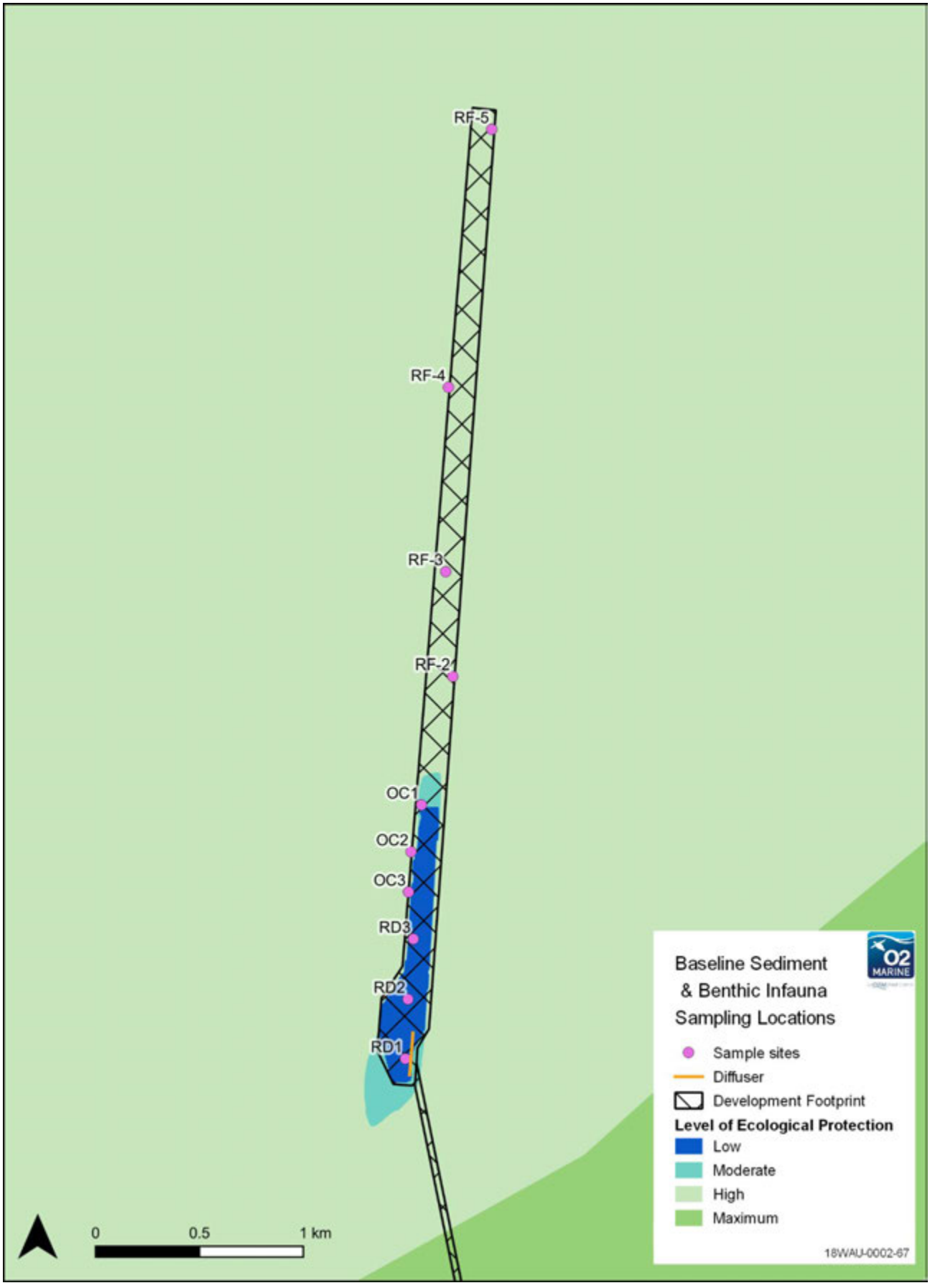

Figure 4-2 Baseline Sediment Quality and Benthic Infauna Monitoring Locations

4.2.4. Sampling Methodology

Physical Observations

General Observations

The following field observations are to be recorded at each site during each sampling event:

- Date and time of sampling at each location;
- Person conducting sampling;
- Site reference;
- GPS coordinates of sampling location;
- Tides and water depth at the time of sampling;
- Wind speed (km/hr) and direction;
- Air temperature (ºC) – recorded using a digital thermometer;
- Sea state (i.e. wave and swell heights); and
- General weather conditions (rain, storms, cloud cover, etc).

Digital photographs should also be taken throughout the monitoring event as weather conditions change and as required to document any notable site observations. Field logs are to be scanned and saved in BCI's records management system and attached as an appendix in the quarterly and annual reports.

Aesthetic Observations

At each sampling location, observations of aesthetic water quality parameters should be recorded for each of the quick reference guide categories provided in **Table 4-6**. Aesthetic observations are to consider waters within an approximate 50 metre radius of the survey vessel.

Table 4-6 Aesthetic observations quick reference guide

Parameter	REF	1	2	3	4	5
Nuisance organisms (Surface coverage %)	**A**	Nil	1-10	11-50	51-80	100+
Large-scale deaths (Marine fauna)	**B**	Nil	1-10	11-51	51-81	100+
Oil/Film (Surface coverage)	**C**	Nil	1-10%	11-50%	51-80%	81-100%
Natural reflectance (Diminished)	**E**	81-100%	51-80%	11-50%	1-10%	Nil
Objectionable odour	**F**	Nil	Slight	Moderate	Strong	Offensive
Floating debris, rubbish, surface slicks (Surface coverage %)	**G**	Nil	1-10	11-50	51-80	100+

Physico-chemical Water Quality Monitoring

In-situ Water Quality Sampling and Analysis

A range of instruments will be deployed at all three (3) monitoring locations as presented within **Table 4-5** to record in-situ physiochemical parameters, each attached to purpose-designed seabed frames. The in-situ loggers will record the following parameters:

- Electrical Conductivity
- Salinity
- Temperature
- Depth/Pressure
- Photosynthetically Active Radiation (PAR)
- Temperature
- Turbidity (NTU)

The seabed frames are designed to stand upright on the seabed, while maintaining the instruments at approximately 0.3 m above the seafloor and to reduce the likelihood of interaction of sensors with sediment, large rocks and rubble on the seafloor.

Water quality instrument maintenance & calibration is conducted regularly (i.e. typically every 6 weeks) in addition to the download of data to ensure data is not compromised through biofouling of the sensors or failed batteries. Maintenance, calibration checks, battery replacement and data download/backup are carried out in line with manufacturer specifications and QA/QC protocols. Where calibration checks are not satisfactory, a new calibration is performed as per manufacturer specification. Each maintenance service involves retrieval of the frame onto land, maintenance and then redeployment typically occurring within a 24-hr period.

Physico-chemical Depth Profiling

A pre-calibrated, Water Quality Sonde will be used to collect physico-chemical water quality profiles at all three (3) sampling locations identified within **Table 4-5**. As a minimum, the following parameters will be measured at 0.5 metre (m) intervals throughout the water column:

- Depth (m);
- Water temperature (ºC);
- pH;
- Salinity (ppt);
- Electrical Conductivity (mS/cm);
- Turbidity (NTU); and
- Dissolved oxygen (% saturation & mg/L).

All recorded measurements are to be stored on the sonde hand-held unit and downloaded to a secure server within 24 hours. The data should be immediately assessed to ensure validity and, any erroneous data should be removed from the analysis as appropriate.

Water Sample Collection

Water samples will be collected at all three (3) sampling locations as identified within **Table 4-5**. Water samples will be collected using a depth-integrated water sampler[1] to pump the required volume of water evenly from the water column between 0.5 m below the surface to 0.5 m above the seabed.

The water sampler will be rinsed with Decon solution (or equivalent) between samples. Water samples will be collected in suitable (laboratory supplied) bottles and immediately stored on ice for transport to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

All sample containers will be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are *marine water* using a waterproof permanent maker. All samples will then be listed on a Chain of Custody (CoC) form to be included with the samples sent to the laboratories.

Laboratory Analysis

General water sample analysis will be performed on samples collected from all 3 sampling locations**.** These samples are required to be analysed by a NATA-accredited laboratory for the following;

- Alkalinity and Hardness;
- Nutrients (NH_4+, NO_2-/NO_3-, TKN, TN, TP) ;
- Total Recoverable Hydrocarbons (TRH);
- Total Petroleum Hydrocarbons (TPH);
- BTEXN;
- Total Organic Carbon (TOC);
- Dissolved Major Cations and Anions;
- Dissolved Metals and Metalloids (Al, Sb, As, Ba, Be, Bi, Bo, Br, Cd, Cr, Co, Cu, I, Fe, Pb, li, Mn, Hg, Mo, Ni, Se, Ag, Sr, Tl, Th, Sn, Ti, U, V, Zn);
- Fluoride, chloride, sulfate;
- Silicon anion,
- Calcium, Magnesium, sodium, potassium cations; and
- Ionic balance.

Field Quality Assurance & Quality Control

All water quality meters are to be in calibration. If monitoring equipment is hired, calibration certificates are to be provided from the supplier. Calibration records are to be saved and attached as an appendix to compliance reports.

The following Quality Assurance & Quality Control (QA/QC) Samples should be collected as described below:

- A ***duplicate sample*** is to be collected at the same site as two (2) of the primary monitoring samples. The purpose of the sample is to confirm that the primary laboratory is able to

[1] If a depth-integrated water sampler is not available, a pole sampler or niskin bottle (or equivalent) may be used to sample at a depth of 0.5m below the surface. Near-surface sampling is generally considered to be representative of water quality at the sample sites as waters in Mardie Coastline experience a high degree of mixing.

produce consistent results when analysing the same sample. The site where it was taken is to be recorded but not reported to the laboratory. Ideally it should be collected at a site that is expected to have higher levels of contamination (based on historic data and potential sources of contamination) as this will confirm a wider range of analytes and reduce the level of instrument error when comparing larger concentrations.

- A ***field split sample*** is collected at the same site as the duplicates and sent to a secondary laboratory for analysis. The purpose of this sample is to confirm that intra-laboratory analysis of the sample produces consistent results.
- A ***rinsate sample*** is collected to confirm that cross contamination doesn't occur during the sampling processes in the field. The rinsate sample should be taken after the decontamination process of the sample collection container by running deionised water over the container and collecting it in laboratory provided bottles.

Laboratory Quality Assurance & Quality Control

Laboratories used for water sample analysis must be NATA accredited. Comprehensive QA/QC testing of water samples should be undertaken in accordance with NATA accreditation and include testing of laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogate recovery outliers (where applicable).

