Operational and Scientific Monitoring Plan

Environmental Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

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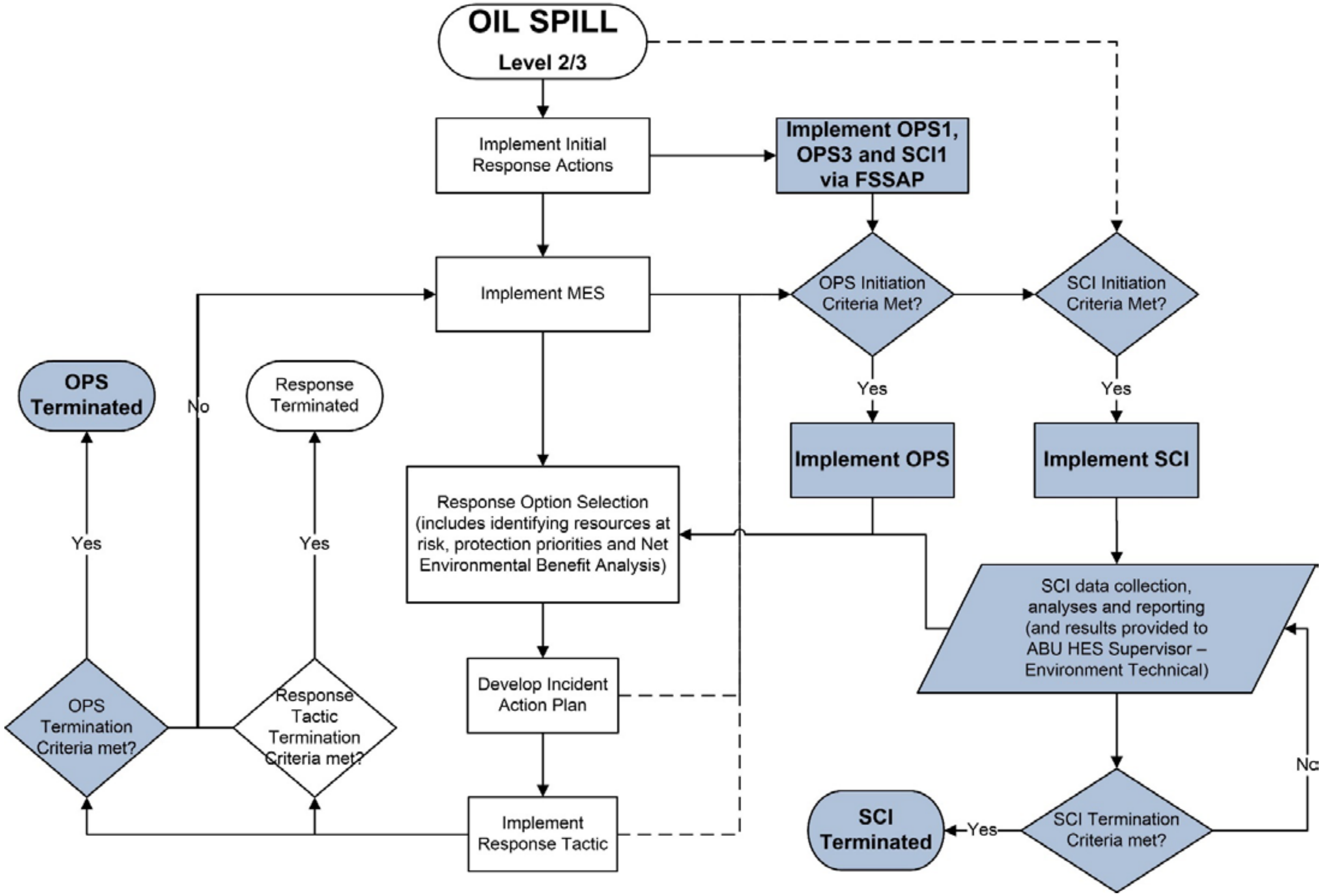
QUICK REFERENCE GUIDE

Operational and Scientific Monitoring within the Oil Spill Response Planning Process



Note: Shaded cells refer to steps related to this Plan. For details relating to other steps, refer to the relevant OPEP.

Overview of Monitoring Components

Code	Operational Component	Aim of Monitoring
OPS1	Oil Characterisation	Identify physical/chemical properties of the oil via laboratory analysis to assist response option(s) selection
OPS2	Chemical Dispersant Efficacy	Rapid information on the efficacy of dispersants as a response option
OPS3	Oil in Water	Collect data on the effects of the spill and response options (including dispersants) on water quality
OPS4	Oil in Sediment	Collect data on the exposure of sediments to oil and any effect of response activities on sediment quality
OPS5	Rapid (Oiled) Shoreline	Assess the state of shoreline habitats, presence and extent of oil, assess impacts of response activities
OPS6	Rapid Seabird and Shorebird	Rapidly quantify the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted or already impacted, assess the impacts of response activities
OPS7	Rapid Marine Megafauna	Rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted or already impacted
OPS8	Fish Tainting	Collect data on the effects of the spill and response options on pelagic and benthic fish species
Code	**Scientific Component**	**Aim of Monitoring**
SCI1	Water Quality	Assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI2	Sediment Quality	Assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI3	Coastal and Intertidal Habitat	Assess impacts to coastal and intertidal habitats and associated biological communities
SCI4	Seabird and Shorebirds	Identify and quantify the post-impact status and recovery of seabirds and shorebirds
SCI5	Marine Megafauna	Identify and quantify the post-impact status and recovery of marine reptiles, pinnipeds and other marine megafauna
SCI6	Benthic Habitat	Assess impacts to subtidal benthic habitat and biological communities
SCI7	Fisheries, Aquaculture, Fish	Monitor lethal and sublethal effects on fish and aquaculture species, and changes in fish population and abundance
SCI8	Heritage	Monitor changes in shipwrecks

Initiation Criteria and Implementation Times

Criteria	What is Initiated	Implement When	By Who	Comments
Level 2 or above spill to marine waters	This Plan, and OPS1,3 and SCI1 & SCI3 via the FSSAP	72hrs of the EMT declaring a Level 2/3 spill	OSMP Team, or field crew. Refer to FSSAP	The First-strike Sampling and Analysis Plan (FSSAP) is a template for rapid implementation of OPS1, 3 and 4.
Dispersant application is selected and is applied	OPS2 – Dispersant Efficacy Testing	Refer to relevant OPEP. Implement when dispersant is applied	Oil spill responder	
Oil predicted to reach coastal areas or shorelines	OPS4 is initiated for sediments	5 days from first prediction of coastal/shoreline exposure	OSMP Team, or field crew. Refer to FSSAP	Refer to First-strike Sampling and Analysis Plan for template
	OPS5 is initiated for rapid shoreline assessment	Refer to applicable OPEP / EP	Oil spill responder – shoreline specialist	
	OPS6 is initiated if those shores support seabirds/shorebird populations or their habitats	48 hrs from predicted/confirmed exposure to birds or shoreline habitats	Initially: Oil spill responder – shoreline specialist Later: OSMP Team	
Predicted exposure of oil to offshore sediments	OPS4 is initiated	5 days from first prediction of exposure to offshore sediments	OSMP Team	Refer to First-strike Sampling and Analysis Plan for template
Predicted exposure to sensitive marine megafauna habitat or migration pathways or fisheries	OPS7 for megafauna	48 hrs from first prediction of exposure to sensitive marine megafauna habitat	Initially: Aerial surveillance specialist Later: OSMP Team	
	OPS8 for fish tainting	5 days from first prediction of exposure of oil to known fisheries	OSMP Team	
OPEP response options implemented	Refer to Table on following page for activation of OPS components due to response options	Refer to each OPS component.	Refer to each OPS component.	Some response options and support functions trigger OPS components, e.g.: dispersant application, shoreline protection, shoreline clean-up, oiled wildlife, and waste management

Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Monitoring, Evaluation, and Surveillance
(Oil Pollution Emergency Plan (OPEP))

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X	X				X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X

OPS1: Oil Characterisation
OPS2: Chemical Dispersant Efficacy Assessment
OPS3: Oil in Water Assessment
OPS4: Oil in Sediment Assessment
OPS5: Rapid (Oiled) Shoreline Assessment
OPS6: Rapid Seabird and Shorebird Assessment
OPS7: Rapid Marine Megafauna Assessment
OPS8: Fish Tainting Assessment

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5.

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1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP) (this Plan) describes the types of environmental monitoring that may be implemented in the event of an emergency condition[1] resulting in a Level 2 or above oil spill to marine or coastal waters where Chevron Australia Pty Ltd (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State). This Plan and associated documents is the principal tool for determining the extent, severity, and persistence of environmental impacts from an oil spill.

This Plan was also developed to meet monitoring requirements under these Commonwealth and State regulations:

- Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
- Petroleum and Geothermal Energy Resources (Environment) Regulations
- Petroleum Pipelines (Environment) Regulations
- Petroleum (Submerged Lands) (Environment) Regulations.

Broadly, this Plan comprises two types of monitoring: operational and scientific. Operational monitoring collects information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations. Operational monitoring typically finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Scientific monitoring focuses on the short-and long-term environmental impact assessment. It may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Scientific monitoring determines the potential ongoing environmental impact attributable to the spill or the associated response activities, and informs the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a particular assessment or study, and has tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. Despite the individual initiation/termination criteria, components are inextricably linked, both across and within the two types of monitoring.

Aside from the initiation and termination criteria, the information in this Plan (and supporting documents, refer to Section 1.2) is not prescriptive; it provides a flexible framework for environmental monitoring that can be adapted based on the characteristics of a specific oil spill event. The Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred so that the monitoring implemented is appropriate to the nature and scale of the event.

[1] Emergency conditions are defined in each activity-specific Environmental Plan (EP) and relevant Oil Pollution Emergency Plan (OPEP).

1.2 Scope

This Plan focuses on operational and scientific monitoring of a Level 2 or above[2] oil spill event only, where CAPL is the Nominated Titleholder or Operator. Oil spill risks, prevention, and response activities are described in the activity-specific Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP). Monitoring, Evaluation, and Surveillance (MES) activities of an oil spill are excluded from operational monitoring in this Plan; these are included in the relevant[3] OPEP.

This Plan is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 1). The relationship between the various emergency management and oil spill documentation is outlined in Figure 1-1. An emergency condition would result in the activation of the Emergency Management Team (EMT), and the relevant OPEP and this Plan would be enacted (Figure 1-1).

In the event of an oil spill, activity-specific plans (which may include Oil Spill Tactical Response Guides and Incident Management Guides) will be enacted by the On-site Response Team (ORT) who will control the source of the spill and initiate any immediate actions required to ensure personnel safety and reduce the volume of oil released to the environment.

For spill events where CAPL is not the Control Agency, the scientific monitoring components are activated as per the initiation triggers listed in Section 5; the Control Agency is responsible for implementing operational monitoring.

[2]Although Level 1 oil spills may have environmental impacts that require investigation (at an appropriate scale), Level 1 spills are typically small in size and of short duration; the spill response may be complete before the OSMP could be implemented.

[3] CAPL is currently transitioning to a consolidated OPEP that will eventually address multiple activity-specific EPs and replace activity-specific OPEPs. This document will use the term ‘relevant OPEP’ until such time as all activity-specific EPs are addressed by the consolidated OPEP. Emergency Management Teams should check with the ABU Oil Spill Coordinator or the OSMP Monitoring Coordinator to understand which OPEP is applicable at the time.

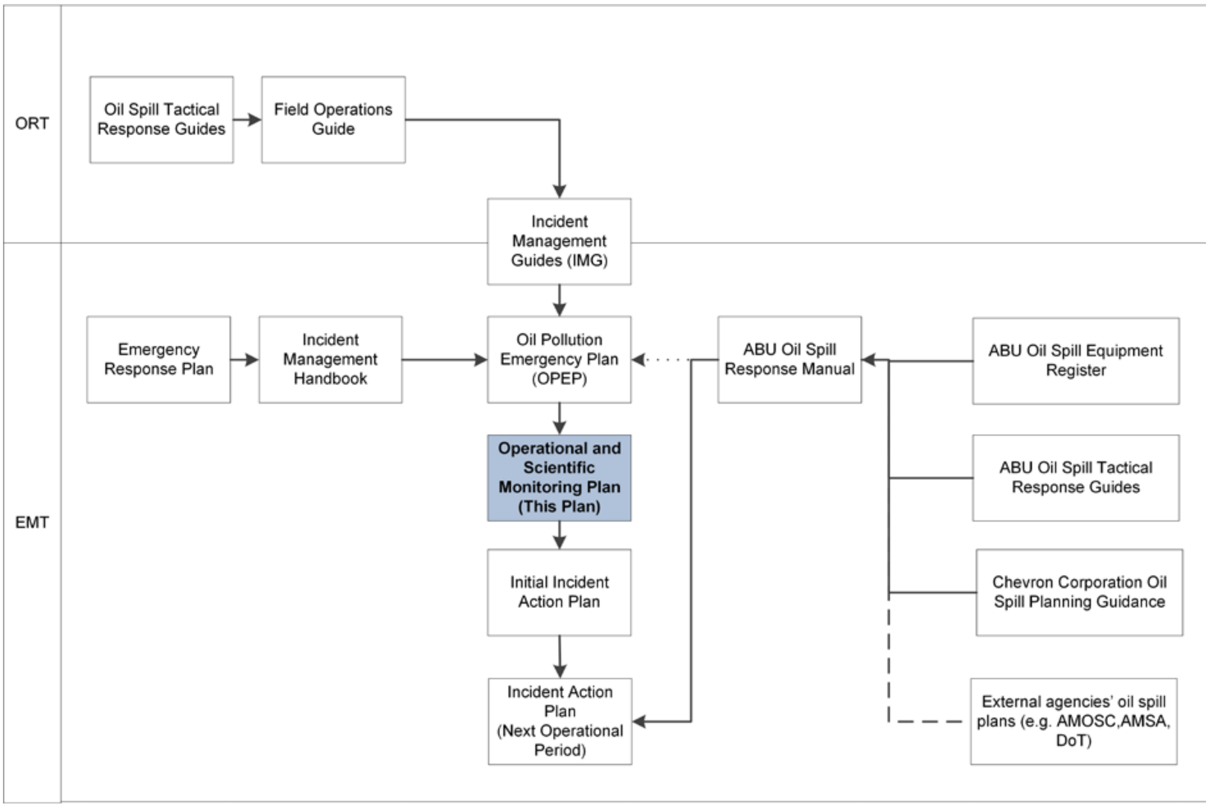

Figure 1-1: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Plan.

This Plan is supported by a number of other documents, tools and processes, as indicated in Figure 1-2.