Sediment Sampling

Sample Collection

Sediment samples will be collected at all ten (10) sampling locations described in **Table 4-5**. Sampling will involve the collection of sediment using a combination of vibro-coring, surface grab sampling and diver-coring. The grab, plastic tray and other equipment in contact with the sediment will be rinsed with Decon solution and seawater prior to sampling each site to reduce potential for contamination. Where insufficient sediment is collected (i.e. less than 1/3rd of grab volume), the grab will be required to be redeployed. Estimate and record the volume of sediment collected and empty the grab into a plastic tray to mix and homogenise the sediment. Photograph each sample once emptied into the plastic tray. Place sample into appropriate sample jars/ containers provided by laboratory. Containers should be refrigerated or placed into an esky with ice bricks before frozen at the completion of each sampling day and sent to a NATA approved laboratory.

All sample containers will be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are *marine water* using a 'Wet-write' permanent maker. All samples will then be listed on a CoC form which will accompany the samples sent to the laboratories.

Laboratory Analysis

Sediment quality sample analysis will be performed on samples collected from all 10 monitoring locations**.** These samples will be analysed by a NATA-accredited laboratory for the following analytical suite:

- Particle size distribution (PSD);
- Total organic carbon (TOC);
- Moisture;

- Metals and metalloids (Al, Ag, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Sb, V and Zn);
- Organic compounds (TPH/TRH, BTEXN, PAHs, TBT);
- Nutrients (TN, TKN, NH4, NO2+NO3, TP, FRP); and
- Pesticides.

Field Quality Assurance & Quality Control

Disposable nitrile gloves should be used during handling of the sediment sample and all equipment in contact with the sediment should be washed down with Decon solution prior to each sample being taken. The following QA/QC Samples should be collected as described below:

- ***Triplicate samples*** (i.e. three separate samples taken with the sediment grab at the same location) should be taken at one (1) site to determine the variability of the sediment physical and chemical characteristics.
- A ***field split sample*** (i.e. one sediment grab sample thoroughly mixed and then split into three sub-samples) should be collected at collected at one (1) site to assess inter and intra-laboratory variation, with one of the three samples sent to a second laboratory.
- A ***transport blank*** (acid-washed silica sand) in a sealed jar should be provided by the laboratory and taken to site but not opened. The transport blank is sent back to the laboratory with the other samples and analysed. This blank is used to assess if any contamination is already present in the acid-washed sand or container.
- A ***method blank*** (acid-washed silica sand) should be used to assess the potential for contamination during the sampling process. The method blank should be placed into the 'van Veen' grab and processed identically to the usual sediment samples. The method blank should be sent to the laboratory and analysed with the other samples to assess presence of contamination during the processing procedures.

Laboratory Quality Assurance & Quality Control

Laboratories used for sediment toxicity sample analysis must be NATA accredited. Comprehensive QA/QC testing of sediment samples should be undertaken in accordance with NATA accreditation and include testing of laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogate recovery outliers (where applicable).

Benthic Infauna

Sample Collection

Sediment samples for benthic infauna analysis will be collected at all 10 locations as identified within **Table 4-5**. Benthic infauna samples will be collected from a vessel using a sediment grab sampler such as a van-veen grab or similar. Three (3) replicate samples will be collected at each location to provide statistical replication required for adequate analysis of benthic infauna.

The following sample process/collection steps will occur:

- Once the sample has been recovered it will be released from the grab sampler into a suitable collection tray
- Weigh the sediment sample and record for post sampling data analysis purposes;

- Sieve the sediment through a 500 µm sieve using either the saltwater deck wash to remove fine sediment; and
- All material retained on the sieve, such as coarse sediment and benthic infauna, will be carefully rinsed into suitable pre-labelled containers and preserved with 95-100% ethanol solution.

This process will be replicated to ensure three (3) individual sediment samples are collected from each location to provide sufficient statistical data to allow assessment of variability within each sample location.

Equipment required for the benthic infauna sediment sampling includes the following:

- Suitable sediment grab sampler;
- Deck winch;
- Deck wash hose;
- Sample collection tray;
- Funnel (x2)
- 500 µm sieve box;
- Suitable sample containers;
- Washing bottles;
- Waterproof labelling pens;
- Decon 90; and
- 95-100% Ethanol solution.

4.2.5. Data Assessment and Reporting

Data Validation

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

Quality Control

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (rinsate, transport blank and method blank);
- Assessment of field variability (duplicate and triplicate);
- Assessment of lab variability (triplicate); and
- Laboratory QA/QC results.

Data Assessment

During this phase no, commissioning or project related operational activities will occur. Therefore, data collected will not be required to be assessed against the EQCs identified within **Section 3.4** to interpret if EVs and EQOs are being compromised. However, for the purposes of providing context to sample results, ANZG (2018) and DEC (2006) guidelines will be applied in accordance with **Figure 3-1**.

At the completion of the two year baseline data collection period a review of the baseline data will be undertaken to derive and determine site specific EQC for the LEPA, MEPA and HEPA LEP Boundary areas in accordance with the process outlined in the EQMF (**Section 3.4**). Site specific EQC will be incorporated into a revised version of this MEQMMP once defined.

Reporting

At the completion of each sampling round a brief summary report will be submitted outlining the results obtained.

A comprehensive report will be compiled at the completion of the two-year data collection period which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical water column profiles;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- Statistical summary of infauna (as per collection frequency)
- An assessment of all data collected against the EQCs;
- Presentation of the calculated site specific EQG and EQS in accordance with ANZG (2018); and
- Any actions or recommendations required as a result of field implementation of the Sampling and Analysis Plan (SAP) and assessment of monitoring data.

4.3. Bitterns Diffuser Outfall Commissioning

4.3.1. Context

In order to discharge bitterns, a diffuser commissioning period will be required. During commissioning it is possible that the bitterns being discharged will not meet the design criteria which was initially used to model the dilutions and recirculation in order to establish an appropriate mixing zone. The end of the commissioning period will be determined when engineering confirms typical operating conditions have been achieved for all facilities and associated infrastructure and monitoring confirms the SPLs for each LEP are achieved.

Management during the initial commissioning process is focused on achieving the desired level of dilution required to ensure the discharged bitterns meets the accepted level of brine discharge. Where desired levels are not being achieved contingency actions will be implemented to ensure the permanent bitterns outfall discharge process and design are optimised prior to completion of commissioning. These actions that are implemented during commissioning will ensure that the end point for routine operations is a discharge process that meets or exceeds the expected targets.

4.3.2. Purpose

The purpose of commissioning monitoring and management is to design a process that meets MEQ expectations, whilst providing flexibility during the initial stages of the bitterns discharge process to allow a staggered start up and optimisation process. Management triggers have been designed which provide assurance around protecting EVs, but also to ensure appropriate contingency management actions, such as alterations to the process or design, are implemented during this period, thus reducing the potential for long-term issues.

4.3.3. Management Triggers

In order to achieve the purpose, two levels of management triggers have been established which will inform Management when contingency measures need to be put into place to ensure the required SPLs are met at the LEP boundaries. Contingency measures are identified in **Section 4.3.5** and are typically based upon conducting an investigation into the reason why a management trigger was exceeded and putting appropriate corrective actions in place to reduce re-occurrence and where possible rectify the situation to ensure optimisation of the process prior to completion of commissioning.

The two levels of management triggers are based upon the maximum instantaneous flow rate and the maximum predicted design concentration for constituents within the bitterns discharge.

Additional management trigger levels are applicable to the MEPA / LEPA boundary, however these are detailed within **Section 4.4**.

Management Trigger 1

Management trigger 1 is based upon the maximum instantaneous flow rate of:

- *0.69 m^3/s constant discharge regime.*

The management trigger level will be exceeded if the maximum instantaneous flow rate is exceeded, thus enacting contingency management as described in **Section 4.3.5.**

Management Trigger 2

Management trigger 2 is based upon maximum discharge concentrations of:

- *325 ppt salinity of the pre-diluted bitterns waste; and*
- *85.4 ppt salinity of the 5 times diluted bitterns waste at the outfall.*

Adjusted management trigger levels will be revised accordingly prior to commissioning to ensure they are appropriately set. If any management triggers are breached contingency management as described in **Section 4.3.5** will be required.

4.3.4. Bitterns Diffuser Outfall Commissioning Monitoring Program

Bitterns diffuser outfall commissioning monitoring will require continuous flow rate monitoring during discharge and water samples to be collected from the raw bitterns wastewater sump and at the diffuser outfall.

Two duplicate water samples will be collected weekly from the raw bitterns wastewater sump directly prior to discharge and at two locations at the point of discharge. Samples will be collected in accordance with ANZG (2018) requirements for water quality sampling. QA/QC samples will require a transport blank.

Physico-chemical water column profiles will be taken in-situ with a suitable and calibrated water quality sensor from the surface to ~0.5 m from the seabed at two location at the point of discharge. Results will be backed up within 24 hours of collection.

Water samples will be sent to a NATA accredited laboratory for analysis. The full analytical suite will be determined at the completion of the pre-commissioning baseline phase and presented within the revised version of this Plan. Laboratory QA/QC requirements will be undertaken in accordance with the NATA accreditation and reported with the sample results.

Data Assessment and Reporting

Data Validation and Quality Control

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (transport blank);
- Assessment of variability (duplicate);
- Laboratory QA/QC results.

Data Assessment

Laboratory analysed samples, physico chemical results and recorded flow rates will be compared with defined management triggers as soon as practicable. Any elevation will require contingency actions as described in **Section 4.3.5** to be implemented**.**

Reporting

At the completion of each sampling round a validated laboratory report and interpreted tabulated data will be submitted to BCI Minerals.

An investigation report will be compiled in accordance with BCI Minerals Management System for any elevated results which requires investigation. Submission to the regulator will be subject to project approval conditions.

A comprehensive report will be developed at the completion of the commissioning phase which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical parameters In-situ;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- An assessment of all data collected against management triggers;
- A review of management trigger exceedances investigations and remedial actions implemented; and
- Any actions or recommendations required as a result of field implementation of the SAP and assessment of monitoring data.

4.3.5. Contingency Management during Commissioning

In the event that the bitterns discharge is not meeting the defined management triggers operational and design solutions will be investigated. Firstly, depending upon the exceedance, an investigation needs to be undertaken to determine the cause(s). Once the cause(s) is determined then appropriate corrective or preventative actions need to be put into place to ensure re-occurrence does not occur. This system of investigation and implementation of remedial actions will ensure that during the commissioning phase all possible design modifications are put into place to ensure optimal performance of the process at the completion of commissioning.

There are several potential operational and design solutions which may be used as contingency measures in response to management trigger exceedances. **Figure 4-3** provides an overview of the contingency response and management framework to be applied during commissioning of the diffuser.