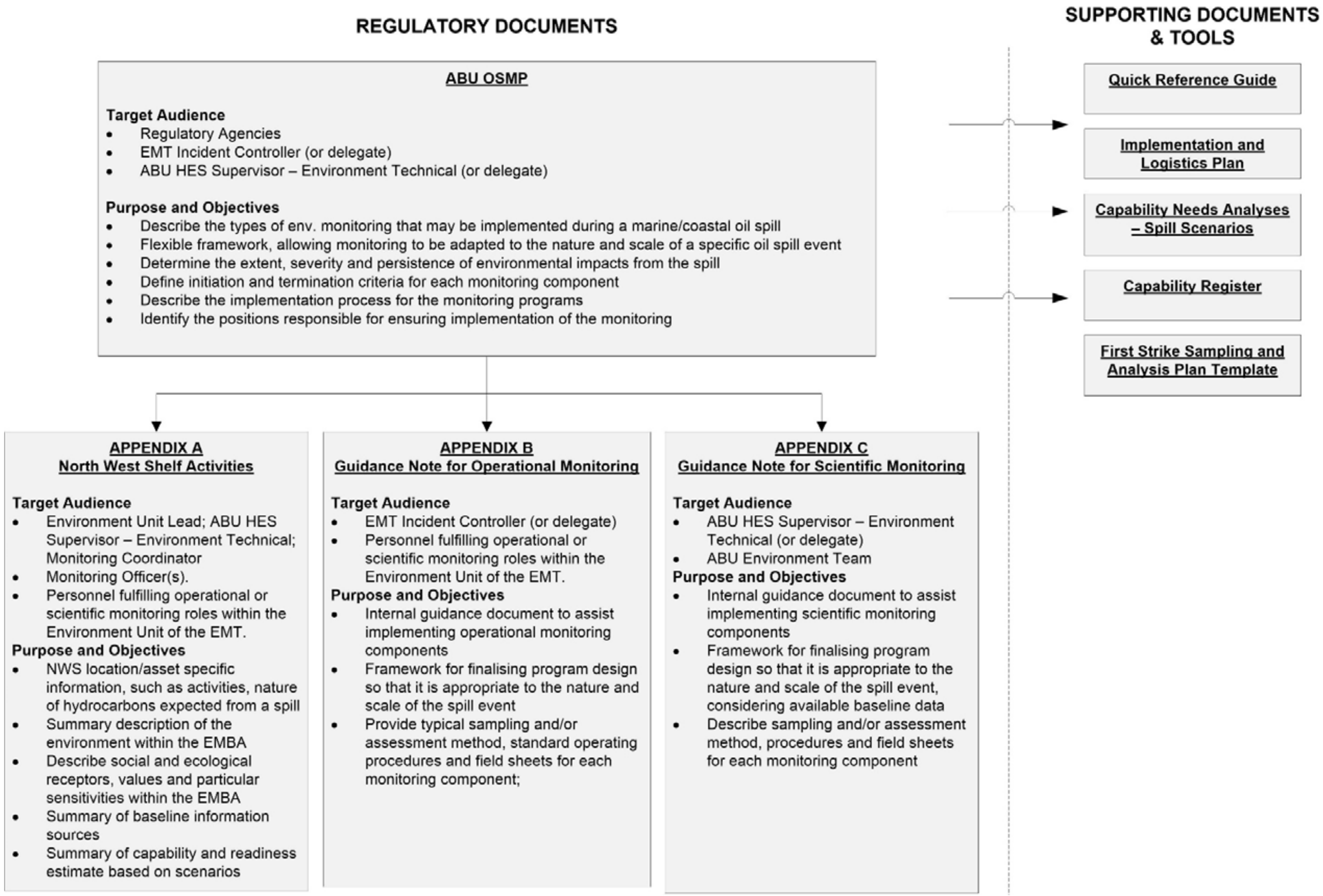

Figure 1-2: ABU OSMP Document Hierarchy and Supporting Tools

1.3 Objectives

The objectives of this document are to:

- describe the components of the operational and scientific monitoring that may be implemented in the event of an oil spill to marine or coastal waters
- define initiation and termination criteria for each monitoring component
- outline the environmental monitoring framework and process for designing and implementing the monitoring components
- identify the positions responsible for ensuring implementation of the monitoring
- outline the process for identifying, developing, and maintaining scalable capability to implement this Plan in a timely manner that is appropriate to the nature and scale of the event
- summarise the Environment that May be Affected (EMBA) by oil spills resulting from CAPL's activities on the North West Shelf; including sensitive environmental receptors within those areas
- outline estimates of capability and readiness required to implement this Plan in those areas
- provide guidance on designing monitoring programs and standard operating procedures for typical monitoring methods.

1.4 Target Audience

This document is intended for use by:

- EMT Incident Commander
- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s).

2 Implementation Strategy

The OSMP (this Plan) is one of the key processes under the Emergency Management (Ref. 2) element of the Operational Excellence Management System (OEMS). The OEMS is a comprehensive management framework that supports Chevron Corporation's commitment to protect the safety and health of people and the environment. The OEMS framework ensures a systematic approach to environmental management, with the environmental aspects of each project addressed from project conception, throughout project planning, and as an integral component of implementation.

This Section outlines:

- Activation of this Plan, initiation of individual components, and implementation of those components
- positions, roles and responsibilities for personnel involved in implementing operational and scientific monitoring, specifically the key positions responsible for meeting the commitments outlined in this Plan
- the systems and processes to ensure that the Plan is fit for purpose and CAPL is ready to implement it
- the mechanism for consulting with stakeholders while implementing the Plan
- the schedule for reviewing this Plan to maintain currency of information and pursue continual improvement.

Specific information related to implementing this Plan on the North West Shelf geographic area is provided in the Appendix A.

2.1 Activation, Initiation, and Implementation

This Plan is activated when the EMT declares a Level 2 (or above) spill to marine or coastal waters[4], where CAPL is the Nominated Titleholder or Operator. For this Plan, activation means the requirements of the Plan are now applicable.

Individual monitoring components are initiated and terminated according to prescriptive initiation and termination criteria, respectively. For the Plan, initiation means starting preparation for implementation.

Upon initiation, some monitoring components have specific timeframes for implementation. For this Plan, the implementation time refers to being ready, at the point of staging or departure, to mobilise for monitoring. For example, for vessel-based monitoring components it could mean being field-ready with equipment, personnel and other resources at the nominated staging area or vessel departure point.

2.2 Roles and Responsibilities

The roles and responsibilities outlined in Table 2-1 apply to monitoring during the incident response while the EMT is active; a subset of these positions may be maintained beyond the response phase. For positions not specific to this Plan, the roles and responsibilities listed in Table 2-1 are in addition to those identified in other Emergency Management documents.

The EMT Incident Commander (or delegate) is ultimately accountable for managing the response operation, which includes this Plan. The OSMP

[4] Marine or coastal waters includes waters within Australian Marine Parks

Monitoring Coordinator is the key coordination role for implementing OPS and SCI components in accordance with this Plan and reporting to the Environment Unit Lead. However, the ABU HES Supervisor – Environment Technical (an everyday non-EMT position) has a key role in advising implementation of scientific monitoring components during the response phase, liaising directly with the EMT Incident Commander or indirectly via the OSMP Monitoring Coordinator. Beyond the response phase the ABU HES Supervisor – Environment Technical assumes responsibility for ongoing scientific monitoring.

Several OSMP-specific roles (see shaded cells in Figure 2-1) are designated through this Plan. Depending on the scale of the event, individual people may perform multiple roles; similarly, multiple people may share the same role.

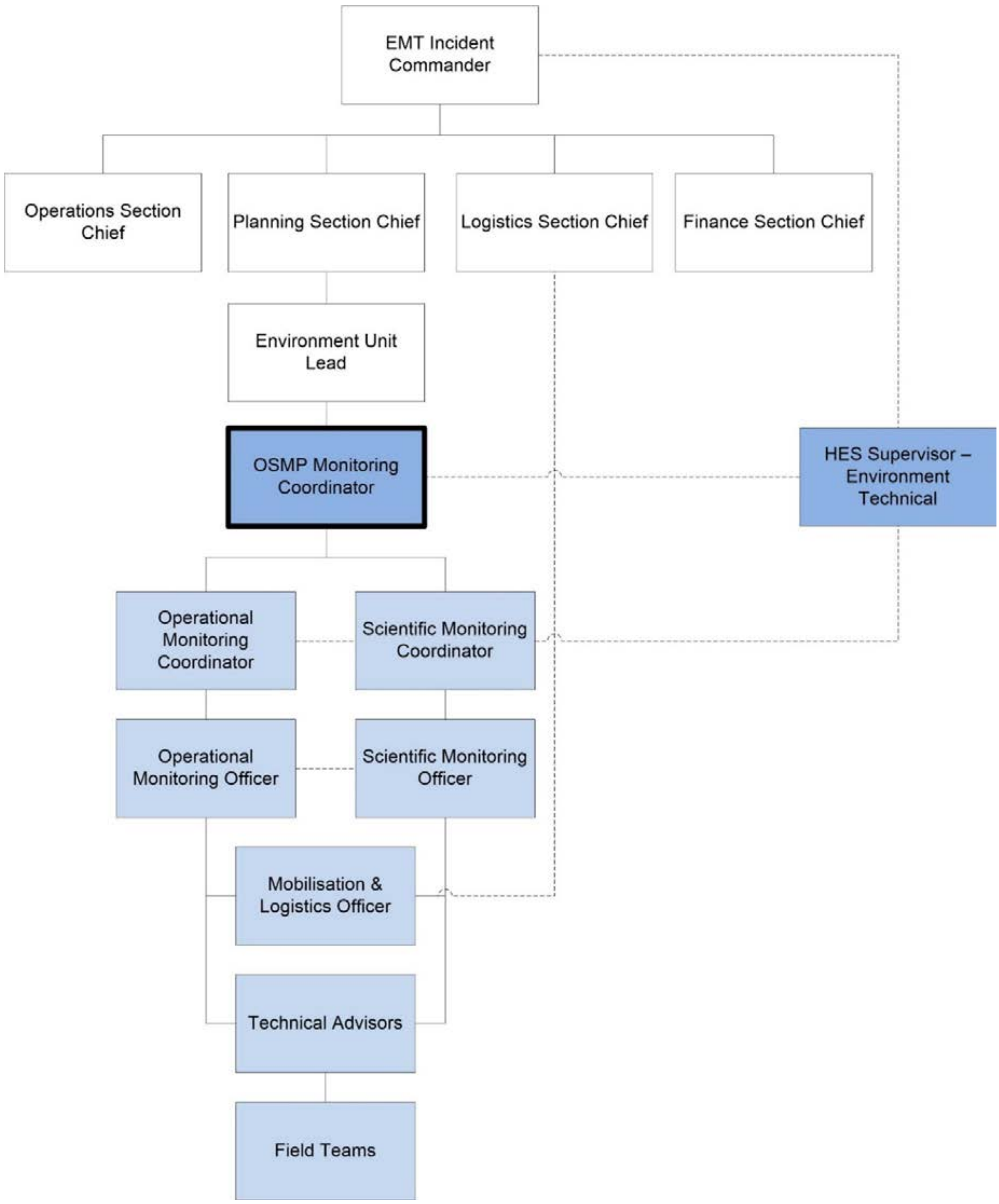

Figure 2-1: Organisational Structure Associated with Implementing Operational and Scientific Monitoring

Note: Shaded cells refer to roles specific to this Plan.

Table 2-1: Roles and Responsibilities

Role	Responsibility Summary
EMT Incident Commander (or delegate)	Ultimately accountable for implementing this Plan. Specific responsibilities: • ensure that the ABU HES Supervisor – Environment Technical (or delegate) and the Environment Unit Lead is sufficiently resourced to oversee and guide implementation of this Plan
Environment Unit Lead	The Environment Unit Lead has a broad range of duties in an emergency response. For this Plan, the Environment Unit Lead is the key position for relaying information between the EMT and the Monitoring Coordinator. Specific responsibilities: • ensure OSMP-specific roles (Figure 2-1) are established • integrate operational and scientific monitoring with the emergency response
OSMP Monitoring Coordinator	Responsible for coordinating the implementation of OPS and SCI components in accordance with this Plan, specifically: • identify the monitoring components that may be triggered based on the information collected during MES, OPS and via implementation of response options • ensure that monitoring components are implemented according to their specific initiation criteria, within nominated response times, and aligned with descriptions provided in Sections 4 and 5 and the relevant guidance notes (Appendix B and Appendix C) • contact point with the EMT via the Environment Unit Lead • facilitate activation of external support, if necessary.
ABU HES Supervisor – Environment Technical (or delegate)	• Oversee implementation of scientific monitoring components • Focal point for liaising with relevant stakeholders on monitoring design, monitoring priorities, and results (as required).
Scientific Monitoring Coordinator and Operational Monitoring Coordinator	The Operational and Scientific Monitoring Coordinators are the key program management roles for each type of monitoring. Responsibilities include: • provide overarching technical advice • advise on environmental impact from implementing monitoring and response options • approve final sampling and analysis plans for monitoring components
Operational Monitoring Officer and Scientific Monitoring Officer	The Operational and Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • ensure sampling and analysis plans align with monitoring objectives • understand the data metrics collected in the event of a spill • advise the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, logistics) are encountered • oversee data analyses and interpretation • manage data, including spatial data • present data in an appropriate and informative format to allow for timely decisions.
Technical Advisors	Technical Advisors are assigned to individual monitoring components as required. Key responsibilities include: • advise on sampling design, methods and analysis. Assist in developing sampling and analysis plans • ensure quality assurance/quality control (QA/QC) of data, and its interpretation • prepare reports.

Role	Responsibility Summary
Mobilisation and Logistics Officer	Responsible for: • ensuring all field teams are mobilised to site as soon as practicable and in accordance with CAPL processes. • liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of monitoring field teams. • Identify and help facilitate procurement of any necessary resources.
Field Teams	A Field Team includes one Field Team Lead, who is the key contact point to the Technical Advisor or Monitoring Officer during a field deployment. The responsibilities of all Field Team members include: • understand the details of monitoring methods • ensure that they are supplied with adequate equipment and field data collection sheets to undertake the monitoring component • ensure awareness and understanding of QA/QC procedures • help with report preparation if required.
Other roles	Other support roles may include: • scribe(s) to document decisions • Document / data manager • External consultant coordinator • Laboratory services coordinator

2.3 Capability and Readiness

Development and maintenance of capability and readiness to implement the OSMP is categorised into three key resource groups:

- personnel
- logistics
- equipment, infrastructure, and support services.

Implementation of system-level measures such as internal reviews, readiness assessments (exercises and drills), and schedules ensure that resources within these interconnected groups are fit for purpose, capable, and ready for deployment to meet the required outcomes of the OSMP. CAPL's compliance assurance process manages compliance by verifying conformance against OSMP commitments (Section 2.4.1).

2.3.1 Personnel

Those capable of implementing this OSMP come from internal (CAPL and corporate global structure) and external (contractor) personnel.

Suggested minimum capability requirements (qualification, training, awareness, and experience) for individuals to fulfil OSMP-specific roles, from HES – Supervisor Environment Technical through to Field Team member, are identified in the ABU OSMP Capability Register (Ref. 3). The estimated number of personnel needed to fulfil roles for any given event depends on the event's circumstances. These estimates are determined internally and guided via internal workshops or exercises for responding to a range of credible scenarios, with a credible worst-case scenario defining the upper limit of the estimate. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

The expected capability of individual personnel to perform OSMP roles is assessed by comparing their skills against the requirements. Personnel are graded into one of three competency levels for each role according to these guidelines:

- SME (Subject Matter Expert level): knowledgeable and qualified. Examples of knowledge include peer reviewed publications, expert panel positions, and extensive experience (15+ years). Examples of qualification include relevant degrees: PhD or MS or BSc Hons with extensive experience. Such a person should be able to direct research and have in-depth knowledge of principles and practices of the role.
- P (Practitioner level): knowledgeable in the specific area. Examples of knowledge include experience (5+ years), and/or publications. Such a person should have a relevant degree (BSc or above) and experience, and be able to implement research and understand the principles of the role.
- A (Awareness level): a level of competency. Examples of competency include some level of practical experience to implement the role. Such a person should have relevant qualifications and/or experience, and be able to assist in implementing the role, but may not thoroughly understand principles or practices.

For specific key OSMP roles, people may be strategically pre-nominated based on their suitability to specific positions; with redundancy in personnel able to fill the key role. When this Plan is enacted, individual personnel will be assigned to key OSMP roles using this process:

- Identify roles that must be filled according to Figure 2-1 and the specific OPS and SCI Plans that have, or are likely to be, initiated. Note: EMT Incident Commander and Environmental Unit Leader roles are filled under Emergency Management.
- Confirm that individuals within CAPL who have been pre-nominated on the ABU OSMP Capability Register (Ref. 3) are still suitable for their roles and are available.
- Assign identified individuals to roles and communicate these assignments to the EMT.

Internal personnel capability is documented every six months in the ABU OSMP Capability Register. External contractors self-assess their capability against the requirements and provide a Statement of Personnel Capability and Readiness every six months.

2.3.1.1 Internal

Internal capability within CAPL includes those based in Western Australia (Perth, Onslow, and Barrow Island). If required, Chevron Corporation’s international offices (e.g. San Ramon [California]; Houston) have personnel skilled in oil spill monitoring if the scale and duration of the response is beyond local personnel.

Internal personnel are assigned to these OSMP-specific roles:

- HES Supervisor – Environmental Technical
- Monitoring Coordinator
- Operational Monitoring Officer/Scientific Monitoring Officer

- Mobilisation and Logistics Officer

Internal staff may perform Field Team roles and responsibilities, particularly first-response OPS monitoring; however, it is expected that Field Team personnel would be sourced externally.

2.3.1.2 External

External personnel, primarily for the roles of Field Team or Technical Advisors, are likely to be filled by contractors to CAPL and/or service providers. Current external capability relevant to specific OPS and SCI Plans and available to CAPL is summarised in Table 2-2.

Further scalability of external personnel is achievable through corporate-level contracts with service providers. For example, Chevron Corporation maintains a contract with Cardno for general environmental services, including responding to emergency situations.

Table 2-2: Capability and Arrangements for External Contractors

Contractor Type	Capability	Activation
Environmental Contractors	All operational and scientific monitoring components	Master contracts exist between CAPL and several specialist environmental consultancies, allowing them to undertake the types of monitoring required under this Plan. Additionally, environmental consultants contracted to Chevron corporation are also available.
Environmental Research Agencies	All operational and scientific monitoring components	Master contracts exist between CAPL, the Cooperative Research Council (CRC), the WA Energy Research Alliance (WA ERA) and Murdoch University, which allow several research agencies and universities to undertake the types of monitoring required under this Plan.
AMOSC	Aerial surveillance and dispersant efficacy testing - field (OPS2), rapid shoreline assessment (OPS5)	CAPL is an AMOSC member company and is represented on the AMOSC board. Activation is via 24hr, 7 days a week emergency hotline.
OSRL	Aerial surveillance and dispersant efficacy testing (OPS2)	CAPL is a member of OSRL. Activation is via 24hr, 7 days a week emergency hotline.
ChemCentre WA	Dispersant efficacy testing – laboratory (OPS2)	CAPL has a direct contract with ChemCentre.

2.3.1.3 Development of Personnel Capability

As described in Section 2.3.1, the ABU OSMP Capability Register (Ref. 3) defines the upper estimate of personnel requirements to implement this Plan for a credible worst-case scenario.

CAPL has a process to develop and record personnel capability (training, awareness, and experience) towards meeting the requirements. This process includes:

- an ABU OSMP Training Plan (included as part of the ABU OSMP Capability Register (Ref. 3)), which is used to identify and schedule capability development activities

- recording the completion of capability development, either through the Learning Management System (for computer-based learning components), or manually via the ABU OSMP Capability Register (Ref. 3)
- collating additional competency data within the ABU OSMP Capability Register (Ref. 3). Data collated include, but are not limited to, qualifications (tertiary education), years of experience, training (e.g. oil spill training, oiled wildlife response, offshore survival), and emergency exercise involvement.

The ABU Environmental Team Lead (or delegate) is responsible for ensuring that the above process and associated procedure(s) are implemented correctly, via six-monthly verification of the ABU OSMP Capability Register (Ref. 3) and six-monthly verification of external contractors' Statements of Personnel Capability and Readiness.

2.3.2 Logistics

Capability and readiness to implement this Plan depends on a functioning logistics system. Although the Mobilisation and Logistics Officer nominated through this Plan is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, the capability and readiness to execute the required work is held within, and delegated to, the CAPL Supply Chain Management Team via the EMT.

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) defines the minimum logistics capability required to implement this Plan within the required time frames. The requirements for any given event depends on the event's circumstances, but the upper estimate of logistics support is determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

Resources and logistics required to resource this Plan are just a subset of those required to resource a spill response. ABU Supply Chain Management, along with a large pool of contractors, is equipped with personnel to service ABU's complex and diverse asset portfolio (including two large LNG plants, an onshore oilfield, and offshore platform and offshore wells). During a spill, logistics resources would be re-directed to the response.

2.3.2.1 Access

For areas not under CAPL's operational control, access will be planned in conjunction with relevant State and Commonwealth statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), WA Department of Biodiversity, Conservation and Attractions (or equivalents) for marine parks, and relevant agencies for access to restricted heritage protection areas.

2.3.3 Equipment, Infrastructure, and Support Services

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) estimates the equipment and infrastructure required to implement this Plan within the required time frames. The requirements for any given event depend on event's circumstances; the upper estimate of logistics support was determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities. Critical equipment is identified and stores/inventories maintained according to need.

The capability and readiness to procure equipment, infrastructure, and support services is held within, and delegated to, the CAPL Supply Chain Management Team. Internal capability and/or external contractual arrangements for many of the support services are already in place; examples are presented in Table 2-3.

Table 2-3: Capability and Arrangements for Equipment, Infrastructure, and Support Services

Support Service	Capability	Activation
Analytical Laboratories	All laboratory analyses	Master contracts exist between CAPL and selected analytical laboratories, allowing them to undertake the types of analysis required under this Plan. Laboratories associated with university or research institutions can also be accessed via the CRC and WA ERA arrangements.
Vessels	Vessels of a range of size classes, specifications and capabilities, from small landing craft and tender vessels up to Platform Support Vessels	Master contracts exist between CAPL and selected vessel providers, with ability to provide all types of survey vessel that may be required under this Plan. Vessel providers are managed by internal CAPL marine logistics experts.
Aircraft	Helicopters and fixed-wing aircraft in a range of size classes and capabilities	Master contracts exist between CAPL and aircraft providers (e.g. Bond helicopters and Cobham aviation). Aircraft providers are managed by internal CAPL aviation experts.
Transport networks	Road and air freight networks	External contractors provide warehousing, line-haul and marine freight services to ABU supply bases and assets, with the ability to scale up services as required.
Travel services	Domestic travel and related services for personnel and small equipment	CAPL has a contract with a corporate travel services business that provides 24-hour support for all personnel travel. Contact with the provider is through CAPL administrators.
Communications	Establishment of communications systems and networks	CAPL telecoms maintain internal capability to procure and deploy communications networks.
Quarantine	Quarantine advice, inspection, detection, response and monitoring	A comprehensive quarantine management system was developed for all freight and personnel movements to/from Barrow Island. This process is administered via the CAPL Supply Chain Management team and, to varying degrees, can be applied to any freight/personnel movements, regardless of the destination. The quarantine management system is managed by internal CAPL experts, with inspection services undertaken by contractors.

2.4 Testing and Verifying Capability

System-level measures (e.g. internal audits, exercises, workshops) test and verify capability and readiness; exercising the OSMP is included in the ABU multi-year exercise schedule. Outcomes from these measures is used for continual improvement.

2.4.1 Compliance Assurance

Compliance Assurance (Ref. 5) is an element of the CAPL OEMS. This process manages compliance by verifying conformance with Operational Excellence requirements in applicable company policy, government laws, and regulations. This process has two key supporting procedures, as detailed below.

2.4.1.1 Compliance Assurance Audit Program

This procedure (Ref. 6) establishes internal audit programs to verify the effectiveness of controls and the extent to which requirements are met by CAPL. Audits may focus on in-field activities or administrative processes depending on the activities being undertaken around the time of audit. A record of audits and the audit outcomes is maintained, and actions arising from internal audits are tracked until closure, in accordance with Section 2.4.1.2.

2.4.1.2 Compliance Assurance Management of Instances of Potential Non-compliance

This procedure (Ref. 7) addresses instances where the requirements may not have been fully met. If findings are identified during internal audits, corrective actions are identified, assigned, and recorded in Essential Suite, which is a Chevron-wide database that sends notifications and follow-up emails to the responsible person for timely closure of audit actions.

2.5 Providing Information and Consulting with Stakeholders

External notification and reporting to regulators, Hazard Management Authorities, and key stakeholders is outlined in the relevant OPEP. The EMT coordinates ongoing communications with stakeholders, via embedding a Policy, Government and Public Affairs (PGPA) representative in the EMT to provide ongoing advice to, and coordination of, stakeholders (e.g. DoT, DBCA, Australian Maritime Safety Authority [AMSA]) or via regular verbal or written communications. The PGPA Officer also coordinates generic communications (e.g. key messaging) with relevant non-regulatory stakeholders through the ABU Communications Response Team.

The ABU HES Supervisor – Environment Technical (or delegate) is the focal point for communication and consultation of a technical scientific nature. This position consults with relevant government stakeholders on monitoring design and priorities, specifically with respect to state marine parks. Claims or objections raised by government stakeholders will be responded to, including communication of changes made to monitoring programs as a result of consultations. Similarly, this role is also responsible for communicating results of monitoring programs. The form, frequency, and content of communications will be appropriate to the nature and scale of the incident.

2.6 Reviewing this Plan

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years or more often as required (e.g. in response to new information). Internal processes linked to implementation of this Plan may be reviewed more frequently.

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, opportunities for improvement identified from inspections, audits, exercises, and any relevant emerging environmental issues.

3 Environmental Monitoring Framework

3.1 Overview

This Plan provides a flexible framework for implementing operational and scientific monitoring, thus allowing adaption to the nature and scale of a specific oil spill event. This Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred. This Plan is linked to the MES component of a spill response, as described in the relevant OPEP and the ABU Oil Spill Response Manual (Ref. 1).

The Plan comprises two types of monitoring:

- Operational – to collect information about the oil spill and associated response options to aid planning and decision making in executing spill response or clean-up operations
- Scientific – to determine the short- and long-term environmental impact of the oil spill and associated responses, and inform the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a discrete assessment or study, with tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. In some cases the criteria are fixed; others are linked to the relevant OPEP. Despite the individual initiation/termination criteria, the components are inextricably linked, both across and within the two types of monitoring.

Typically, operational monitoring is initiated by the spill event itself, through MES information collected during the response, or by implementation of a response option. Operational monitoring usually finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Specific components of scientific monitoring are triggered by the spill itself, while others are triggered by data generated by MES and operational monitoring. Scientific monitoring may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Either type of monitoring may occur in areas impacted by the spill, areas not yet impacted by the spill (to gather pre-impact data), and areas not likely to be impacted by the spill (to act as reference or control data).

Figure 3-1 summarises how operational and scientific monitoring relates to oil spill response. The Quick Reference Guide at the front of the document summarises the initiation criteria, termination criteria, and time frames for implementation, while Sections 4 and 5, and Appendix B and Appendix C provide further details for each monitoring component.

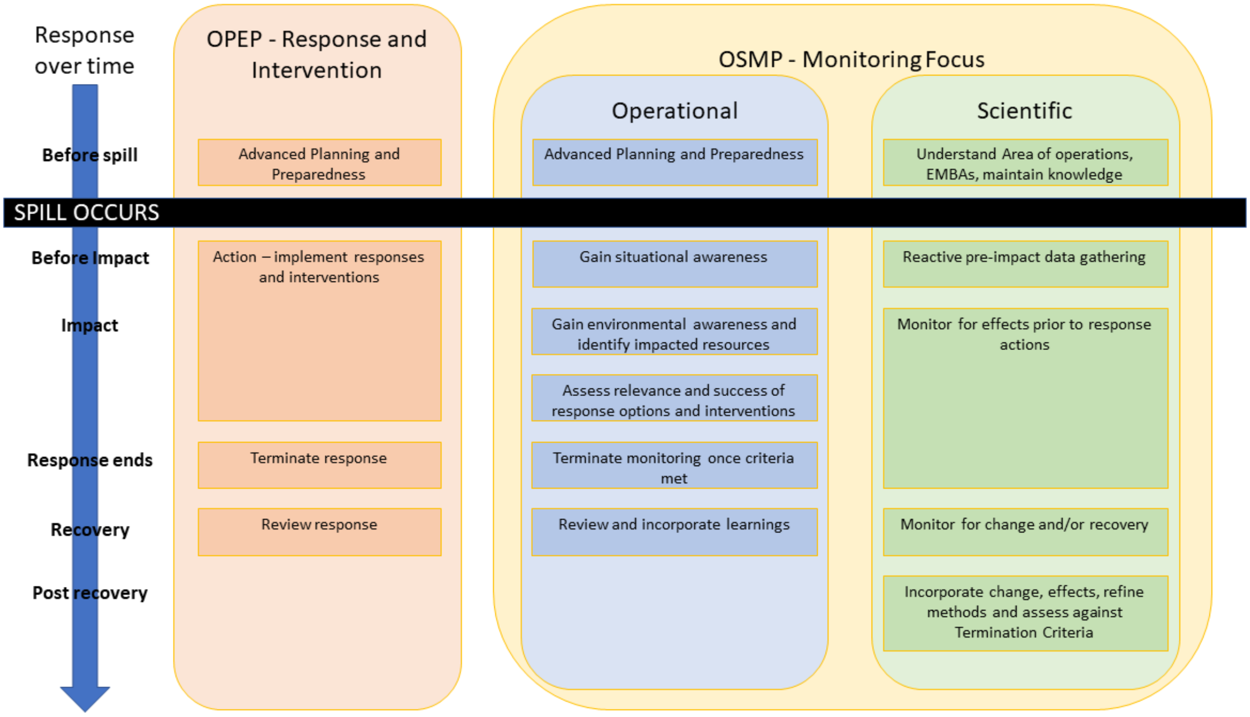

Figure 3-1: Oil Spill Response and Role of Operational and Scientific Monitoring

3.2 Design and Implementation

In the event of a spill to marine or coastal waters, advance planning and pre-mobilisation activities commence in anticipation of initiating monitoring components; these activities include consultation with stakeholders on monitoring design and priorities, as appropriate to the nature and scale of the spill (see Section 2.5).