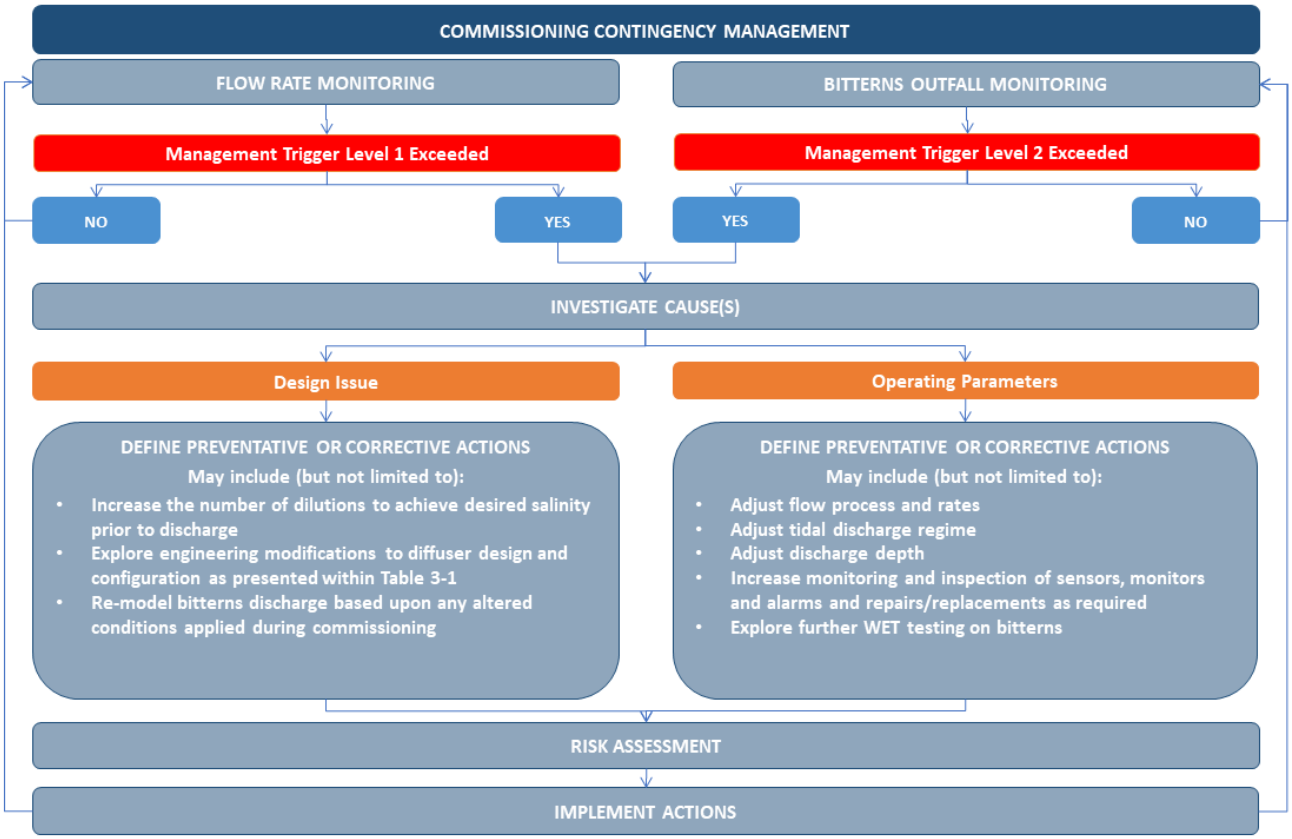

Figure 4-3 Contingency management framework during bitterns discharge commissioning

4.4. Bitterns Diffuser Outfall Validation

4.4.1. Context

To determine the actual impacts from project related activities to the MEQ a comprehensive MEQ validation monitoring and management program has been designed. This program is broken into several smaller components which each have different objectives, methodologies and contingency actions. These components are:

- Whole Effluent Toxicity (WET) testing to determine actual discharge toxicity;
- Bitterns discharge validation testing to characterise the discharge from the outfall diffuser against design; and
- EQC and modelling validation monitoring at strategically positioned impact and reference locations surrounding the outfall to allow an assessment against defined site specific EQC.

Management during validation is focused on ensuring that predicted impacts are commensurate with actual impacts within the respective spatial LEPs, therefore protecting the associated EVs and EQOs. Where desired levels are not being achieved contingency actions will be implemented to ensure the permanent discharge of bitterns and associated engineering design are optimised for routine operations, and Project related activities either meet or exceeds the predicted impacts within the defined LEPs.

4.4.2. Purpose

The purpose of MEQ validation monitoring and management is to ensure that the predicted and modelled impacts are accurate (model validation) and that actual Project impacts are within the limits of acceptable change as defined for each LEP. This will ensure that the defined EVs and EQOs are not compromised by operational activities associated with the Mardie Project once typical conditions have been reached (i.e. completion of the commissioning phase).

4.4.3. Management Triggers

In order to achieve the purpose, three levels of management triggers have been established which will inform Management when contingency measures need to be put into place to ensure Project related impacts are within the acceptable levels. Contingency measures specific to each validation program are identified below and are typically based upon conducting an investigation to determine the cause of any management trigger exceedances and implementing appropriate corrective actions to reduce re-occurrence and where possible rectify the situation to ensure optimisation of Project related processes.

The three levels of management triggers are based upon the maximum instantaneous flow rate, the maximum predicted design concentration for constituents within the bitterns discharge and the EQC defined within **Section 3.4** for the constituents being monitored. The management trigger levels are detailed below.

Management Trigger 1

Management trigger 1 is based upon the maximum instantaneous flow rate of:

- *0.69 m3/s constant discharge regime.*

The management trigger level will be exceeded if the maximum instantaneous flow rate is exceeded, thus enacting contingency management as described below**.**

Management Trigger 2

Management trigger 2 is based upon maximum discharge concentrations of:

- *325 ppt salinity of the pre-diluted bitterns waste; and*
- *85.4 ppt salinity of the 5 times diluted bitterns waste at the outfall.*

Adjusted management trigger levels may be adjusted accordingly to ensure they are appropriately set. If any management triggers are breached contingency management as described below will be required.

Management Trigger 3

Management Trigger 3 are defined as the EQCs and are based upon assessment against MEQ samples collected at the LEPA/MEPA or MEPA/HEPA boundaries or within the LEPs.

MEQ samples collected from designated sample locations are to be assessed against the defined EQCs to be derived in accordance with **Section 3.4**. Validation monitoring will ensure that the defined LEPs have been accurately modelled and spatially set, whilst the derived EQCs are effective to achieve the EQOs and protect the EVs.

Where an exceedance of any of the EQCs occur contingency management as described in the following sections will be required.

4.4.4. Whole Effluent Toxicity Testing

Purpose

The purpose of WET testing is to identify the specific toxicity of the bitterns wastewater under accredited laboratory conditions, using indigenous selected species. Results are to be assessed against the established EQC defined for the mixing zone boundary (i.e. interface between the LEPA, MEPA and HEPA) to ensure they are appropriately defined based upon predictive modelling. Where inconsistencies are identified EQCs or the spatial boundaries of LEPs will be revised accordingly.

Sampling Design

WET testing has been undertaken of the prototype bitterns discharge effluent by ESA. Once the commissioning phase of the Project nears completion WET testing will be undertaken when water quality of the discharge is considered to be within design specifications and therefore representative of actual conditions experienced during routine operations. WET testing will be conducted twice on samples taken directly from the raw bitterns namely:

1. towards the finalisation of Project commissioning to identify the toxicity of the bitterns under normal operating conditions; and
2. within 12 months of commission to validate routine operational discharge.

Additional WET testing will also be required at any time during which the Project process is altered in any way, thus potentially altering the levels of constituents and therefore possibly the toxicity within the discharge stream.

The proposed WET testing sampling program will involve two processes namely:

1. Range finding test for toxicity to determine if the effluent is toxic and if so, determine the appropriate concentration range for subsequent tests, and
2. Definitive toxicity testing to determine the 50% Effect Concentration (EC50), 50% Inhibitory Concentration (IC50), 50% Lethal Concentration (LC50) and No Observed Effect Concentration (NOEC) values of effluent for selected species.

WET testing is proposed to be undertaken on a minimum of five (5) locally relevant species from four (4) taxonomic groups. Testing will be in accordance with laboratory NATA accredited methodologies and in accordance with ANZG (2018) toxicity sampling and testing protocols. The proposed tests and locally relevant species identified for WET testing are listed below:

1. 48-hour larval development test: *Saccostrea echinate* (Milky Oyster).
2. 96-hr toxicity test: *Melita plumulosa* (Amphipod).
3. 8-day Sea anemone pedal lacerate development test: *Aiptasia pulchella*
4. 72-hr sea urchin larval development test: *Heliocidaris tuberculata*.
5. 96-hr Fish Imbalance toxicity test: *Lates calcarifer* (Barramundi).
6. 7-hr Fish Imbalance and biomass toxicity test: *Lates calcarifer*.
7. 72-hr marine algal growth test: *Nitzschia closterium*.

The above tests will be validated closer to the time in collaboration with the preferred laboratory to ensure appropriateness of the selected tests and to determine availability of the selected species. If new tests or other species are identified in collaboration with the laboratory then the above WET tests may be revised accordingly.

Sampling Methodology

Samples for WET testing will be collected directly from the raw bitterns prior to any dilutions at the point directly before it enters the discharge pipe. Samples will be collected in laboratory supplied sample containers and in accordance with sampling instructions and ANZG (2018) protocols. Typically, this involves filling plastic sample bottles (~2.5 L) from the bitterns sump once normal operational processes are established and normal discharges are occurring. Samples are typically required to be chilled and transported to the laboratory within stipulated timeframes. Diluent water will be collected from a source within the HEPA that has been determined to have no impacts from the outfall discharge (i.e. through interpreting modelling results) from a depth equal to the outfall diffuser. Samples will be transported directly to the laboratory to ensure ecotoxicity testing can occur as soon as practicable after sample collection.

Data Assessment and Reporting

WET testing results may be used to re-run the predictive modelling and refine the spatial application of the mixing zone and designation of the LEPs.

Data Validation and Quality Control

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

An assessment of quality control data needs to be undertaken and included in all reports including:

- Laboratory QA/QC results.

Data Assessment

Ecotoxicity testing results will be entered into a software program (e.g. BurrilOZ) to calculate the value required to achieve a 90% SPL at the boundary of the LEPA/MEPA and a 99% SPL at the boundary of the MEPA/HEPA. These results will be used to validate, or as a basis for review, of the defined spatial LEPs as presented within this Plan.

Reporting

At the completion of each WET Testing round a validated laboratory report and interpreted tabulated results will be submitted to BCI.

A summary report will be compiled at the completion of any WET testing requirements which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- A table summarising laboratory analysis results;
- An interpretation of the raw date from the software program used (i.e. BurrilOZ);
- Analysis of results against predictive modelling with respect to dilution contour modelling and spatial allocation of LEPs with the mixing zone boundary required to meet the 99% SPL; and
- Any actions or recommendations required as a result of field implementation of the SAP and assessment of monitoring data.

4.4.5. Bitterns Discharge Validation Testing

Purpose

The purpose of the bitterns discharge validation testing is to ensure that the optimal design targets for bittern constituents are being achieved once the Project has completed commissioning. Ongoing bitterns discharge validation testing will also allow the variation within concentrations of bitterns discharge constituents to be characterised, thus allowing a definitive prediction of the levels of impacts from routine discharges to be predicted.