Once a component of operational or scientific monitoring is triggered, a series of steps, beginning with preparing the final program design, is implemented (Figure 3-2). Each spill event is unique, and therefore the receptors at risk, selection of sites, and implemented monitoring programs will vary between each event.

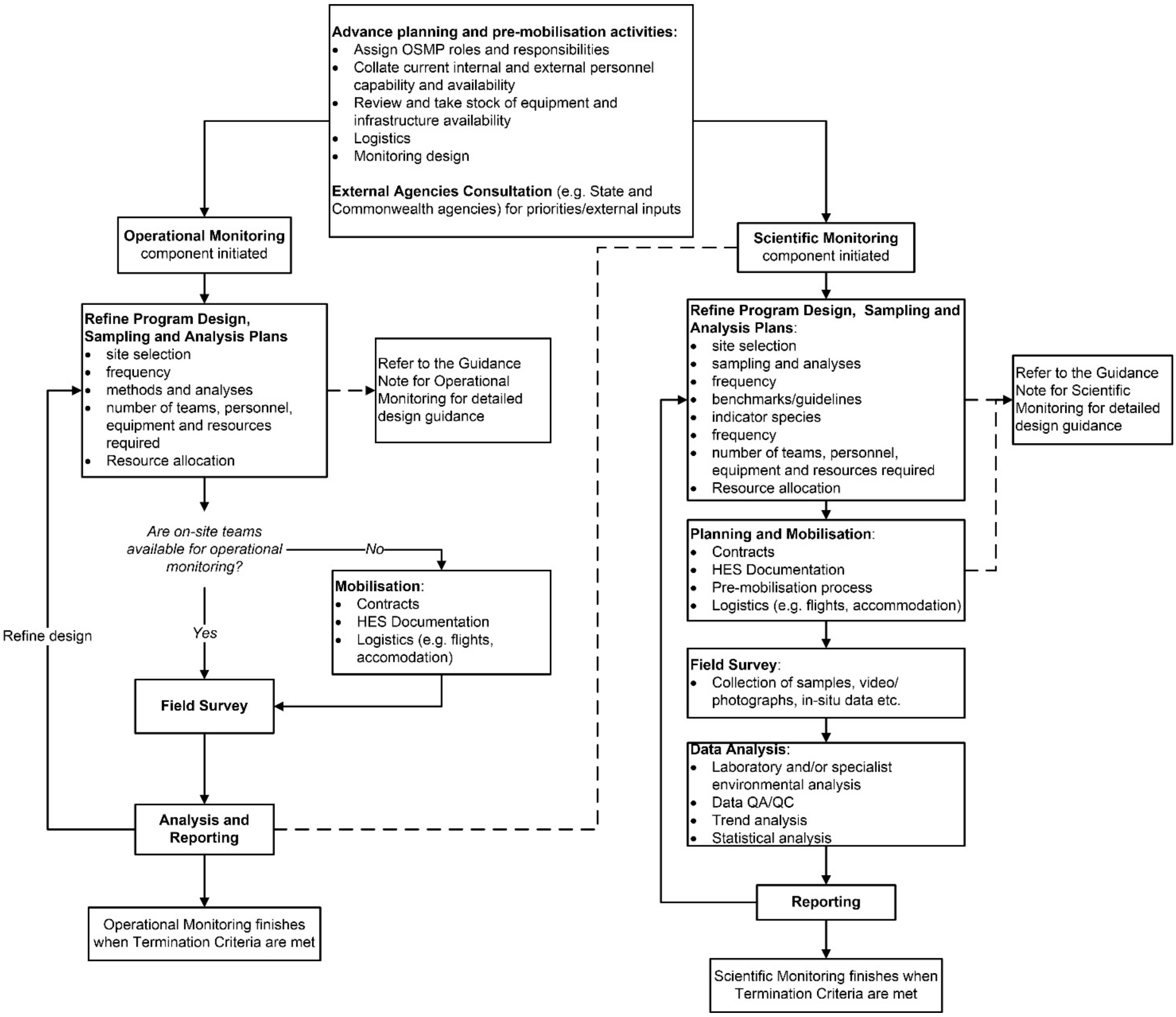

Figure 3-2: Implementation Process for Operational and Scientific Monitoring

Monitoring design is different for the two types of monitoring; however, the methods to obtain the data may be common between monitoring types. Operational monitoring focuses on informing planning and decision making in executing spill response; therefore, the objectives of this monitoring are closely linked to the MES tactics and response options used. Scientific monitoring focuses on determining the short- and long-term impacts; therefore, the main objective of this monitoring is to establish cause and to quantify effects.

Regardless of the monitoring type, common elements of designing a monitoring program include:

- clarify how the monitoring information will be used
- set the objectives of the study – what does the program seek to measure (e.g. descriptive; measurement of change; determination of cause and effect)
- define the parameters to include in monitoring
- define the spatial boundaries of the study

- identify monitoring priorities
- determine the most effective allocation of available resources.

3.2.1 Operational Monitoring

The Guidance Note and Standard Operating Procedures for Operational Monitoring (Appendix B) provides fine-level detail aimed at environmental personnel who implement operational monitoring components, including:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Where practicable, operational monitoring standard operating procedures are aligned with existing processes, including:

- DoT oiled shoreline assessment
- Special Monitoring of Applied Resource Technologies (SMART) protocol (Ref. 8) and the American Petroleum Institute (API) Subsea Dispersant Monitoring method (Ref. 9) for dispersants
- AMSA sampling guides (Ref. 10).

3.2.2 Scientific Monitoring

The Guidance Note and Standard Operating Procedures for Scientific Monitoring (Appendix C) is aimed at environmental personnel implementing scientific monitoring components. The guidance note includes:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors (e.g. Before-After-Control-Impact, impact vs control, gradient of impacts, lines of evidence, control charts), taking into consideration existing baseline data and current monitoring techniques
- guidance on effects size and power to detect change
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Selection of the survey design(s) will depend on these criteria:

- the scale and pattern of potential effects of the spill
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of OPS data

- availability of appropriate reference sites
- statistical approach proposed to analyse the data
- the range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

To ensure the application of robust designs and sampling approaches that have the highest likelihood of detecting an environmental impact while allowing suitable flexibility, these guiding principles have been adopted:

- align with existing baseline sampling design and methods wherever possible to maximise data comparability
- allow for appropriate spatial and temporal replication to account for natural dynamics in the system
- use exposure gradients where appropriate
- use indicator taxa where appropriate
- use benchmarks where appropriate (see further information below)
- assess statistical power (if relevant).

If benchmarks[5] are relevant in the scientific studies, they will be selected taking into consideration trigger values that have already been established (e.g. Ref. 11, Ref. 12, Ref. 13, Ref. 14) or if appropriate, follow the process as outlined in Ref. 11 to develop a relevant benchmark value. If several levels of protection are available (e.g. Ref. 11), the 95% species protection level will be adopted, except in areas where a higher (99%) protection level is appropriate (e.g. marine parks, undisturbed ecosystems) or, conversely, a lower (80% or 90%) protection level is appropriate (e.g. highly disturbed ecosystems, defined low ecological protection areas).

3.3 Identifying Monitoring Priorities

Priorities for monitoring will be specific to the nature and scale of the event and will change throughout the duration of the monitoring effort. Factors to be considered when setting monitoring priorities include:

- presence of sensitive ecological and social receptors within the EMBA and protection prioritisation of those receptors
- predicted time until sensitive receptors are exposed to hydrocarbons
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of appropriate reference sites

[5] Benchmarks are used to describe concentrations above which there is the possibility of risk to the environmental receptor.

- statistical approach proposed to analyse the data
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

3.3.1 Sensitive Receptors

CAPL has a process for identifying and ranking ecological and social receptors that are sensitive to oil spills, including: shoreline types; marine habitats; marine, coastal and terrestrial species. This process is described in the ABU Oil Spill Protection Prioritisation Process (Ref. 15), and is generally aligned with the Western Australian (WA) Department of Transport (DoT) Protection Prioritisation Process (Ref. 16).

CAPL's Protection Prioritisation Process for the North West Shelf consists of seven broad steps. In summary, the steps are:

1. Determine the Environment that May Be Affected (EMBA) by an oil spill using modelling
2. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
3. Use literature and research data to determine the sensitivity of the various receptors to the effects of oil
4. Rank each receptor according to its sensitivity to oil and display the rankings geospatially
5. Review deterministic oil modelling runs used for response planning assessment.
6. Overlay the results on PP geospatial data
7. List the highest value PPs

Steps 1 to 4 are done during the planning stage, while steps 5 to 7 are undertaken following an oil spill.

The ecological and socioeconomic values and sensitivities known to occur with the EMBA of each activity are defined in the activity-specific EPs. A Description of the Environment, which includes a summary of the values and sensitivities relevant to CAPL's North West Shelf Activities, is provided in Appendix A.

These values and sensitivities identified within the EMBA are used to assist CAPL in identifying the appropriate response strategies to implement through the application of a Net Environmental Benefit Analysis (NEBA). NEBA is way to compare the net environmental benefits associated with multiple management alternatives. Used both prior to a spill occurring (Strategic NEBA) and after a spill (Operational NEBA), NEBA is the process of considering advantages and disadvantages of different spill response options (including no response) to arrive at a spill response decision that results in the lowest overall environmental and social impacts. Operational Monitoring data will contribute to on-going Operational NEBAs by providing information relevant to understanding the feasibility and effectiveness of the response options being carried out.

3.3.1.1 Ecological

The alignment of sensitive environmental receptors, relevant to CAPL's North West Shelf Activities, and the operational and scientific monitoring components is provided in Appendix A.

3.3.1.2 Socioeconomic

The Commonwealth and State regulations (outlined in Section 1.1) define the 'environment' to mean ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places, and the socioeconomic and cultural features of those matters.

For this Plan, a direct cause-effect pathway needs to be identified to allow for the successful monitoring of any potential significant impact. Direct monitoring of shipwrecks is addressed by SCI8; however, CAPL considers that the ecological impacts of an oil spill are suitable as a substitute measure of any potential significant impact on the remainder of socioeconomic and heritage features, including heritage features protected by the EPBC Act. CAPL has identified seven categories of socioeconomic and heritage features; the justification for the inclusion/exclusion of additional monitoring for these features is provided in Appendix A.

If the monitoring of ecological receptors indicates that a potential significant impact to socioeconomic and/or heritage features may occur, then CAPL will liaise with suitably qualified archaeologists, including relevant CAPL Aboriginal engagement representatives, to document accurate records, including map references, photographs, and descriptions of the material from in situ evaluations. Similarly, CAPL will liaise with relevant statutory bodies (i.e. government heritage and tourism agencies, Aboriginal affairs agency, fisheries and maritime agencies) to incorporate aspects of monitoring into operational and scientific monitoring programs, or if impacts have occurred, to determine an appropriate management action (e.g. in regards to temporary closures) and termination criteria. Refer to Section 2.5 for further details.

3.4 Resource Allocation

Responding to the spill itself often involves scaling of resources to effectively manage the spill. This is also the case with operational and scientific monitoring. Whilst a predicted worst-case scenario is planned for, each spill will be unique in terms of trajectory, required logistics (e.g. access, communications) and presence of sensitive receptors.

In the initial hours and days after a spill has been reported, the Environment Unit Lead (EUL) ensures the relevant operational monitoring components are commenced within the timeframes specified in the relevant OPEP and/or OSMP. The EUL works with the Operations Section Chief and OSMP Monitoring Coordinator to determine the most appropriate location and distribution of the available monitoring teams using the common operating picture (COP) and operational net environmental benefit analysis (NEBA) results.

The location and distribution of the monitoring teams in the initial stages of the spill will be influenced by the ecosystem components most at risk of impact from the spill. For example, if the spill is a considerable distance offshore and COP data indicates no shoreline contact is expected for a number of days, then the EUL may determine that the most appropriate resourcing strategy would be to direct the monitoring teams to focus on OPS1: oil characterisation and OPS3: oil in water assessment close to the spill source. However, once dispersant is applied, it may be necessary to divert some resources to conduct OPS2: chemical dispersant efficacy assessment, OPS3: oil in sediment assessment and SCI6: Benthic Habitat Impact Study, as the oil becomes more entrained into the water column.

The ABU OSMP Capability Register (Ref. 3) documents the skills and competency of personnel who may be called upon for monitoring activities. Many personnel are capable of performing a number of different roles, so that the OSMP structure is flexible enough to suit the nature and scale of the incident. The flexibility of monitoring teams is important to ensure resources can be directed towards the most relevant monitoring component.

Once the location and distribution of monitoring teams has been agreed, it is stated in the monitoring section of the EMTs Incident Action Plan (IAP). The Operational and Scientific Monitoring Coordinators appoint Technical Advisors for each monitoring component and work with them to finalise sampling and analysis plans. Data generated during the current operational period should be communicated directly back to the EMT via the EUL. This information is important to ensure the EMT make informed decisions around the allocation of resources for response activities and monitoring activities for the next operating period.

If the spill response is ongoing, additional resources to conduct operational and scientific monitoring will be scaled in. It is also possible that some OPS components will be replaced by SCI components, depending upon whether termination and initiation triggers have been met.