Sampling Design

Bitterns discharge validation monitoring will require continuous flow rate monitoring during discharge and water samples to be collected from the bitterns discharge diffuser prior to discharge weekly for a period of six weeks post commissioning. Samples will be collected concurrently with the MEQ

monitoring surveys so that the actual discharge waters can be compared against the water quality results obtained at sampling location around the outfall.

Sampling Methodology

Two duplicate water samples will be collected weekly from the raw bitterns wastewater sump directly prior to discharge and at two locations at the point of discharge. Samples will be collected in accordance with ANZG (2018) requirements for water quality sampling. QA/QC samples will include a transport blank.

Physico-chemical water column profiles will be taken in-situ at two locations at the point of discharge with a suitable and calibrated water quality sensor from the surface to ~0.5 m from the seabed. Results will be backed up within 24 hours of collection.

Water samples will be sent to a NATA accredited laboratory for analysis and reporting for all water quality EQCs defined in accordance with **Section 3.4**. Laboratory QA/QC requirements will be undertaken in accordance with the NATA accreditation and reported with the sample results.

Data Assessment and Reporting

Data Validation and Quality Control

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (transport blank);
- Assessment of variability (duplicate);
- Laboratory QA/QC results.

Data Assessment

Laboratory analysed samples and physico-chemical results will be compared with the previously defined management triggers as soon as practicable. Any elevation will require contingency actions as described below to be implemented**.**

At the completion of the six week period and in combination with WET testing and MEQ monitoring data, bitterns discharge samples will be used for model validation to predict (with more accuracy) the number of dilutions required to achieve the 90% and 99% SPLs at the LEPA/MEPA and MEPA/HEPA boundaries or within the sample sites respective LEP.

Reporting

At the completion of each sampling round a validated laboratory report and interpreted tabulated data will be submitted to BCI.

An investigation report will be compiled in accordance with BCI Environmental Management System for any elevated results which requires investigation. Submission to the regulator will be subject to project approval conditions.

A comprehensive report will be developed at the completion of the validation monitoring which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical water column profiles;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- An assessment of all data collected against management triggers;
- A review of management trigger exceedances investigations and remedial actions implemented; and
- Any actions or recommendations required as a result of field implementation of the MEQMMP and assessment of monitoring data.

4.4.6. Marine Environmental Quality Validation Monitoring

Purpose

The purpose of the MEQ validation is to provide an assessment of environmental performance to identify if the defined EQCs are being met within their respective LEPs. Results will also be used to determine if the modelled bitterns constituent concentrations and predicted dilutions are being achieved at the LEPA/MEPA and MEPA/HEPA boundaries.

Sampling Design

Table 4-7 provides a summary of the proposed sampling frequency.

Table 4-7 Monitoring Frequency for EQC Validation Monitoring

Monitoring Event	Frequency	Commencement	Completion
Water Quality Sampling	Weekly	End of Commissioning	6 weeks post commissioning
Physico-chemical Water Quality Profiling	Weekly	End of Commissioning	6 weeks post commissioning
Physical Observations	Weekly	End of Commissioning	6 weeks post commissioning

The program includes a total of 19 MEQ monitoring locations, including:

- Six (6) sites at the LEPA/MEPA boundary;
- Nine (9) sites at the MEPA/HEPA boundary; and
- Four (4) sites within the HEPA.

Details of the 19 monitoring locations and associated routine sampling tasks to be completed at each location are presented in **Table 4-8** and displayed in **Figure 4-4**.

Table 4-8 Marine Environmental Quality Monitoring Locations and Associated Routine Sampling Tasks for MEQ Validation

Site Name	Site Reference	Level of Ecological Protection	Easting	Northing	Routine Sampling Tasks		
					Physical Observations	Physico-chemical Water Column Profiling	General Water Sample Analysis
MLB1-6	These sites are located on the LEPA/MEPA boundary. They are positioned within the predicted bitterns outfall plume as modelled by Baird (2020) to ensure impacts are within the predictions and the LEP. They also represent potential impact boundaries from the Offshore Shipping Facility	Moderate	389611.6 389661.9 389709.3 389595.6 389534.3 389454.1	7673256.0 7673378.3 7673261.1 7672206.6 7672059.9 7672198.1	X	X	X
MMB1-9	These sites are located on the MEPA/HEPA boundary. They are positioned within the predicted bitterns outfall plume as modelled by Baird (2020) to ensure impacts are within the predictions and the LEP.	High	389612.5 389684.9 389719.4 389681.3 389586.8 389387.5 389359.5 389434.1 389577.6	7673446.5 7673542.6 7673454.8 7672754.7 7671988.8 7671857.9 7672006.6 7672420.6 7673011.4	X	X	X
MH1-4	Sites MH1-4 are outside of the predicted bitterns outfall plume as modelled by Baird (2020) to ensure impacts are within the predictions and the LEP. They also collectively provide an assessment of any measured change within the High LEP from the Offshore Shipping Facility.	High Maximum (MH4)	388640.0 389693.0 390650.1 389338.8	7672814.3 7674287.2 7672847.0 7670946.0	X	X	X

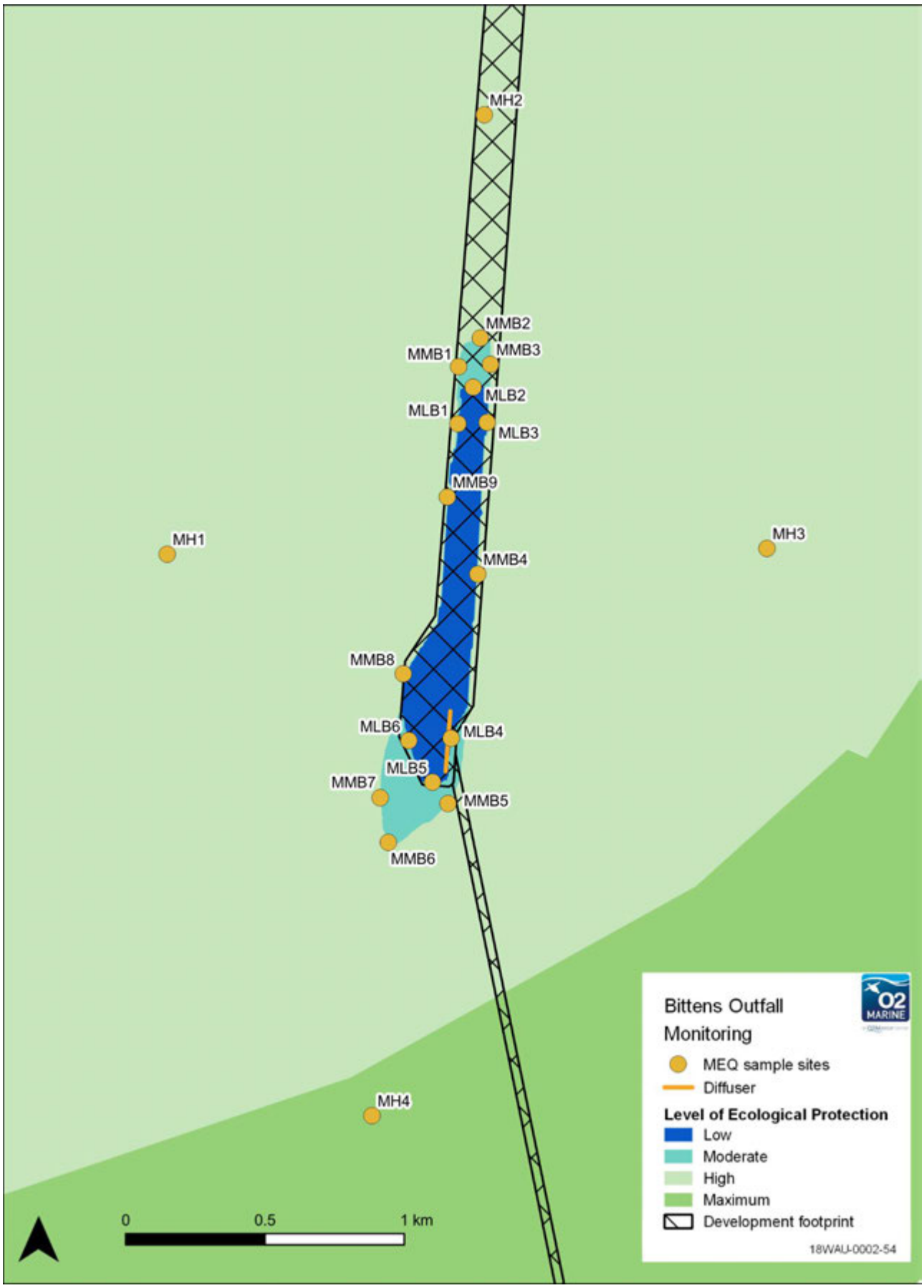

Figure 4-4 Bitterns Outfall and Offshore Marine Facilities Sites for Validation Sampling

Sampling Methodology

Sampling methodologies for the following activities will be conducted in accordance with the protocols outlined within **Section 4.2.4:**

- Physical Observations; and
- Physico-chemical water column profiles.

Water Quality Sampling activities will be undertaken in accordance with the protocol described below.

Water Sample Collection

Water samples will be collected at all 19 sampling locations identified within **Table 4-8**. Water samples will be collected from three separate depths, as required to validate and identify modelled stratification (Baird 2020). The following samples will be collected:

- 0.5m below surface;
- Middle of water column; and
- 0.5m above seafloor.

Samples will be collected using an electronic water sample pump or niskin bottle to collect the required volume of water from each of the depths identified above.

The water sampler will be rinsed with Decon solution (or equivalent) between samples. Water samples will be collected in suitable (laboratory supplied) bottles and immediately stored on ice for transport to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

All sample containers will be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are *marine water* using a waterproof permanent maker. All samples will then be listed on a Chain of Custody (CoC) form to be included with the samples sent to the laboratories.

Laboratory Analysis

General water sample analysis will be performed on samples collected**.** These samples are required to be analysed by a NATA-accredited laboratory for the following parameters;

- Alkalinity and Hardness;
- Nutrients (NH_4+, NO_2-/NO_3-, TKN, TN, TP) ;
- Total Recoverable Hydrocarbons (TRH);
- Total Petroleum Hydrocarbons (TPH);
- BTEXN;
- Total Organic Carbon (TOC);
- Dissolved Major Cations and Anions;
- Dissolved Metals and Metalloids (Al, Sb, As, Ba, Be, Bi, Bo, Br, Cd, Cr, Co, Cu, I, Fe, Pb, li, Mn, Hg, Mo, Ni, Se, Ag, Sr, Tl, Th, Sn, Ti, U, V, Zn);
- Fluoride, chloride, sulfate;
- Silicon anion,
- Calcium, Magnesium, sodium, potassium cations; and

- Ionic balance.

Field Quality Assurance & Quality Control

All water quality meters are to be in calibration. If monitoring equipment is hired, calibration certificates are to be provided from the supplier. Calibration records are to be saved and attached as an appendix to compliance reports.

The following Quality Assurance & Quality Control (QA/QC) Samples should be collected as described below:

- A ***duplicate sample*** is to be collected at the same site as two (2) of the primary monitoring samples. The purpose of the sample is to confirm that the primary laboratory is able to produce consistent results when analysing the same sample. The site where it was taken is to be recorded but not reported to the laboratory. Ideally it should be collected at a site that is expected to have higher levels of contamination (based on historic data and potential sources of contamination) as this will confirm a wider range of analytes and reduce the level of instrument error when comparing larger concentrations.
- A ***field split sample*** is collected at the same site as the duplicates and sent to a secondary laboratory for analysis. The purpose of this sample is to confirm that intra-laboratory analysis of the sample produces consistent results.
- A ***rinsate sample*** is collected to confirm that cross contamination doesn't occur during the sampling processes in the field. The rinsate sample should be taken after the decontamination process of the sample collection container by running deionised water over the container and collecting it in laboratory provided bottles.

Laboratory Quality Assurance & Quality Control

Laboratories used for water sample analysis must be NATA accredited. Comprehensive QA/QC testing of water samples should be undertaken in accordance with NATA accreditation and include testing of laboratory control samples, method blanks, matrix spikes, laboratory duplicates and surrogate recovery outliers (where applicable).

Data Assessment and Reporting

Data Validation

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

Quality Control

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (rinsate, transport blank and method blank);
- Assessment of field variability (duplicate and triplicate);
- Assessment of lab variability (triplicate);
- Laboratory QA/QC results.

Data Assessment

Compliance with the EQCs (to de derives in accordance with (**Section 3.4**) for the respective LEP at each sample location will be assessed through a comparison of the median results for each parameter from the commissioning and six-week post-commissioning phases. Data from the commissioning phase and medians for each parameter calculated from the six-week dataset for each site from the post commissioning phase will be compared directly to the EQCs. Results for each individual site will be compared to the relevant guideline value or the relevant Reference percentile. Reference percentiles will be calculated from the six-week median for each individual Reference site.

Reporting

At the completion of each sampling round a validated laboratory report and interpreted tabulated data will be submitted to BCI Minerals.

An investigation report will be compiled in accordance with BCI Minerals Environmental Management System for any elevated results which require investigation. Submission to the regulator will be subject to project approval conditions.

A comprehensive report will be compiled at the completion of the validation phase which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical water column profiles;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- An assessment of all data collected against management triggers;
- A review of management trigger exceedances investigations and remedial actions implemented; and
- Any actions or recommendations required as a result of field implementation of the SAP and assessment of monitoring data.

Sample Preservation, Storage and Holding Times

Analytical Limits of Reporting (LoRs) should be appropriate to provide suitable detection levels as appropriate to allow comparison with ANZG (2018) or DEC (2006) guidelines for baseline monitoring and for the purposes of establishing site specific EQC at the completion of baseline monitoring.

Storage and holding times need to be confirmed with the laboratory prior to sampling to ensure the sampling program is compliant with specified standards

Contingency Management

In the event that the Project related impacts exceed the desired management trigger levels a range of operational and design solutions will be investigated. Firstly, depending upon the exceedance, an investigation needs to be undertaken to determine the cause(s). Once the cause(s) is determined then appropriate corrective or preventative actions need to be implemented to ensure re-occurrence does not occur. This system of investigation and implementation of remedial actions will ensure that during

the post-commissioning phase all possible design or process modifications are established to ensure optimal performance of the process for ongoing operations.

There are several potential operational and design solutions which may be used as contingency measures in response to management trigger exceedances. **Figure 4-5** provides an overview of the contingency response and management framework to be applied during MEQ validation for the Mardie Project.

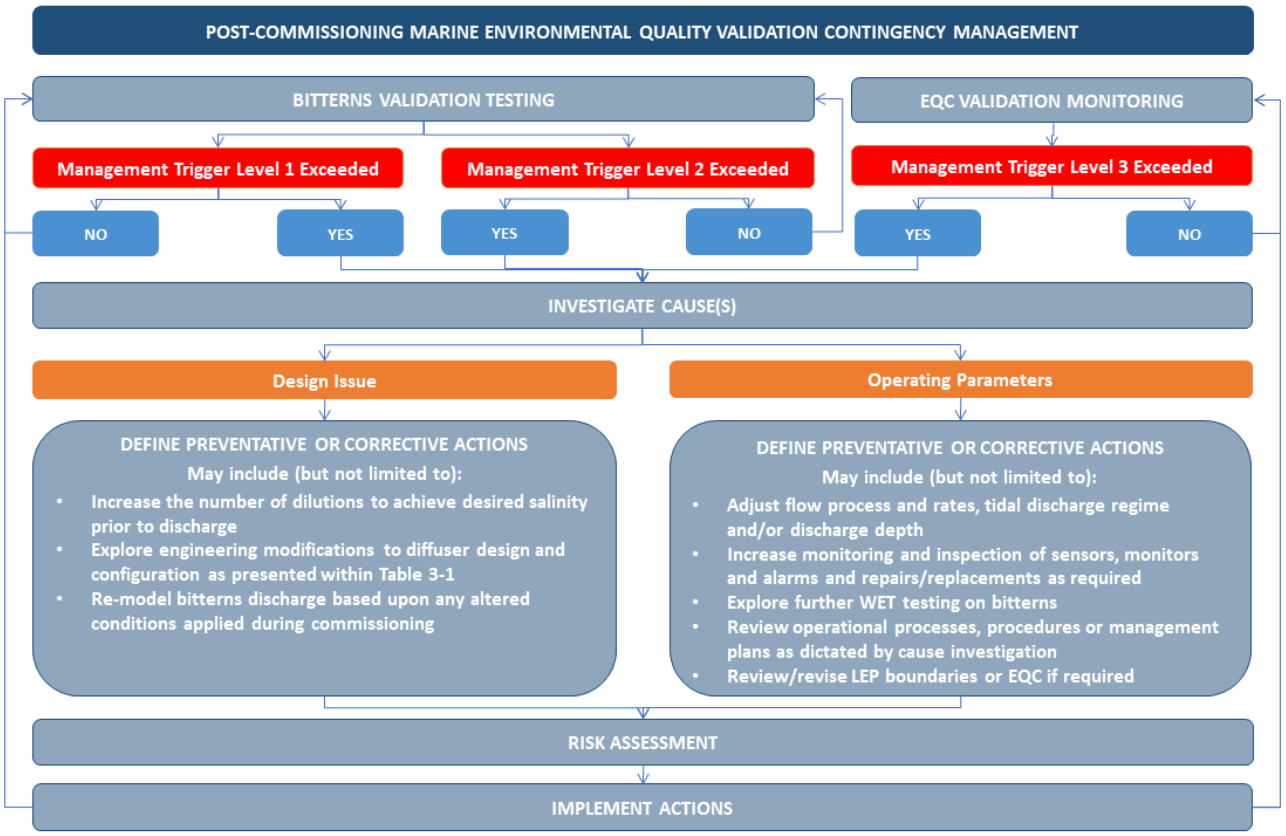

Figure 4-5 Post-commissioning brine discharge quality validation contingency management.

4.5. Routine Operational Performance Assessment

4.5.1. Context

To determine any actual impacts from routine operational activities associated with the Mardie Project, a comprehensive MEQ monitoring and management program has been designed. This program comprises two smaller components which each have a different purpose, methodologies and contingency actions. These components include:

- Ongoing assessment of bitterns discharge quality against design specifications; and
- Ongoing MEQ monitoring to ensure that potential impacts from operational activities are occurring within the limits of acceptable change allocated within each spatial LEP.

Management during ongoing operations will be focused on ensuring that the predicted levels of impact within the defined spatial LEPs are achieved, therefore protecting the associated EVs and EQOs. Where desired levels are not being achieved contingency actions will be implemented to ensure the impacts are restricted, investigated and remediated through implementing a course of actions. At this stage compliance reporting requirements will also be stipulated, with outcomes from these monitoring programs reported against their objectives and criteria and submitted, as required, to the regulator.

4.5.2. Purpose

The purpose of the routine operational performance assessment is to determine if typical operational activities associated with the Mardie Project are compliant with defined management triggers and that no temporal impacts are being observed. To determine if operations are impacting MEQ the following two monitoring and assessment programs will be implemented:

1. Bitterns Discharge Quality; and
2. Ongoing MEQ Monitoring.

4.5.3. Management Triggers

In order to achieve the purpose, three levels of management triggers have been established which will inform Management when contingency measures need to be put into place to ensure that Project related impacts are within the acceptable levels so that the EVs and EQOs defined for the Project area are not compromised. Contingency measures specific to each assessment program are identified in **Sections 4.5.4** and **4.5.5** and are typically based upon conducting an investigation into the reason why a management trigger was exceeded and putting appropriate corrective actions in place to reduce re-occurrence.

The three levels of management triggers are based upon the maximum instantaneous flow rate, the maximum predicted design concentration for constituents within the bitterns discharge and the EQC defined within **Section 3.4** for the constituents being monitored. The management trigger levels are detailed below.

Management Trigger 1

Management trigger 1 is based upon the maximum instantaneous flow rate of:

- *0.69 m3/s constant discharge regime.*

The management trigger level will be exceeded if the maximum instantaneous flow rate is exceeded, thus enacting contingency management as described in **Section 4.5.4.**

Management Trigger 2

Management trigger 2 is based upon maximum discharge concentrations of:

- *325 ppt salinity of the pre-diluted bitterns waste; and*
- *85.4 ppt salinity of the 5 times diluted bitterns waste at the outfall.*

Adjusted management trigger levels may be adjusted accordingly to ensure they are appropriately set. If any management triggers are breached contingency management as described in **Section 4.5.4** will be required.

Management Trigger 3

Management Trigger 3 are defined as the EQCs and are based upon assessment against MEQ samples collected at the LEPA/MEPA or MEPA/HEPA boundaries or within the LEPs.

MEQ samples collected from designated sample locations are to be assessed against the defined EQCs to be derived in accordance with **Section 3.4**. MEQ monitoring will ensure that the defined LEPs have been accurately modelled and spatially set, whilst the derived EQCs are effective to achieve the EQOs and protect the EVs.

Where an exceedance of any of the EQCs occur contingency management as described in **Section 4.5.4** will be required.

4.5.4. Bitterns Discharge Quality

Purpose

The purpose of bitterns discharge quality testing is to ensure that design specifications for bitterns discharge constituents, as verified through Bitterns Discharge Validation Testing, are achieved through the lifecycle of the Project.

Sampling Design and Methodology

Bitterns discharge quality monitoring will be conducted in accordance with **Section 4.4.5** with the following deviation:

- Samples are to be collected biannually for a period of two years, or as applicable in accordance with specific Project approval conditions; and
- During any time which the wastewater treatment plant alters the bitterns discharge in any way.

Data Assessment and Reporting

Data collected will require immediate comparison with management triggers identified above. Any elevation will require contingency actions as described below**.**

Data Validation and Quality Control

All data is required to be validated prior to the release of any monitoring reports to confirm that data has been entered correctly. Data entry is to be checked and verified against raw data logs and laboratory reports by an independent person.

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (transport blank);
- Assessment of variability (replicate);
- Laboratory QA/QC results.