4 Operational Monitoring

4.1 Overview

Operational monitoring provides information for use in EMT response planning and decision making by measuring the impacts and effectiveness of response options. As such, operational monitoring needs to be able to provide data within a time frame relevant to the Incident Action Plan cycle. Operational monitoring can also provide information that can initiate components of the scientific monitoring program, where applicable (see Section 5).

The components of the operational monitoring program are:

- OPS1: Oil Characterisation
- OPS2: Chemical Dispersant Efficacy Assessment
- OPS3: Oil in Water Assessment
- OPS4: Oil in Sediment Assessment
- OPS5: Rapid (Oiled) Shoreline Assessment
- OPS6: Rapid Seabird and Shorebird Assessment
- OPS7: Rapid Marine Megafauna Assessment
- OPS8: Fish Tainting Assessment.

Appendix B contains the full suite of operational monitoring components listed above. Each plan provides fine detail aimed at personnel who implement operational monitoring components, including:

- Monitoring rationale;
- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

Where practicable, the standard operating procedures are aligned with existing standards and processes, including:

- Department of Transport (Western Australia) oiled shoreline assessment (Ref. 17)
- Special Monitoring of Applied Resource Technologies (SMART) protocol for dispersants (Ref. 18).
- CSIRO Oil Spill Monitoring Handbook (Ref. 19)
- AMSA sampling guides (Ref. 20)
- ANZECC Guidelines (Ref. 11)
- Revised ANZECC/ARMCANZ Sediment Quality Guidelines (Ref. 21).

OPS components may be implemented concurrently with each other, and/or in conjunction with response activities such as Monitoring, Evaluation and Surveillance (MES) tactics described in the relevant OPEP. Examples of such synergies include:

- Complete aspects of OPS6 and OPS7 during aerial observation (MES)
- Complete OPS1, OPS2, OPS3, OPS4, OPS6 and OPS7 during vessel observation (MES)
- Deploy a tracking buoy, complete shoreline assessment and visual observations (MES) whilst implementing OPS1, OPS3, OPS4 and OPS5

Depending on the size and nature of the spill, OPS components may need to be implemented multiple times, or continuously, during the spill response; the frequency will be based on the data needs of the EMT.

Further to the initiation criteria specified for each operational monitoring component, Table 4-1 identifies operational monitoring components that may be triggered for the different response options and support functions.

Table 4-1: Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X					X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X
OPS1: Oil Characterisation	*OPS5: Rapid (Oiled) Shoreline Assessment*							
OPS2: Chemical Dispersant Efficacy Assessment	*OPS6: Rapid Seabird & Shorebird Assessment*							
OPS3: Oil in Water Assessment	*OPS7: Rapid Marine Megafauna Assessment*							
OPS4: Oil in Sediment Assessment	*OPS8: Fish Tainting Assessment*							

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5

4.2 OPS1: Oil Characterisation

Overview	OPS1 provides the EMT with the chemical properties of the released oil.
Initiation Criteria	Activation of this Plan
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 72 hours of initiation
Aim	Provide quantitative information on the chemical properties of the oil to assist the EMT in selecting the most effective response option(s).
Monitoring Approach	**Sampling**: • Collect spilt oil sample **Analysis**: • Chemical characterisation • Toxicological (if required) analysis **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • OPS1 is no longer contributing to or influencing spill response decision making, and • All data required by the EMT Incident Commander (or delegate) are received.

4.3 OPS2: Chemical Dispersant Efficacy Assessment

Overview	OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil.
Initiation Criteria	The EMT has decided to apply dispersant as a response option.
Implementation Time	Within 24 hours of initiation
Aim	To provide rapid information on the efficacy of dispersant as a response option.
Monitoring Approach	**Sampling**: • Surface chemical dispersant: SMART Protocol • Subsurface chemical dispersant: API method **Analysis**: • On-site and/or laboratory analysis of hydrocarbon and dispersant presence and state (e.g. concentration, oil droplet size) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS2 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS2 monitoring is likely to increase overall environmental impact.

4.4 OPS3: Oil in Water Assessment

<table>
<tr><td>Overview</td><td>OPS3 provides the EMT with ongoing information on the water quality, particularly the oil content, within the response areas.</td></tr>
<tr><td>Initiation Criteria</td><td>Activation of this Plan</td></tr>
<tr><td>Implementation Time</td><td>Preparation to deploy field personnel and equipment will commence upon initiation
Implementation will be achieved within 72 hours of initiation</td></tr>
<tr><td>Aim</td><td>The key component of this monitoring program is collecting data on the effects of the spill and response options on water quality.</td></tr>
<tr><td>Monitoring Approach</td><td>Sampling:
In situ water quality monitoring
Surface and subsurface sampling (if required).
Analysis:
Data analysis to look for oil signatures from in situ data
Chemical characterisation of samples
Compare hydrocarbon characteristics to results of released oil from OPS1
Assess bioavailability of oil
Reporting and/or data:
To be provided to the EMT Incident Commander (or delegate) once available.</td></tr>
<tr><td>Termination Criteria</td><td>The EMT Incident Commander (or delegate) determines that continuing OPS3 monitoring will not result in a change to the scale or location of active response options; or
The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or
The Monitoring Coordinator (or delegate) determines that continuing OPS3 monitoring is likely to increase overall environmental impact; and
OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.</td></tr>
</table>

4.5 OPS4: Oil in Sediment Assessment

Overview	OPS4 provides the EMT with ongoing information on the sediment quality, particularly the oil content, within the response areas.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to marine and/or coastal sediment.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation
Aim	The key component of this monitoring program is collecting data on the exposure of sediments to oil and any effect of response activities on sediment quality.
Monitoring Approach	**Sampling**: • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical characterisation of samples • Compare hydrocarbon characteristics to results of released oil from OPS1 • Assess bioavailability of oil **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS4 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS4 monitoring is likely to increase overall environmental impact; and – OPS4 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.6 OPS5: Rapid (Oiled) Shoreline Assessment

Overview	OPS5 provides the EMT with ongoing information on: • the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed • any observed impacts to shorelines and associated habitats from response activities • the effectiveness of clean-up activities. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to shoreline habitat
Implementation Time	Within the response times for oiled shoreline assessment, as described in the relevant OPEP.
Aim	To assess the state of shoreline habitats, to identify the presence and extent of oil, and to assess impacts of response activities through shoreline assessments.
Monitoring Approach	**Sampling**: • Oiled Shoreline Assessment **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS5 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS5 monitoring is likely to increase overall environmental impact; and – OPS5 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.7 OPS6: Rapid Seabird and Shorebird Assessment

Overview	OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts/confirms an exposure of oil to seabirds, shorebirds or shorelines known to support seabird and shorebird populations and/or habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS6 monitoring may be implemented during MES activities.
Aim	To provide rapid quantification of the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted to be impacted or have been impacted by the oil spill, and to assess the impacts of response activities on seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (ground, aerial, and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS6 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS6 monitoring is likely to increase overall environmental impact; and – OPS6 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.8 OPS7: Rapid Marine Megafauna Assessment

Overview	OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known sensitive marine megafauna habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS7 monitoring may be implemented during MES activities.
Aim	To rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted to be impacted or that have been impacted by the oil spill.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (aerial and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	OPS7 should be implemented until these termination triggers are met: • The EMT Incident Commander (or delegate) considers that continuing OPS7 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS7 monitoring is likely to increase overall environmental impact; and – OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.9 OPS8: Fish Tainting Assessment

Overview	Monitoring undertaken to better manage fisheries, public, or media concerns relating to potential effects of the spill or response activities.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known fisheries.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation.
Aim	The key component of this monitoring program is collecting data on the effects of the spill and response options on pelagic and benthic fish species.
Monitoring Approach	**Sampling**: • Collect samples of target fish species • Benthic and pelagic species **Analysis**: • Determine if oil tainting is present • Determine if dispersed/entrained oil has tainted fish (only applicable if dispersant used as a response option) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) considers that continuing OPS8 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS8 monitoring is likely to increase overall environmental impact; and – OPS8 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

5 Scientific Monitoring

5.1 Overview

Scientific monitoring focuses on short-and long-term environmental impact assessments. The scientific monitoring implemented will be appropriate to the scale, location, and duration of the oil spill and only the relevant components (determined by the receptors exposed) will be implemented. CAPL will engage experts (internal or external) specific to each study scope as required.

The components of the scientific monitoring program are:

- SCI1: Water Quality Impact Study
- SCI2: Sediment Quality Impact Study
- SCI3: Coastal and Intertidal Habitat Impact Study
- SCI4: Seabird and Shorebird Impact Study
- SCI5: Marine Megafauna Impact Study:
  - SCI5a: Marine Reptiles
  - SCI5b: Pinnipeds
  - SCI5b: Other Marine Megafauna.
- SCI6: Benthic Habitat Impact Study
- SCI7: Fish Effects Impact Study:
  - SCI7a: Fishery and Aquaculture Impact Study
  - SCI7b: Fish Impact Study.
- SCI8: Heritage (including Shipwrecks)

Appendix C contains the full suite of scientific monitoring plans listed above. Each plan provides fine detail aimed at environmental personnel who will implement the scientific monitoring components, including:

- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring;
- Descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors taking into consideration existing baseline data and current monitoring techniques; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

These components are presented separately below; however, in practice they may be carried out simultaneously, and monitoring may commence while response activities are still occurring.

5.2 SCI1: Water Quality Impact Study

Overview	The behaviour of the oil once released will vary depending on several factors, including sea temperature and weather conditions. Sampling of the oil in the water will provide quantitative data on the fate, weathering, and distribution of the oil. The geographic scope of SCI1 is the region offshore from the LAT.
Initiation Criteria	Activation of this Plan.
Implementation Time	Implementation will be achieved within 7 days of initiation
Aim	To assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • In situ water samples • Collect surface and subsurface samples **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by a National Association of Testing Authorities (NATA) accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There is no demonstrable impact on water quality from hydrocarbons/dispersants; or • Hydrocarbon and dispersed hydrocarbon concentrations in water are below relevant benchmarks or guideline values, or have returned to within the expected natural dynamics of baseline state and/or reference sites; or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring. Note: SCI1 may still be required by other SCI studies even after the termination criteria are reached.

5.3 SCI2: Sediment Quality Impact Study

Overview	Sampling of the oil in sediments will provide quantitative data on the fate, weathering, and distribution of the oil in sediments. The geographic scope of SCI2 is the region offshore from the LAT. The main concerns are the persistence of poly-aromatic hydrocarbons and total petroleum hydrocarbons.
Initiation Criteria	Operational monitoring (OPS4) has confirmed hydrocarbon concentrations are above: • relevant benchmarks or guideline values at the termination of the response option, or • baseline values at the termination of the response option.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by NATA-accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• All hydrocarbon concentrations in sediments are below relevant benchmarks or guideline values or below baseline or reference site values, whichever is greater; or • No ongoing impacts to biological receptors can be linked to sediment quality, or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring Note: SCI2 may still be required by other SCIs even after the termination criteria are reached.

5.4 SCI3: Coastal and Intertidal Habitat Impact Study

Overview	SCI3 determines the extent, severity, and persistence of impacts on coastal and intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequence response activities.
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of coastal or intertidal habitats or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess impacts to coastal and intertidal habitats and associated biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • State of habitats and associated biological communities (transects, quadrats) • Aerial imagery **Analysis**: • Percent cover, community composition, health/condition **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to coastal and intertidal habitats and associated biological communities (confirmation that habitats and species were not exposed to hydrocarbons); or • Measures of coastal and intertidal habitats and associated biological communities have returned to within the expected natural dynamics of baseline state and/or reference sites, at areas that were impacted by hydrocarbons spills, or • The extent of damage and rate of recovery of key coastal and intertidal parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

1.1 SCI4: Seabird and Shorebird Impact Study

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on seabirds and shorebirds from an oil spill.
Initiation Criteria	Operational monitoring (OPS6) has: • predicted or confirmed shoreline contact of hydrocarbons at important bird habitat location or known bird colonies, and/or • recorded dead, oiled, or injured bird species during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Surveillance surveys (ground and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Community composition, abundance, health/condition • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on seabirds and/or shorebirds; or • Measured parameters of seabird and/or shorebird communities have returned to within the expected natural dynamics of baseline state or reference sites, within seabird or shorebird communities that have been impacted by hydrocarbon spills, or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5 SCI5: Marine Megafauna Impact Study

5.5.1 SCI5a: Marine Reptiles

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine reptiles (turtles and sea snakes) from an oil spill. Monitoring will primarily focus on marine turtles, given sea snakes have a highly dispersed distribution that results in limited opportunities for monitoring.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed shoreline or habitat contact of hydrocarbons at important habitat locations for turtles (foraging and rookery) and sea snakes, or • recorded dead, oiled, or injured turtles or sea snakes during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine reptiles.
Monitoring Approach	**Sampling**: • Surveillance surveys (aerial or vessel, i.e. field), including nesting sites • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance (counts), species identification • Nest characteristics • Necropsy and chemical analysis. **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on turtles or sea snakes; or • Measured parameters of turtles (and sea snake communities if determined appropriate) have returned to within the expected natural dynamics of baseline state or reference sites, within turtle and sea snake communities that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.2 SCI5b: Pinnipeds

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on pinniped populations (Australian Sea Lion *Neophoca cinerea*, New Zealand Fur Seal *Arctocephalus forsteri*, and the Australian Fur Seal *A. pusillus*, and other pinnipeds present) from an oil spill. Monitoring will focus on onshore populations (e.g. breeding colonies and haul-out sites). This is based on the priority of the life cycle stage (e.g. breeding), and that population estimates are generally based on onshore counts.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for pinnipeds (foraging, breeding colonies, and haul-out sites), or • recorded dead, oiled or injured pinnipeds during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of pinnipeds.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Health/condition • Observed behaviour, counts of abundance, population structure • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on pinnipeds; or • Measured parameters of pinniped populations have returned to within the expected natural dynamics of baseline state or reference sites, within pinnipeds that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.3 SCI5c: Other Marine Megafauna

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine megafauna from an oil spill. Note: The understanding of abundance and distribution of many marine mammals (e.g. cetaceans and dugongs) and large cartilaginous fish (e.g. Whale Sharks) is often poor, making it difficult to assess potential impacts from oil spill incidents. The low density and mobility of these animals also makes it difficult to assess and quantify effects.
Initiation Criteria	SCI5c is triggered when operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for marine megafauna, or • recorded dead, oiled or injured megafauna during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine megafauna.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance, community composition, population structure, track census counts • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on marine megafauna; or • Measured parameters of marine megafauna have returned to within the expected natural dynamics of baseline state or reference sites, within marine megafauna that have been impacted by hydrocarbon spills; • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.6 SCI6: Benthic Habitat Impact Study