Data Assessment

Laboratory analysed samples and physico-chemical results will be compared with the previously defined management triggers as soon as practicable. Any elevation will require contingency actions as described below to be implemented.

Reporting

At the completion of each sampling round a validated laboratory report and interpreted tabulated data will be submitted to BCI Minerals.

An investigation report will be compiled in accordance with BCI Minerals Environmental Management System for any elevated results which requires investigation. Submission to the regulator will be subject to project approval conditions.

A comprehensive report will be developed at the completion of the monitoring program which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical water column profiles;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- An assessment of all data collected against management triggers;
- A review of management trigger exceedances investigations and remedial actions implemented; and
- Any actions or recommendations required as a result of field implementation of the MEQMMP and assessment of monitoring data.

Contingency Management

In the event that the treatment process is not meeting the desired management trigger levels a range of operational and design solutions will be investigated. Firstly, depending upon the exceedance, an investigation needs to be undertaken to determine the cause(s). Once the cause(s) is determined then appropriate corrective or preventative actions need to be put into place to ensure re-occurrence does not occur. This system of investigation and implementation of remedial actions will ensure that optimal performance of the process continues through the lifecycle of the project.

There are several potential operational and design solutions which may be used as contingency measures in response to management trigger exceedances. **Figure 4-6** provides an overview of the

contingency response and management framework to be applied during routine operation of the Mardie Project.

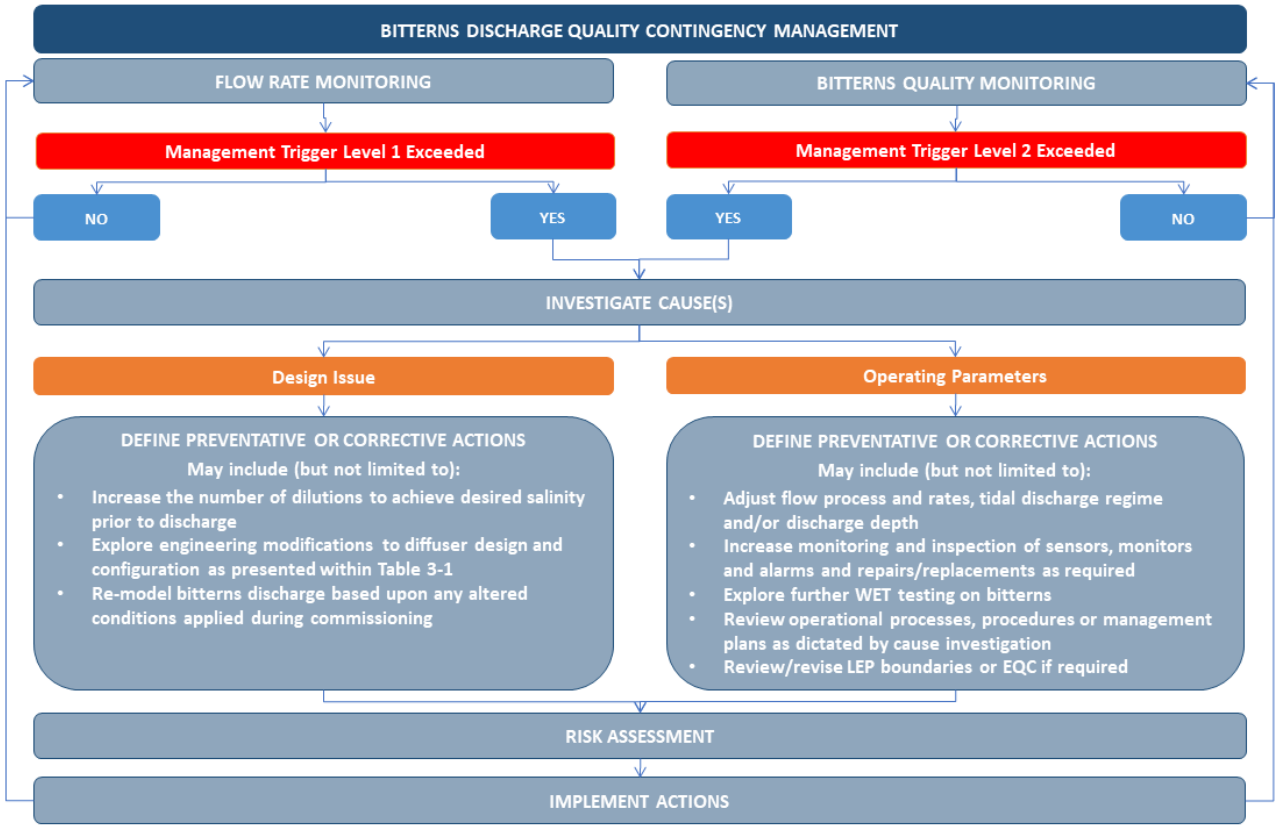

Figure 4-6 Contingency management framework for routine bitterns discharge quality

4.5.5. Ongoing Marine Environmental Quality Monitoring

Purpose

The purpose of the ongoing MEQ monitoring program is to collect quantitative data to assess against management triggers and ensure that impacts from operational activities do not impact MEQ outside the limits of acceptable ecological change for each LEP.

Sampling Design

Table 4-9 shows the MEQ monitoring events and sampling frequencies, which are based on the lower level of risk presented to MEQ by ongoing operational activities than those associated with the commissioning and validation phases.

Table 4-9 Monitoring Frequency for Ongoing Marine Environmental Quality Monitoring

Monitoring Event	Frequency	Commencement
Water Sampling	Quarterly	Post six-week validation period
Physico-chemical Water Quality Profiling	Quarterly	Post six-week validation period
Sediment Sampling	Annually	Post six-week validation period
Benthic Infauna	Annually	Post six-week validation period
Physical Observations	Quarterly	Post six-week validation period

The program includes a total of 21 MEQ monitoring locations, which are:

- Bitterns outfall:
  - Six (6) sites at the LEPA/MEPA boundary;
  - Nine (9) sites at the MEPA/HEPA boundary; and
  - Four (4) sites within the HEPA.
- Mardie Creek:
  - One (1) adjacent to the Mardie Creek small vessel launch facility within the HEPA.
- Intake Creek:
  - One potential impact site positioned adjacent to the seawater abstraction intake within the HEPA.

Details of the 21 monitoring locations are presented in **Table 4-10**, **Figure 4-4** and **Figure 4-7**.

Table 4-10 Marine Environmental Quality Monitoring Locations and Associated Routine Sampling Tasks for Ongoing Monitoring. NOTE: please refer to Table 4-8 for further details including site description and coordinates.

Site Name	Level of Ecological Protection	Routine Sampling Tasks				
		Physical Observations	Physico-chemical Water Column Profiling	General Water Sample Analysis	Sediment Quality Sampling	Benthic Infaiuna Sampling
MLB-1	Moderate	X	X	X	X	X
MLB-2	Moderate	X	X	X	X	X
MLB-3	Moderate	X	X	X	X	
MLB-4	Moderate	X	X	X	X	X
MLB-5	Moderate	X	X	X	X	X

Site Name	Level of Ecological Protection	Routine Sampling Tasks				
		Physical Observations	Physico-chemical Water Column Profiling	General Water Sample Analysis	Sediment Quality Sampling	Benthic Infaiuna Sampling
MLB-6	Moderate	X	X	X	X	
MMB-1	High	X	X	X	X	
MMB-2	High	X	X	X	X	X
MMB-3	High	X	X	X	X	
MMB-4	High	X	X	X	X	X
MMB-5	High	X	X	X	X	
MMB-6	High	X	X	X	X	X
MMB-7	High	X	X	X	X	
MMB-8	High	X	X	X	X	
MMB-9	High	X	X	X	X	X
MH-1	High	X	X	X	X	X
MH-2	High	X	X	X	X	
MH-3	High	X	X	X	X	X
MH-4	Maximum	X	X	X	X	
NC1	High	X	X	X	X	
MIC1	High	X	X	X	X	

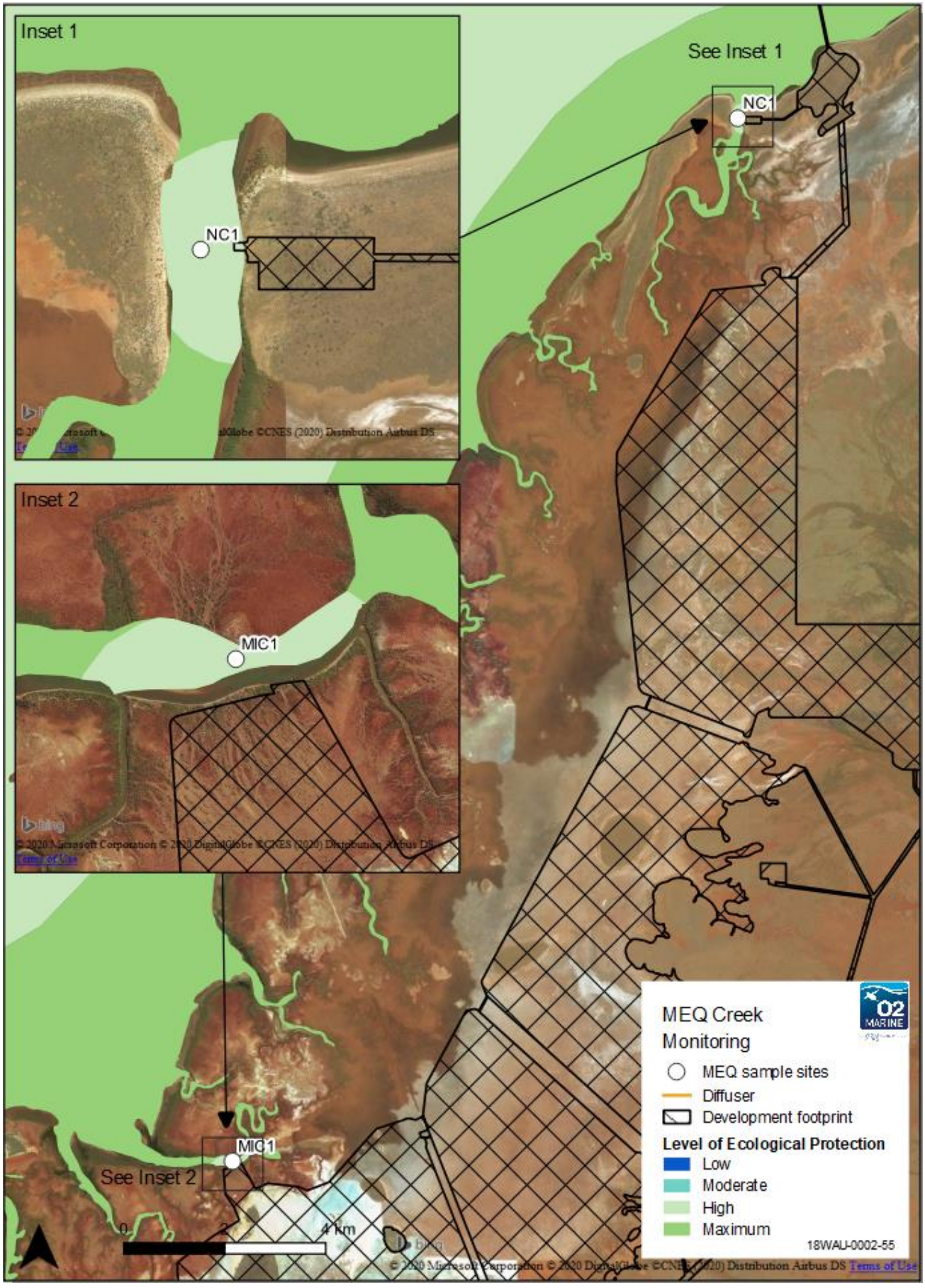

Figure 4-7 Seawater abstraction and small vessel facility MEQ monitoring locations

Sampling Methodology

Sampling methodologies for the following activities will be conducted in accordance with the protocols outlined within **Section 4.2.4,** in accordance with the sampling locations identified within **Table 4-10:**

- General Observations;
- Aesthetic Observations;
- Physico-chemical Water Column Profiling
- Water Sample Collection;
- Sediment Sample Collection; and
- Benthic Infauna Sampling.

In addition, the following field QA/QC variations for water and sediment sample collection and methodology for toxicants in biota will apply.

Water Quality Sampling

Field Quality Assurance & Quality Control

The following Quality Assurance & Quality Control (QA/QC) Samples should be collected as described below:

- A ***duplicate sample*** is to be collected at the same site as two (2) of the primary monitoring samples. The purpose of the sample is to confirm that the primary laboratory is able to produce consistent results when analysing the same sample. The site where it was taken is to be recorded but not reported to the laboratory. Ideally it should be collected at a site that is expected to have higher levels of contamination (based on historic data and potential sources of contamination) as this will confirm a wider range of analytes and reduce the level of instrument error when comparing larger concentrations.
- A ***field split sample*** is collected at the same site as the duplicates and sent to a secondary laboratory for analysis. The purpose of this sample is to confirm that intra-laboratory analysis of the sample produces consistent results.
- A ***rinsate sample*** is collected to confirm that cross contamination doesn't occur during the sampling processes in the field. The rinsate sample should be taken after the decontamination process of the sample collection container by running deionised water over the container and collecting it in laboratory provided bottles.

Sediment Quality Sampling

Field Quality Assurance & Quality Control

The following QA/QC Samples should be collected as described below:

- ***Triplicate samples*** (i.e. three separate samples taken with the sediment grab at the same location) should be taken at three (3) site to determine the variability of the sediment physical and chemical characteristics.
- A ***field split sample*** (i.e. one sediment grab sample thoroughly mixed and then split into three sub-samples) should be collected at collected at two (2) site to assess inter and intra-laboratory variation, with one of the three samples sent to a second laboratory.

- A ***transport blank*** (acid-washed silica sand) in a sealed jar should be provided by the laboratory and taken to site but not opened. The transport blank is sent back to the laboratory with the other samples and analysed. This blank is used to assess if any contamination is already present in the acid-washed sand or container.
- A ***method blank*** (acid-washed silica sand) should be used to assess the potential for contamination during the sampling process. The method blank should be placed into the 'van Veen' grab and processed identically to the usual sediment samples. The method blank should be sent to the laboratory and analysed with the other samples to assess presence of contamination during the processing procedures.

Toxicants in Biota

Bioaccumulation is a late stage testing and monitoring methodology within the phased approach described in **Figure 4-8**. The objective of monitoring is to determine if toxicants are bioaccumulating at a rate that could affect marine life and/or result in seafood being not safe for human consumption.

Initially, a desktop study will be to determine the likelihood/risk of contaminant bioaccumulation across the Project study area. The desktop study will review the concentrations of any contaminant that has exceeded the bioavailable EQSs and whether or not the contaminant is likely to bioaccumulate in locally relevant species. Guidance procedures and assessment for bioaccumulation testing will follow Simpson *et al*. (2005) and Simpson *et al*. (2008), and in the ASTM International guide E1688 (2016), *Standard Guide for Determination of the Bioaccumulation of Sediment-Associated Contaminants by Benthic Invertebrates*.

One or both of the following methods will be used for monitoring toxicants in biota, as appropriate:

- Field collected and caged/transplanted organisms; and
- Laboratory bioaccumulation test sampling.

Direct field collected and caged/transplanted organisms involve measuring any toxicants accumulating in tissues of organisms at the affected site and comparing with the same species in one or more suitable reference sites. Field collected samples rely on existing information on the concentrations of contaminants that have exceeded the relevant EQSs prior to the detection of elevated levels, whereas caged/transplanted organisms involves the deployment of relevant species (usually filter-feeding bivalves) at the affected and reference sites to measure the change in the contaminants that have exceeded the relevant EQC over time. An appropriate gut depuration interval is generally required (typically 24 hours) prior to analysis although the specific requirements should be discussed with the laboratory.

Laboratory bioaccumulation tests generally run for 28 days and use several test species. At least two bioaccumulation tests should occur, preferably on a bivalve mollusc and burrowing polychaete (Simpson *et al*., 2005). The requirements for these species are similar to toxicity testing in that each species should provide adequate biomass for analysis, ingest water/sediments and be efficient metabolisers of contaminants. However, the organisms do not need to be sensitive to the contaminants that are under investigation for bioaccumulation potential.

The location, nature and frequency of reactive monitoring required will be tailored on advice from appropriate specialists for the collection of the appropriate information required to inform any management responses to specific exceedance events. Monitoring sites will target areas of concern,

with the inclusion of extra reference sites and the duration of reactive monitoring is likely to be acute. Consideration will be given to the utilisation of historical data as well as physical and chemical sediment data.

For any contaminant where bioaccumulated concentrations are statistically greater than that measured in the controls, an investigation into the source of the contaminant will be conducted. Where environmental and public health risks are identified as a possibility, the appropriate government agencies will be notified accordingly.

Data Assessment and Reporting

Data Validation

All data will be validated prior to the release of any monitoring and assessment reports. Data used or otherwise presented in the reports is to be checked and verified against raw data logs and laboratory reports.

Quality Control

An assessment of quality control data needs to be undertaken and included in all reports including:

- Assessment of field contamination (rinsate, transport blank and method blank);
- Assessment of field variability (duplicate and triplicate);
- Assessment of lab variability (triplicate); and
- Laboratory QA/QC results.

Data Assessment

Laboratory samples and in-situ results will be compared with the management triggers as soon as practicable to ensure that the appropriate levels of laboratory assessment are undertaken in accordance with **Figure 4-8**.

Elevated results will be assessed in accordance with **Figure 4-9** to determine the level of management actions or investigative monitoring required.

Reporting

An investigation report will be compiled in accordance with BCI Minerals Environmental Management System for any elevated results which requires management response in accordance with **Figure 4-10**. Submission to the regulator will be subject to project approval conditions.

A comprehensive report will be developed at the completion of each monitoring round which will include, but not be limited to:

- Summary of the methods applied and any deviations from this MEQMMP;
- Timeseries graphs of physicochemical water column profiles;
- A table summarising laboratory analysis results;
- Timeseries graphs of laboratory analysis results;
- An assessment of all data collected against management triggers;

- A review of management trigger exceedances investigations and remedial actions implemented; and
- Any actions or recommendations required as a result of field implementation of the SAP and assessment of monitoring data.

Contingency Management

In the event that Project related operational activities result in an exceedance of the defined management triggers, a tiered risk-based investigative monitoring program will be required as defined within **Figure 4-9. Figure 4-8** provides a flowchart to guide the interpretation required based upon the level of investigative monitoring, while **Figure 4-10** provides the management contingency actions required.

Firstly, depending upon the exceedance, an investigation needs to be undertaken to determine the cause(s). Due to the nature of the monitoring program potential causes can be isolated from the following four point sources:

1. Bitterns discharge water quality;
2. Offshore Port and shipping related activities;
3. Onshore vessel related activities (Mardie Creek MEPA); and
4. Seawater abstraction and related activities (Peters Creek)

Once the cause(s) is determined then appropriate corrective or preventative actions need to be put into place to ensure re-occurrence does not occur. This system of investigation and implementation of remedial actions will ensure that optimal environmental performance continues through the lifecycle of the Project.

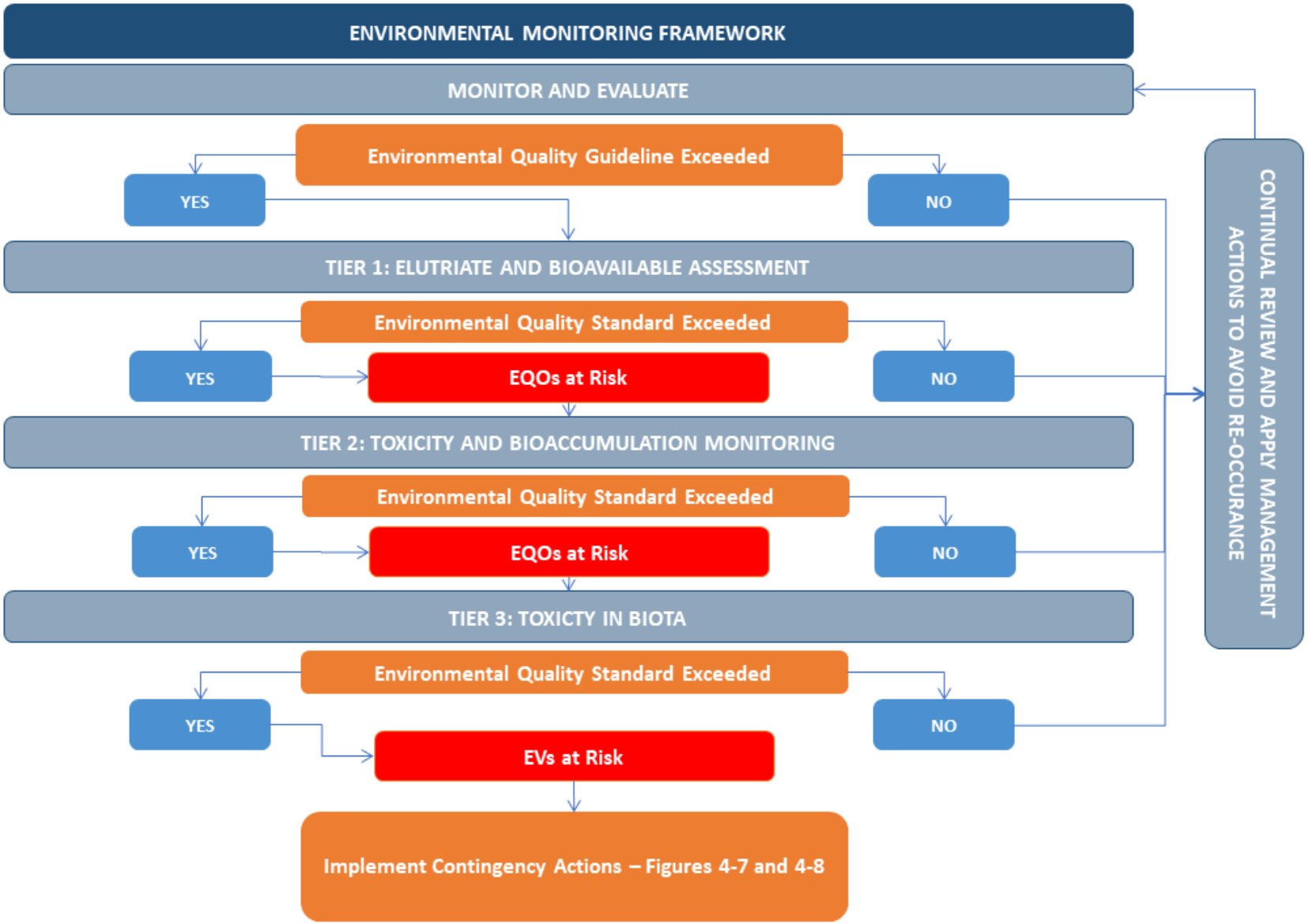

Figure 4-8 Environmental Monitoring Framework including elevation points when certain EQC are exceeded