Overview	This scientific monitoring program is designed to: • determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities • collect information to determine short-and long-term (including direct and indirect) impacts of hydrocarbons (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following termination of the response
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of subtidal benthic habitat or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess the impact on subtidal benthic habitat and biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Benthic habitat survey (e.g. photographed/video transects) • Fauna and flora (e.g. tissue sampling) **Analysis**: • Percent cover, community composition, health/condition, benthic grabs **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to benthic habitat and communities (confirmation that benthic habitats were not exposed to hydrocarbons); or • Measures of benthic habitat and communities have returned to within the expected natural dynamics of baseline state or reference sites, at benthic areas that were impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key benthic habitat parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.7 SCI7: Fisheries and Fish Impact Study

5.7.1 SCI7a: Fisheries and Aquaculture Impact Study

Overview	This scientific monitoring study focuses on the direct effects of an oil spill on fish and aquaculture resources. Monitoring for the impact of the oil spill on fish health will be carried out using fish tissue sampling and analysis to ascertain direct contamination.
Initiation Criteria	Operational monitoring (OPS3, OPS4, OPS8), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to hydrocarbons of fishing areas, habitat for commercial fisheries, or active aquaculture leases.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor lethal and sublethal effects of oil spills on fish and aquaculture species.
Monitoring Approach	**Sampling**: • Fish physiological indicators and biochemical markers, fish tissue sample, including muscle, biopsy and gut contents, blood, bile, gonads, and dead fish counts **Analysis**: • Chemical analysis (e.g. hydrocarbon, dispersants [if used in the response] etc.), tainting **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impacts on fish and aquaculture; or • Measured parameters of fish and aquaculture have returned to within the expected natural dynamics of baseline state or reference sites, within marine fisheries and aquaculture locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key fisheries and aquaculture parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.7.2 SCI7b: Fish Impact Study

Overview	This scientific monitoring study focuses on the effects of an oil spill on fish population and abundance if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.
Initiation Criteria	Operational monitoring (OPS3), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to fish areas or fish habitat to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in fish population and abundance as a result of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Population surveys (e.g. baited underwater video surveys, remotely operated vehicles [ROVs], towed camera) **Analysis**: • Community composition, abundance **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on fish and fish population structure, or • Measured parameters of fish and fish habitat have returned to within the expected natural dynamics of baseline state or reference sites, within locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.8 SCI8: Heritage (including Shipwrecks)

Overview	This scientific monitoring study focuses on the effects of an oil spill on shipwrecks in areas considered to have heritage.
Initiation Criteria	MES, operational or scientific monitoring has predicted or confirmed exposure of shipwrecks to hydrocarbon or associated response activities.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in shipwrecks as a result of an oil spill and associated response activities (e.g. anchoring and ROV disturbance).
Monitoring Approach	**Sampling**: • Surveys (e.g. ROV) **Analysis**: • Heritage attributes **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	SCI8 will be terminated when: • There has been no demonstrable impact on shipwrecks, or • Measured parameters of shipwrecks have been documented and no further change as a result of hydrocarbons or response activities is anticipated.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
ABU	Australian Business Unit
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
BSc Hons	Bachelor of Science, with Honours
CAPL	Chevron Australia Pty Ltd
CRC	Cooperative Research Council
DoT	Western Australian Department of Transport
EMBA	Environment that May be Affected
Emergency Condition	As defined in each activity-specific EP and relevant OPEP
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
HES	Health, Environment, and Safety
ICS	Incident Command System
IMG	Incident Management Guide
Implementation	Being ready, at the point of staging or departure, to mobilise for monitoring
Initiation/Termination	'Or' means only one of the possible options, 'and' means both need to occur before initiation/termination
LAT	Lowest Astronomical Tide
MES	Monitoring, Evaluation, and Surveillance
MS	Master of Science
NATA	National Association of Testing Authorities, Australia
NEBA	Net Environmental Benefit Analysis
OEMS	Operational Excellence Management System
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OPS1	Oil Characterisation
OPS2	Chemical Dispersant Efficacy Assessment
OPS3	Oil in Water Assessment
OPS4	Oil in Sediment Assessment
OPS5	Rapid (Oiled) Shoreline Habitat Assessment
OPS6	Rapid Seabird and Shorebird Habitat Assessment
OPS7	Rapid Marine Megafauna Assessment

Acronym / Abbreviation	Definition
OPS8	Fish Tainting Assessment
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
PGPA	Policy, Government and Public Affairs
PhD	Doctor of Philosophy
QA/QC	Quality Assurance/Quality Control
ROV	Remotely Operated Vehicle
SCI	Scientific monitoring
SCI1	Water Quality Impact Study
SCI2	Sediment Quality Impact Study
SCI3	Coastal and Intertidal Habitat Impact Study
SCI4	Seabird and Shorebird Habitat Impact Study
SCI5	Marine Megafauna Impact Study
SCI6	Benthic Habitat Impact Study
SCI7	Fish Effects Impact Study
SCI8	Heritage (including shipwrecks)
Significant Impact	Defined as a moderate or higher consequence rating as per the Chevron Integrated Risk Prioritization Matrix. This aligns with 'moderate to significant environmental damage' as described in the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009; and to 'moderate, or more serious than moderate environmental impact' as described in the Western Australian Petroleum and Geothermal Energy Resources (Environment) Regulations 2012, Petroleum Pipelines (Environment) Regulations 2012, and the Petroleum (Submerged Lands) (Environment) Regulations 2012; as applicable.
SMART	Special Monitoring of Applied Resources Technologies
WA	Western Australia
WA ERA	WA Energy Research Alliance

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	ABU Oil Spill Response Manual (Chevron Australia, 2014)	OE-11.01.101
2.	Emergency Management Process – ABU Standardised OE Process (Chevron Australia, 2012)	OE-11.01.01
3.	ABU OSMP Capability Register (Chevron Australia)	ABU181001264
4.	ABU OSMP Capability Register – Resource Requirements Analysis (Chevron Australia)	
5.	ABU OE Compliance Assurance Process – ABU Standardised OE Process (Chevron Australia, 2014)	OE-12.01.01
6.	Compliance Assurance Audit Program – ABU Standardised OE Procedure (Chevron Australia, 2015)	OE-12.01.19
7.	Compliance Assurance Management of Instances of Potential Noncompliance – ABU Standardised OE Procedure	OE-12.01.18
8.	Special Monitoring of Applied Resource Technologies (SMART) protocol	
9.	Industry Recommended Subsea Dispersant Monitoring Plan, API Technical Report 1152 (American Petroleum Institute, 2013)	
10.	Oil Spill Monitoring Handbook (Commonwealth Scientific and Industrial Research Organisation, 2016)	
11.	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand, 2000).	
12.	Aquatic Life Benchmarks (United States Environmental Protection Authority, 2012). Available from: http://www.epa.gov/bpspill/water-benchmarks.html	
13.	National Assessment Guidelines for Dredging (Department of the Environment, Water, Heritage and the Arts, 2009).	
14.	Australia New Zealand Food Standards Code.	
15.	Chevron Australia. 2018. ABU Oil Spill Protection Prioritisation. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
16.	DoT 2017. DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment – Protection Priorities. Protection Priority Assessment for Zone 2: Pilbara – Final Report. Report for the WA Department of Transport, Perth.	
17.	Department of Transport – Shoreline Assessment Form. Available at www.transport.wa.gov.au/	
18.	USCG *et al.* (2006). *Special Monitoring of Applied Response Technologies* (SMART). U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), U.S. Environmental Protection Agency (U.S. EPA), Centers for Disease Control and Prevention (CDC), Minerals Management Service (MMS).	

Ref. No.	Description	Document ID
19.	Hook, S., Batley, G., Holloway, M., Irving, P., and Ross, A. (2016). Oil Spill Monitoring Handbook. CSIRO, Clayton South. Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra.	
20.	AMSA (2003) Oil Spill Monitoring Handbook. Prepared by Wardrop Consulting and the Cawthron Institute for the Australian Maritime Safety Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra	
21.	Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water	

Appendix A North West Shelf Activities

Operational and Scientific Monitoring Plan

North West Shelf Activities

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Operational and Scientific Monitoring Plan
North West Shelf Activities

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Approvals

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Contents

Tables

Figures

1 General Introduction

1.1 Purpose

The Australian Business Unit (ABU) OSMP (Figure 1-1; Ref. 3) sits above this OSMP NWS Activities document and is an overarching document that covers all CAPL assets in State and Commonwealth waters. The ABU OSMP includes information, relevant to all assets, on implementing the OSMP (including capability and readiness), the environmental monitoring framework (including operational and scientific monitoring) and monitoring components (initiation criteria, termination criteria, and implementation timeframes).

This Operational and Scientific Monitoring Plan North West Shelf Activities (OSMP NWS; this document) provides location- and asset-specific information related to Chevron Australia Pty Ltd (CAPL) activities on the North West Shelf of Western Australia (WA) that would be used if an unplanned hydrocarbon discharge from a CAPL asset occurred in the region. The document covers upstream and downstream marine assets of the Gorgon Gas Development, Wheatstone Project, and Barrow Island Joint Venture – including platforms, pipelines, and processing and export facilities.

This document summarises or refers to information in other CAPL documents such as Environment Plans (EPs), Oil Pollution Emergency Plans (OPEPs), and CAPL’s Description of the Environment document (Ref. 2). The aim of the asset-specific information is not to repeat such information but to direct the reader to the relevant sections in those documents and therefore expedite the response process.

1.2 Scope

This document is a component of the OSMP framework described in the ABU OSMP (Ref. 3), where the overall scope is presented. It guides CAPL personnel in responding to a hydrocarbon spill in the NWS. Service providers are expected to read and understand this document before providing hydrocarbon spill standby services to CAPL.

1.3 Objectives

The overarching objective of this document is to direct responders to existing information and baseline data that may assist monitoring during an oil spill; more specifically, this document’s objectives are to:

- briefly describe the environment that may be affected (EMBA) by a hydrocarbon spill, with reference to relevant EPs, the Description of the Environment document (Ref. 2), and other relevant documents (Section 3).
- collate baseline information sources (Section 4.3).
- provide a summary of estimates of capability and readiness for the NWS region including scenarios, scalability, sustainability, and response times (Section 5).

1.4 Target Audience

This document is intended for use by:

- Emergency Management Team (EMT) Incident Commander
- Environment Unit Lead

- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- OSMP Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s)
- personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a basic understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Related Documentation

This document is specific to NWS activities and is a component of the OSMP framework described in the ABU OSMP (Figure 1-1).

Table 1-1 summarises and provides links to CAPL documents that are relevant to NWS activities. Refer to Section 4.3 for information and documents relating to the baseline state of environment.

CAPL uses GeoHouse to reference environmental aspects relative to oil spill modelling outputs. GeoHouse is mapping software that can store literature with georeferenced tags that allow users to identify where studies have been undertaken. This expedites access to key literature that is needed during the early phases of implementation of operational (OPS) and scientific (SCI) monitoring.

Table 1-1: Chevron Australia Key Documents Relevant to NWS Activities

Document Title	Summary of Interface with this Appendix
EP and OPEP Register (Ref. 6; ABU180500351)	The EP and OPEP Register lists all current ABU EPs and OPEPs that have been accepted and are in force. This Appendix, along with the ABU OSMP and other supporting documents describe the environmental monitoring that may be implemented in the event of an emergency condition described in the activity specific EPs listed within this register. Operational monitoring outcomes support OPEP implementation and termination by collecting information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations.
Description of the Environment (Ref. 2)	This document describes the environment within CAPLs planning area (the outer area in which CAPL's activities may interact with the environment).
ABU Protection Prioritisation Process (Ref. 4)	This process outlines and ranks the receptors (i.e. values or resources) at risk and helps CAPL understand which receptors should take priority in terms of protection from a spill.

ABU OSMP

Target Audience

- Regulatory Agencies
- EMT Incident Controller (or delegate)
- ABU HES Supervisor – Environment Technical (or delegate)

Purpose and Objectives

- Describe the types of env. monitoring that may be implemented during a marine/coastal oil spill
- Flexible framework, allowing monitoring to be adapted to the nature and scale of a specific oil spill event
- Determine the extent, severity and persistence of environmental impacts from the spill
- Define initiation and termination criteria for each monitoring component
- Describe the implementation process for the monitoring programs
- Identify the positions responsible for ensuring implementation of the monitoring

APPENDIX A
North West Shelf Activities

Target Audience

- Environment Unit Lead; ABU HES Supervisor – Environment Technical; Monitoring Coordinator
- Monitoring Officer(s).
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives

- NWS location/asset specific information, such as activities, nature of hydrocarbons expected from a spill
- Summary description of the environment within the EMBA
- Describe social and ecological receptors, values and particular sensitivities within the EMBA
- Summary of baseline information sources
- Summary of capability and readiness estimate based on scenarios

APPENDIX B
Guidance Note for Operational Monitoring

Target Audience

- EMT Incident Controller (or delegate)
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives

- Internal guidance document to assist implementing operational monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event
- Provide typical sampling and/or assessment method, standard operating procedures and field sheets for each monitoring component;

APPENDIX C
Guidance Note for Scientific Monitoring

Target Audience

- ABU HES Supervisor – Environment Technical (or delegate)
- ABU Environment Team

Purpose and Objectives

- Internal guidance document to assist implementing scientific monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event, considering available baseline data
- Describe sampling and/or assessment method, procedures and field sheets for each monitoring component

Operational Specific Documents
Supporting the OSMP

ABU OSMP Quick Reference Guide

Initiation summary; checklists for the first 48hrs; OSMP framework and hotlinks to important documents

Implementation and Logistics Plan

Detailed steps required to implement the various monitoring components, and links, contact details and information related to logistics. Includes:
- Step by step ‘playbooks’ for each component
- Logistics arrangements for mobilising vessels, personnel, equipment and other resources, both internal and 3rd party

ABU Capability Needs Analyses – LOWC scenario and HFO scenario

A tool used to determine the resourcing requirements for operational and scientific monitoring under particular (pre-nominated) spill scenarios, for up to 4 phases of the response. Includes:
-number of teams required per component, number of personnel per team, and the skill/role makeup of those teams
- equipment and resources required per team
- summation of resourcing per phase
- sources and suppliers of those resources
- gap analysis of what equipment might be available in the short-term and what items are long-lead or unlikely to be available
- explanatory document on using the tool

ABU OSMP Capability Register

A register of personnel and equipment (CAPL, Chevron corporate and 3rd party) that is likely to be available in the event of a spill. Includes:
- personal information contact details
- qualifications and training relevant to OSMP
- self assessment of capability to fill OSMP roles (SME, Practitioner or Assistant)
- pre-nomination of internal people into specific OSMP roles

First Strike Sampling and Analysis Plan Template

Provide a well developed framework, methods and QAQC procedures for rapid implementation of first-strike sampling required under OPS 1, OPS3 and OPS4, within 48 hours of a spill. Includes:
- outline of the sampling program design, number, type and location of sampling required
- sampling equipment required
- methods for sampling, preservation, transportation and storage,
- QA/QC procedures

Figure 1-1: OSMP Document Structure

2 Region-specific Introduction

2.1 Description of the Assets

Assets and activities on the NWS, which are under the operational control of CAPL and outlined in Table 2-1. Further information on the individual assets or activities can be found in the activity specific EPs (Table 1-1; Ref . 6).