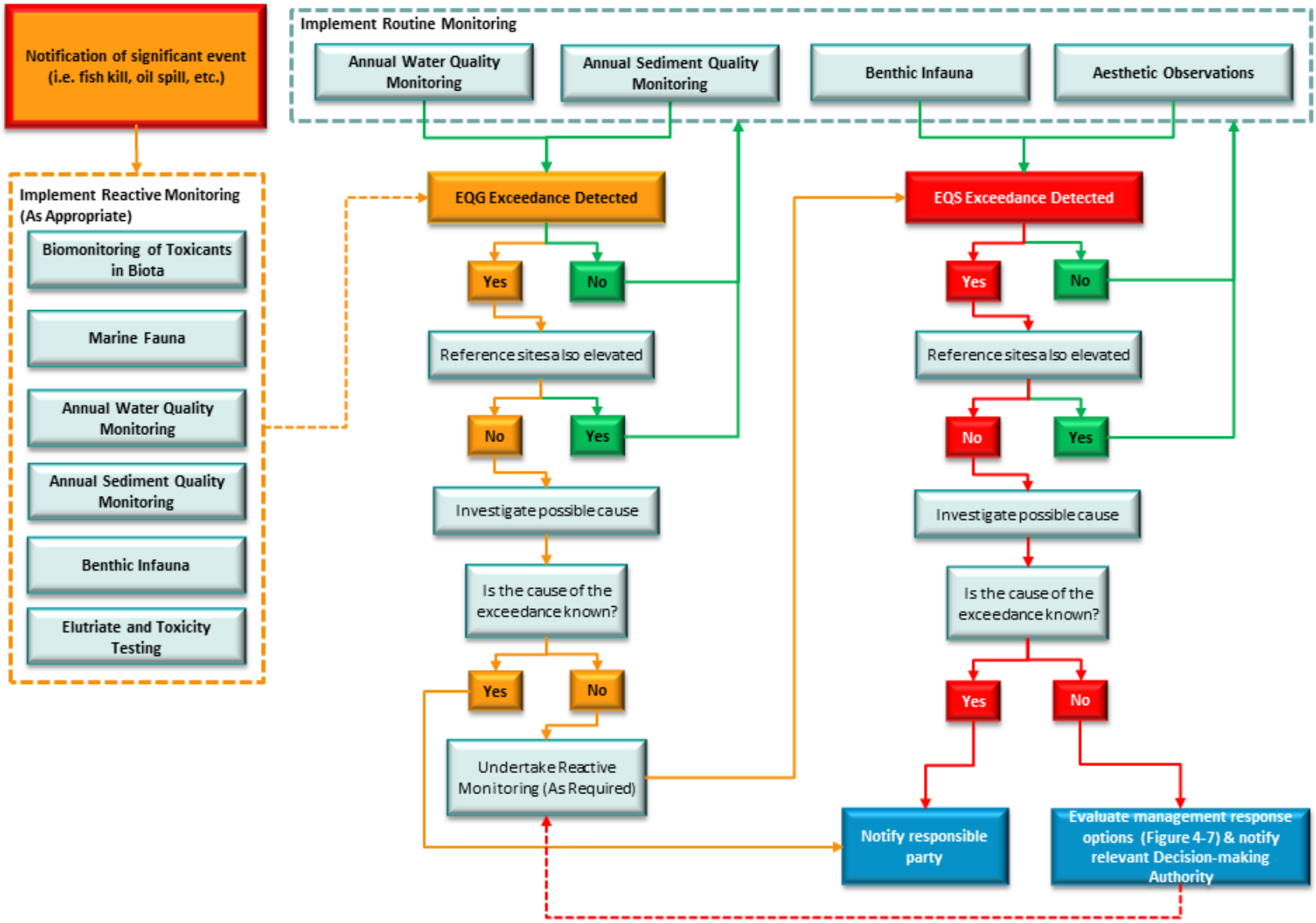

Figure 4-9 Management Response Framework for assessment of required action from routine and investigative monitoring programs

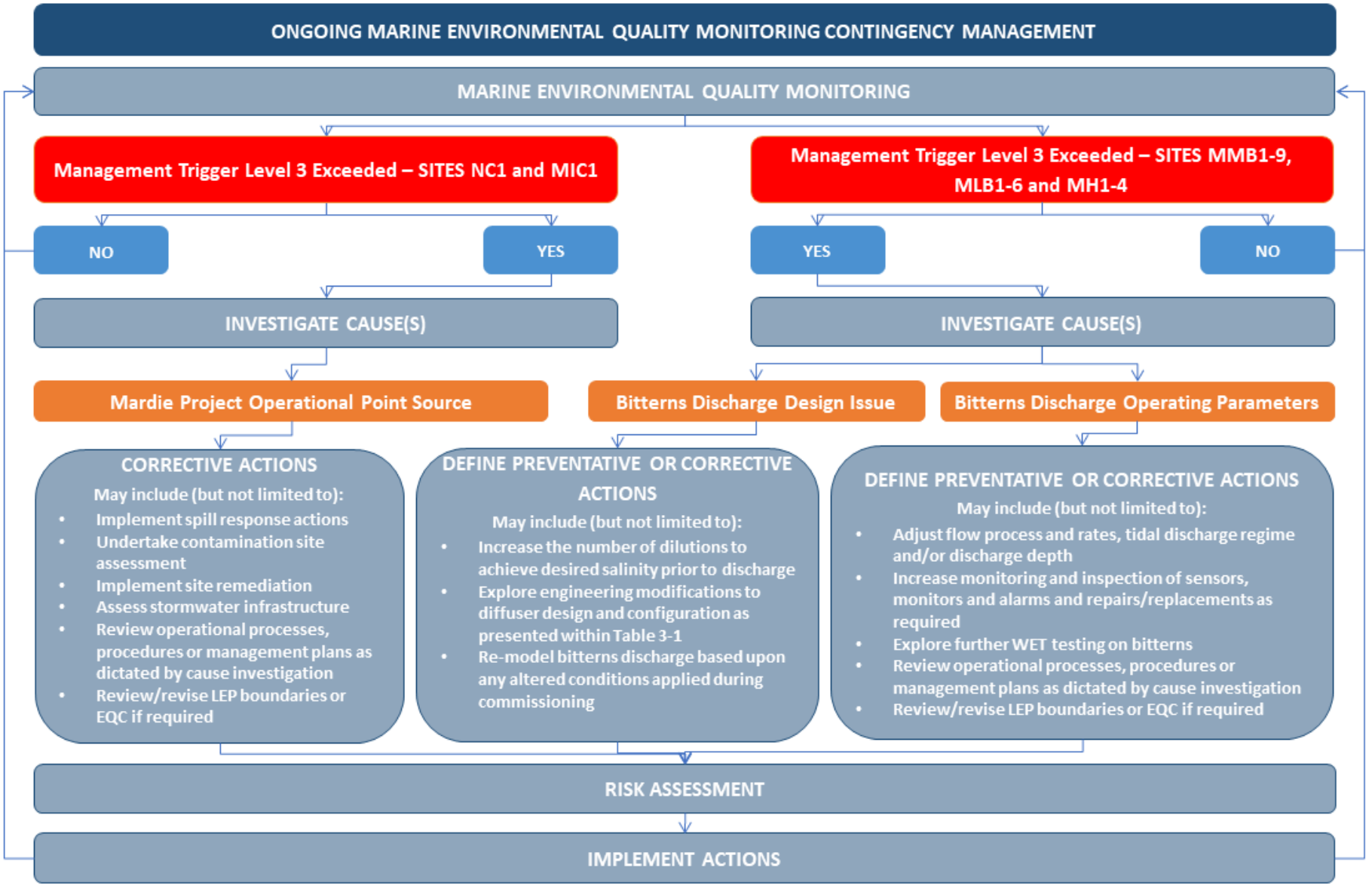

Figure 4-10 Ongoing Marine Environmental Quality Monitoring Contingency Management Actions

5. Review

This MEQMMP is a living document and will be regularly reviewed in accordance with **Table 5-1** to ensure it remains relevant to the Project and aligns with industry best practice.

Table 5-1 MEQMMP review timeframes for the Project lifecycle

Timing	Rationale
Scheduled Review	
Upon receipt of Approval Conditions	Ministerial Statement approval conditions obtained will necessitate a comprehensive review of this MEQMMP to ensure all relevant aspects are covered within this Plan to ensure compliance.
Upon completion of Baseline Data Assessment	This review is required to derive the site specific EQCs for the ongoing assessment of Project impacts, along with any other findings that require update upon completion of the baseline data collection phase.
Upon Completion of Commissioning	This will typically be required to update management triggers associated with the discharge design for the bitterns wastewater.
Upon Completion of Validation assessment	A comprehensive review of the LEPs and EQC will be required based upon data obtained during this phase. A comprehensive review of the entire MEQMMP will be required to ensure adequacy for management of the ongoing MEQ with respect to the final operational Processing Facility.
Annually during routine operations	At the completion of annual reporting requirements any recommendations for alteration of the MEQMMP will need to be incorporated into a revised version suitable for the next 12 months of operations.
Ad-Hoc Review	
Any time operational activities significantly alter	Operational changes to the project may result in an altered risk profile. Therefore, the MEQMMP will require a review to ensure that it remains fit-for-purpose for altered operational conditions.
Any time Bitterns discharge quality or regime alters	Process or design alterations changes to the bitterns discharge may result in an altered risk profile. Therefore, the MEQMMP will require a review to ensure that it remains fit-for-purpose for altered operational conditions.

During review of the MEQMMP consideration should be given to (but not limited to):

- Overall effectiveness of the Plan;
- Appropriateness of EVs, EQO and LEPs;
- To refine EQC with compiled baseline data set;
- New threats to MEQ that may be identified;
- Lessons learned during sampling or analysis;
- Changes in industry best practice;
- Changes in environmental risk; and
- Any changes in methodology or equipment used.

6. References

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