Table 2-1: Summary of Operating Assets, Infrastructure and Spill Scenarios covered in related EP and/or OPEPs

Asset	Infrastructure Location	Spill Scenarios in Related EP and/or OPEP
Wheatstone	Producing and infill wells, all located within Commonwealth Waters; Commonwealth and State Waters components of the trunkline; Marine Terminal area at Ashburton North	Spill scenarios include: • the release of marine diesel oil (MDO), intermediate fuel oil (IFO), or Heavy Fuel Oil (HFO) at all asset locations, including CAPL's operations within the Port of Ashburton and in adjacent waters including the Port of Onslow • the loss of condensate and produced fluids from the hydrocarbon system, including wells and trunkline
Gorgon	Producing wells, future production wells, and a future exploration well in Commonwealth Waters; Commonwealth and State Waters component of the feed gas pipeline; liquefied natural gas (LNG) jetty on Barrow Island; Gorgon domestic gas (DomGas) pipeline including pipeline and subsea installation and pre-commissioning	Spill scenarios include: • an MDO spill arising from a vessel collision or failure of the mobile offshore drilling units (MODUs) in Commonwealth Waters • the release of MDO or HFO from vessels operating within the Port of Barrow Island or adjacent State Waters • a Gorgon or Jansz condensate leak arising from a major defect in the production pipeline (in scope for both State and Commonwealth Waters) • a Gorgon or Jansz condensate release arising from a loss of well control (LOWC) during well intervention, abandonment, or infill drilling (Commonwealth Waters only)
Barrow Island Joint Venture (BWIJV)	Exploration and production operations on Barrow Island and surrounding areas; tanker loading line for Barrow Island crude offtake	Spill scenarios include: • failure of the tanker loading line

2.2 Hydrocarbon Properties

Credible spill scenarios relevant to CAPLs activities are outlined in the activity specific EPs. Depending on the activity, the hydrocarbon released to the environment may be one of several hydrocarbon types. The composition and physical properties of the hydrocarbons will evolve over time through weathering processes that change its composition and properties, such as the viscosity, density, water content and pour point. The rate of change of the hydrocarbon properties will affect the likely time-window of monitoring opportunities for OSMP components and the associated logistical requirements of these programs. As such it is important that OSMP teams are aware of the characteristics of the hydrocarbon types they will encounter.

Hydrocarbons represented in the worst credible spill scenarios within activity specific EPs can be grouped into oil types as defined by the International Tanker Owners Pollution Federation Ltd (ITOPF) classification system:

- Group 1 – Including Iago, Wheatstone, and Jansz condensate; Wheatstone trunkline fluids; and Wheatstone flowline fluids
- Group 2 – Including MDO, Gorgon condensate, Barrow Island crude and Gorgon/Jansz mixed trunkline fluids
- Group 3/4 – Including HFO and IFO (depending on blend).

Chevron ABU: Oil Properties and Dispersion Application Applicability (Ref. 5) outlines the basic hydrocarbon characteristics of the hydrocarbons that may be spilt to the environment. A summary of this information is presented in Table 2-2.

Table 2-2: Oil Types that may be Spilt to the Environment from CAPL NWS Activities

Product and Asset	Oil Type and ITOPF Group	API
Jansz Condensate (Gorgon Project)	Condensate – Group 1 AMSA Classification: Group I, light, non-persistent oil	51.4
Gorgon Condensate (Gorgon Gas Development)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.3
Gorgon/Jansz Condensate Blend (Gorgon Gas Development)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	45.3
Wheatstone Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	55.4
Iago Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, very light, non-persistent oil	49.1
Wheatstone Trunkline (Processed trunkline fluids from Wheatstone, Iago and JDP wells.)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	52.3
Barrow Island Crude (WA Oil)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.9
MDO (General vessel use)	Diesel – Group 2 AMSA Classification: Group III Medium, persistent oil	35.9
HFO/IFO (General cargo vessel use)	IFO – HFO – Group 3 / Group 4 AMSA Classification: Group III and IV heavy, persistent oils	15.1

3 Description of the Environment

Within each individual EP, the environment that may be affected (EMBA) by planned operations is described. The EMBA for a particular activity or asset is determined by modelling the potential worst-case spills from the petroleum activities; the EMBA represents a combination of multiple model outputs based on many plausible spill scenarios. Importantly, the EMBA does not represent the area that would be affected during a single spill event. A single spill would affect only a small proportion of the EMBA.

The Description of the Environment (Ref. 2) defines an Planning Area for CAPLs activities and assets (and associated spill scenarios) on the NWS, as described in Section 2.1. The Planning Area was derived using impact thresholds from conservative stochastic spill modelling undertaken for the range of emergency conditions described within the relevant activity specific EPs and is based on low level hydrocarbon presence, representative of a socio-economic impact.

Comprehensive descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2). Further descriptive information for the EMBA specific to certain ABU activities is detailed in the activity specific EPs.

4 Monitoring Ecological and Social Receptors in the EMBA

Descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2) and activity specific EPs. The process for identifying and ranking ecological and social receptors that are present within the EMBA and sensitive to oil spills is described in the ABU Oil Spill Protection Prioritisation Process[1] (Ref. 4). The process involves these steps:

1. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
2. Use the latest available literature and research data to determine the sensitivity of the various receptors to the effects of oil
3. Rank each receptor according to its sensitivity to oil and display the rankings geospatially

The ranking of ecological and socio-economic receptors allows the emergency management team to make timely and defensible decisions around response and monitoring priorities. A key mechanism for this is through the completion of strategic and operational Net Environmental Benefit Analysis (NEBA), which are completed both pre-spill (strategic) and at regular intervals during the response operation (operational). Further, the ranking values will be considered when designing and implementing operational and scientific monitoring and prioritising resources.

4.1.1 Ecological Receptors

The alignment of sensitive ecological receptors to OPS and SCI monitoring plans is detailed in Table 4-1 and in Section 3.3.1.1. of the ABU OSMP (Ref. 3).

Table 4-1: Sensitive Ecological Receptors within the NWS EMBA and Corresponding Monitoring Components

Receptor	Summary Description
Marine Fauna	
Turtles	Presence of oiled turtles and any impact on potential nesting areas from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS7: Rapid Marine Megafauna Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI5: Marine Megafauna Impact Study
Seabirds and shorebirds	Presence of oiled seabirds and shorebirds and any potential impact to coastal habitat from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS6 Rapid Seabird and Shorebird Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study

[1] The EMBA represented in the ABU Oil Spill Protection Prioritisation Process relates to an uncontrolled loss of condensate from the Wheatstone or Gorgon production platforms. These scenarios have the greatest geographical coverage of any spill scenarios.

Receptor	Summary Description
Cetaceans, pinnipeds, and large cartilaginous fish	Presence of oiled marine megafauna including whales, dolphins, Dugong, pinnipeds, Whale Sharks, sharks, manta rays, sawfish, and other marine megafauna can be monitored via: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study
Fish	Monitoring of any potential impact on fish populations and fisheries, including aquaculture can be monitored via: • OPS8: Fish Tainting • SCI7: Fish Effects Impact Study
Sea snakes	Monitoring of any potential impact on sea snake populations is considered infeasible due to difficulties in finding and tracking a suitable population to enable scientific rigour. Opportunistic observations can be made through appropriate monitoring scopes, including: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study
Shoreline Habitats	
Mangroves, intertidal mudflats and sandflats, intertidal shoals and sandbars, sandy beaches, intertidal rock pavement, and rocky shores	Extent of oil presence, persistence, associated change in percent (live) cover of these habitats, and impacts from spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • SCI3: Coastal and Intertidal Habitat Impact Study
Marine Habitats	
Pelagic	Monitoring of any potential impact on micro flora and fauna (e.g. plankton) inhabiting the pelagic zone can be inferred by water and sediment quality studies: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study
Benthic habitats	Extent of oil presence, persistence, associated change in percent (live) cover of these benthic habitats such as coral reefs, seagrass, macroalgal communities, filter-feeding communities, and soft sediment communities can be monitored via: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study

4.1.2 Socioeconomic Receptors

The alignment of sensitive socioeconomic and heritage receptors to OPS and SCI monitoring plans is detailed in Table 4-2.

Table 4-2: Socioeconomic and Heritage Features and Corresponding Monitoring Components

Category	Justification
Infrastructure	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within areas of infrastructure are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study
Commercial shipping	Oil spills are not considered to have a long-term significant impact on the use of existing commercial shipping channels and regional ports
Commercial fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Recreational fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Aquaculture	Potential impacts of an oil spill and associated response activities on aquaculture are considered in: • OPS3: Oil in Water Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Tourism and recreation	Potential impacts of an oil spill and associated response activities on water, sediment, benthic habitat, or marine fauna within tourism and recreation areas are considered in: • OPS3: Oil in Water Assessment • OPS5: Rapid (Oiled) Shoreline Assessment • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study • SCI7: Fish Effects Impact Study
Heritage (including shipwrecks)	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within heritage areas are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study • SCI8: Heritage (including Shipwrecks)

4.2 Stakeholder Consultation

The process for consultation with key stakeholders is presented in the ABU OSMP (Ref. 3). Table 4-3 shows a matrix of key values and sensitivities, and the core stakeholders that may need to be consulted. The stakeholder list not exhaustive; consult the stakeholder management plan within the relevant EP for a full list of stakeholders consulted when preparing that EP.

Table 4-3: EP Values and Sensitivities and Associated Core Stakeholders for Consultation

Particular EP Values and Sensitivities	Core Stakeholders										
	DAWE	AFMA	AMSA	NOPSEMA	DBCA	DoT	DPIRD	WAFIC	DWER	Port Authorities	Local Gov’ t
National Heritage Areas	X			X	X				X		X
World Heritage Areas	X		X	X	X				X		X
Ramsar Wetlands	X			X	X				X		X
Australian Marine Parks	X	X	X	X	X				X		
State Marine Areas/Reserves	X			X	X	X	X	X	X		X
Commonwealth Marine Areas – KEFs identified through Marine Bioregional Plans	X	X	X	X							
Commonwealth and State Fisheries and Aquaculture			X					X	X		
Recreation and Tourism			X		x	X		X		X	X

Note:

DAWE = Department of Agriculture, Water and the Environment

AFMA = Australian Fisheries Management Authority

AMSA = Australian Maritime Safety Authority

NOPSEMA = National Offshore Petroleum Safety and Environmental Management Authority

DBCA = Department of Biodiversity, Conservation and Attractions

DoT = WA Department of Transport

DPIRD = Department of Primary Industries and Regional Development

WAFIC = Western Australian Fisheries Industry Council

DWER = Department of Water and Environment Regulation

4.3 State of the Environment (Baseline) – Information Sources

Baseline monitoring provides information on the condition of ecological receptors prior to, or spatially independent (e.g. if used in control chart analyses) of, a spill event and is used for comparison with the post-impact scientific monitoring where required. This is particularly important for scientific monitoring where the ability to detect changes between pre-impact and post-impact conditions is necessary.

CAPL has completed several studies around project and asset sites that would provide suitable quantitative data for comparison with post-spill conditions. Additionally, CAPL also completes ongoing monitoring programs that would also inform baseline state; these studies and the type of data available are summarised in Section 4.3.1.

CAPL also has access to information from industry partners through direct or collaborative agreements (Section 4.3.1.2). Public information sources (Section 4.3.3) complement CAPL and industry partner data.

Some operational and scientific monitoring components are suited to pre-impact baseline monitoring. If an oil spill to marine or coastal waters occurs, reactive pre-impact monitoring will, where practicable, be implemented to gather additional data on the current state of the environment. Where timing, logistics, and safety considerations allow for the implementation of reactive baseline monitoring, methods will follow the relevant operational or scientific monitoring components.

Baseline information on the ecological receptors of the NWS will be reviewed and updated annually. The process for obtaining and maintaining baseline data is outlined below:

1. Assess existing CAPL studies (much of the baseline information will come from the comprehensive Description of the Environment (Ref. 2), which provide a baseline description of the physical, ecological, cultural, and socioeconomic marine environment of north-west WA relevant to CAPL's petroleum activities and potential oil spill scenarios.
2. Systematically assess scientific and grey literature searched through Web of Science, Web of Knowledge, Google Scholar, and any other relevant sources.
3. Assess industry–government environmental metadata (I-GEM), or other industry portals, to understand design and collection methods (which would strongly influence data collection and project design post-spill).
4. Document in logical sequence the existing baseline data gathered from steps 1 to 3 above. Collect, manage, and cite research sources to create a database of abstracts/summary, keywords, and links to literature locations that can be easily searched and rapidly produce a reference list.
5. Identify gaps in the knowledge and consider what further information is required (i.e. undertake a data gap analysis).
6. Undertake a risk assessment of the gaps.
7. Identify how data would be collected to fill gaps (if required).

4.3.1 Data Collected by Chevron Australia

Baseline environmental data resources held by, or on behalf of CAPL are described in the following sections and summarised in Table 4-4.

4.3.1.1 Data Stored Internally

CAPL stores environmental data across a range of accessible platforms and repositories, the mixture of which changes over time depending on the age, type, originator, and IS facilities/platforms available at the time.

Table 4-4 provides an indication of the data storage location at the time of writing this revision.

Table 4-4: Available Baseline Data Relevant to Monitoring the Effects of Oil Spills in the Marine Environment

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Gorgon Gas Development						
• Coastal and Marine Baseline State and Environmental Impact Report • Materials Offloading Facility (MOF), Liquefied Natural Gas (LNG) Jetty, Dredge Spoil Disposal Ground	2008–2011 • East coast of Barrow Island	• Benthic habitat mapping (broadscale mapping, finer detail at selected coral monitoring sites) • Coral (composition, % cover, size class frequency, growth and survival, recruitment) • Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health) • Fish – intertidal and subtidal (composition,	SCI1 SCI2 SCI3 SCI6 SCI7	**CAPL website** Report # **G1-NT-REPX0001838** Appendices # **G1-NT-REPX0001838**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • Document Management System (DMS)	I-GEM – Chevron – Coral (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Macroalgae (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Seagrass (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Mangrove (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Demersal Fish (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Demersal Fish (Gorgon Post-
• Coastal and Marine Baseline State and Environmental Impact Report • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing	2008–2011 • West coast of Barrow Island			**CAPL website** Report # **G1-NT-REPX0002749**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Coastal and Marine Baseline State and Environmental Impact Report • Domestic Gas Pipeline	2008–2011 • DomGas Pipeline Route, DomGas Mainland Shore Crossing			**CAPL website** Report # **G1-NT-REPX0002750**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		abundance, fork length) • Sediments (particle size distribution, total organic/inorganic carbon) • Water quality (light, turbidity, profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity])				Development Surveys) 2011–2014 I-GEM – Chevron – Water Quality (Gorgon) 2009 I-GEM – Chevron – Sediment Quality (Gorgon) 2009–2010
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 1: 2011–2012 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 2: 2012–2013 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 3: 2013–2014	2011–2014 East coast of Barrow Island	• Coral (composition, % cover, size class frequency, growth and survival, recruitment) • Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health)	SCI2 SCI3 SCI6 SCI7	**CAPL website** Year 2, Report #G1-NT-REPX0005152	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	I-GEM – Chevron – Coral (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Macroalgae (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Seagrass (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Mangrove (Gorgon Post-Development Surveys) 2011–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish – intertidal and subtidal (composition, abundance, fork length) • Sediments (particle size distribution)				
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 1: 2013 • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 2: 2014	2013–2015 West coast of Barrow Island	• Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Fish – intertidal and subtidal (composition, abundance, fork length)	SCI3 SCI6 SCI7	**CAPL website** Year 2, Report # **G1-NT-REPX0007241**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Baseline Marine and Coastal Sediment Sampling and Analysis (unpublished)	• East coast of Barrow Island • West coast of Barrow Island • DomGas Pipeline Route, DomGas	2009–2011 • Sediments (particle size distribution, total inorganic/organic carbon, moisture content, nitrogen [NH_3, NO_X, Total Kjeldahl Nitrogen (TKN)], phosphorus, metals/ metalloids,	SCI2 SCI3		• Network drive (O drive)	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
	Mainland Shore Crossing	organotins, PAHs, TPHs, BTEX, organochlorine/ organophosphate pesticides, oil/grease)				
• Baseline Study of the Composition and Quality of Nearshore Waters	East coast of Barrow Island	2008 • Water quality (profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity], nutrients [NH_3, NO_X, orthophosphate], total organic carbon, metals, carbonates, Total Dissolved Solids [TDS], turbidity)	SCI1		• Network drive (O drive)	
• Marine Environmental Quality Management Plan	East coast of Barrow Island	• 2016–ongoing • Water quality (metals) • Sediment quality (metals and hydrocarbons) • Biota quality (metals)	SC1 SC12 SCI7		• Network drive (O drive) • SharePoint 3PC site	
• Baseline Hydrocarbon Content of Bivalves on Barrow Island (unpublished)	East coast of Barrow Island	• 2014 • PAH, TPH, BTEX, and metals	SCI3 SCI7		• Network drive (O drive). Report# G1-VE-H-CE00-H23C8325700019	I-GEM – Chevron – Oysters (Gorgon) 2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
• Monitoring programs required under the Long-term Marine Turtle Management Plan	• East coast of Barrow Island • Mainland coast (Mundabullangana)	• 2005–ongoing (annual survey) • Flatback Turtles (nest success, track counts and satellite tracking, hatchling survival and dispersal)	SCI5	**CAPL website** Gorgon Gas Development and Jansz Feed Gas Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Marine Turtle Nesting (Gorgon) 2005–2014
• Terrestrial and Subterranean Baseline State and Environmental Impact Report	• East coast of Barrow Island • West coast of Barrow Island • DomGas Mainland Shore Crossing	• 2003–2006 • Avifauna (assemblage, total counts) • Physical landforms (coastal foredunes, cliffs, and gorges)	SCI4	**CAPL website** Terrestrial and Subterranean Baseline State Environmental Impact Report. Report # G1-TE-H-0000-REPX027	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Barrow Island Seabird Monitoring Program (as required under Terrestrial and Subterranean Environmental	• East coast of Barrow Island • West coast of Barrow Island	• 2008–ongoing (annual survey) • Abundance, nest density, presence/absence of egg or chick/fledgling	SCI4	**CAPL website** Gorgon Gas Development and Jansz Feed Gas	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site	I-GEM – Chevron – Seabirds (Gorgon) 2008–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Monitoring Program)	• Middle Island, Boodie Island, Parakeelya Island, Double Island North, Double Island South	in burrows, predation and mortality records		Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• DMS	
• Introduced Marine Pest Monitoring for the Gorgon Gas Development	East coast of Barrow Island	• 2010–ongoing • Intertidal species composition • Subtidal species composition	SCI3		• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	
• Coastal Monitoring	East coast of Barrow Island	• 2008–ongoing • Coastal landforms, stability, and habitat	SCI2 SCI3 SCI4 SCI5		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Project						
Wheatstone Baseline State of the Marine Environment Report	• Onslow area • Thevenard Island area	• 2012–2013	SCI1 SCI2 SCI6		• Network drive (O drive) • SharePoint 3PC site • DMS Report	I-GEM – Chevron – Coral (Wheatstone Baseline State of the Marine Environment) 2009–2013 I-GEM – Chevron – Macroalgae (Wheatstone Baseline

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
						State of the Marine Environment) 2012 I-GEM – Chevron – Seagrass (Wheatstone Baseline State of the Marine Environment) 2012 I-GEM – Chevron – Filter Feeders (Wheatstone Baseline State of the Marine Environment) 2012
Wheatstone Marine Fauna Monitoring Program	• Onslow Area • Thevenard Island Area • Montebello Island Area	• 2009–2010 • Whales (acoustic loggers)	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Exmouth Gulf to Barrow Island	• 2009–2010 • Whales (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2012–2014 • Dugong (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	I-GEM – Chevron – Dugong (Wheatstone) 2012–2014
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2010–2011	SCI7		• Network drive (O drive) • DMS	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish (community composition, abundance)				
Deepwater Benthic Habitats	• Onslow Area	• 2008–2009 • Benthic habitat (composition)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Baseline Benthic Habitat Monitoring	• Onslow Area	• 2009–2013 • Benthic habitat (composition, percent cover)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Mangrove Monitoring Program	• Onslow Area	• 2009–ongoing • Mangroves (composition, canopy density, qualitative health) • Algal mat coverage	SCI3		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Coastal Habitat Survey	• Onslow Area	• 2008–2009 • Intertidal habitat, coastal type • Physical shoreline features	SCI3			
Wheatstone Turtle Impact Monitoring Program	• Onslow Area	2013–ongoing • Flatback Turtles (nest success, track counts, hatchling survival and dispersal)	SCI5	**CAPL website** EIS/ERMP APPENDIX O11 – TECHNICAL APPENDIX MARINE TURTLES	• Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Turtles (Wheatstone) 2012–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Baseline Hydrocarbon Content of Bivalves and Sediments (unpublished)	• Onslow Area • Offshore Islands • Thevenard Island Area	2013 PAH, TPH, BTEX, and Metals	SCI2 SCI3		• Network drive (O drive) • DMS	
Thevenard Island (TVI) Marine Environmental Monitoring Program	• Thevenard Island Area	• 1991–ongoing • Coral (composition, abundance) • Sediment (hydrocarbons, metals) • Bivalve (hydrocarbons, metals)	SCI2 SCI3 SCI6		• Network drive (O drive) • DMS	
TVI Marine Environmental Monitoring Program	• Thevenard Island Area	• 2009–2010 • Benthic Habitat	SCI6		• Network drive (O drive) • DMS	
Sea Serpent Project	Various	• Deep-sea benthic surveys • Deep-sea marine fauna surveys • Sediment sampling	SCI2 SCI5 SCI6 SCI7		• Network drive (O drive) • DMS	
Deep-sea sediment sampling	2013 HERA-1 and Delphin-1	• Sediment sampling (hydrocarbons)	SCI2		• Network drive (O drive) • DMS	

4.3.1.2 Data Stored Externally

Additional baseline datasets are available to CAPL, but are held by external consultants and described in reports held by CAPL. These data can be accessed when required from the consultants.

4.3.2 Industry Agreements (including I-GEM)

Vermillion Oil and Gas (Australia) Pty Ltd have confirmed that, in the event of an oil spill, they would release data collected at the Montebello Islands on sediment and water quality, mangrove condition, marine turtle nesting activity, and bird presence (roosting; nesting and foraging) for CAPL's use in environmental assessment.

I-GEM is an industry and government collaboration to collate and present spatial metadata on marine environmental baseline and monitoring studies collected in the last decade. The objective of this program is to ensure industry and government have the same marine studies knowledge.

The intention of I-GEM is to capture spatially referenced metadata on marine environmental studies from the Abrolhos Islands to the Timor Sea and from the nearshore waters of the coast to the edge of Australia's continental shelf. This metadata database will allow organisations to understand what environmental baseline studies exist and where, and identify the custodian. The database provides a valuable shared resource to support impact assessment in the unlikely event of a major oil spill in the region.

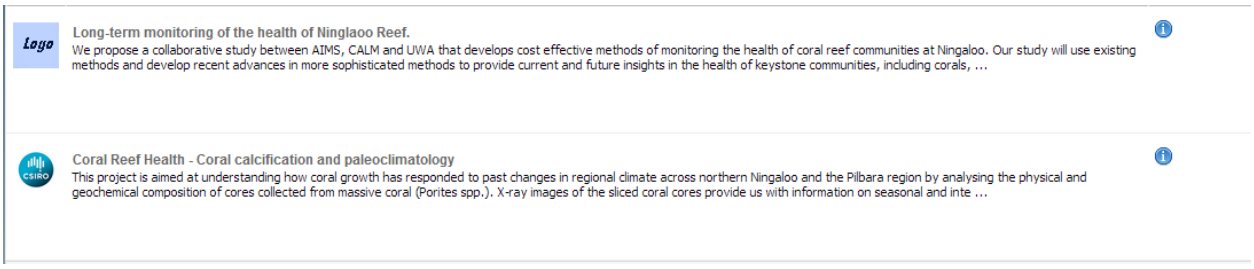
I-GEM metadata are publicly accessible from the AODN metadata catalogue, with accessibility to the WAODN metadata catalogue. It is not necessary to apply for a user name and password to search publicly available metadata records and public data; however, a user name and password is required to create metadata records or download and view restricted data.

Login details for CAPL are included in Environment Unit Lead guidance documents and a user guide is available via this link.

An example of an I-GEM metadata search is provided below.

Search: *coral health Ningaloo*

Results as viewed online:



Extract of titles relevant to example search:

- Long-term monitoring of the health of Ningaloo Reef
- CSIRO Coral Reef Health – Coral calcification and paleoclimatology

- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Environmental Drivers: Coastal Reef Monitoring (Ningaloo) 2014–2015
- Methods for monitoring the health of benthic communities, Ningaloo Reef, Western Australia (WAMSI Node 3 Project 3.1.2)
- AIMS Long-Term Monitoring of Ningaloo Marine Park: Status of Drupella and shallow water benthic reef communities
- Data on the long-term monitoring of Ningaloo Marine Park
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Fish Short Transect Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Target Fish Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Survey – Reef Benthic Survey 2013–2015
- CSIRO Coral Reef Health Sediment Survey 2013–2015
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Stable isotope ratios of selected flora and fauna from Ningaloo and the Pilbara 2014–2016
- CSIRO Coral Reef Broadscale Invertebrate Survey – 2013–2015
- CSIRO Macroalgae and seagrass biomass and diversity across the Pilbara Region in November 2013 and May 2014
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Fish and Sharks – Raw Stereo-BRUV Imagery – 2015_08_Ningaloo.deep.sanctuaries_stereoBRUVs

Example of metadata record linked to each title:

Link: http://catalogue.aodn.org.au:80/geonetwork?uuid=506cd950-371b-4c99-a43e-584557972348

Abstract: This project is aimed at understanding how coral growth has responded to past changes in regional climate across northern Ningaloo and the Pilbara region by analysing the physical and geochemical composition of cores collected from massive coral (*Porites* spp.). X-ray images of the sliced coral cores provide us with information on seasonal and inter-annual changes in the density and rate of vertical extension from which we can calculate annual rates of coral growth, or more precisely, calcification. Coral cores from massive *Porites* spp. were collected from sites across northern Ningaloo (Tantabiddi and Coral Bay in July 2013) and the western Pilbara (Onslow to the Dampier peninsula in April 2014).

4.3.3 Public Information Sources

A bibliography of research and data relevant to CAPL's Resources at Risk project was created in 2014. This document listed published and unpublished material relevant to the marine and intertidal environments within the EMBA in the event of a worst-case scenario hydrocarbon release associated with the Wheatstone or Gorgon Gas Developments. The output was a comprehensive bibliography of the physical, ecological, and biological components of the marine and intertidal environments within the EMBA. An overview of this output is stored as a list in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe83127eae/chronicleId/09024afe83127e9f/versionLabel/CURRENT or on SharePoint at this link Resources at Risk

Chevron holds a Zotero user licence to enable access to the details of the bibliography. The relevant text file to be opened with Zotero is stored in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe8312927d/chronicleId/09024afe8312927d/versionLabel/CURRENT.

5 Capability and Readiness Estimate

5.1 Process for Determining Required Capability

The ABU OSMP (Ref. 3) outlines the high-level process for determining capability requirements and maintaining an appropriate level of capability, internally and externally. This Section summarises the process for estimating the personnel, logistics, and equipment required to implement operational and scientific monitoring for two representative modelled spill scenarios on the NWS:

- Offshore loss of well control event
- Heavy Fuel Oil spill (1040 m^3 over three days) at the Wheatstone Product Loading Facility (Ashburton North)

The requirements for one field team to implement each individual monitoring component were determined via internal workshops that considered:

- number of personnel per team
- team composition (e.g. field leader, subject matter experts [SMEs], field workers)
- sampling equipment per team (generic equipment [e.g. laptop] and that specific to the monitoring component [e.g. water column profiler])
- work platform (e.g. 4WD vehicle, fixed-wing aircraft, inshore vessel, offshore vessel).

For each scenario, the number of teams required to implement the monitoring components was determined for up to four phases of the event:

- Phase 1: Initial (0–30 days)
- Phase 2: 30 days to end of release and dispersion; ~240 days
- Phase 3: Initial Recovery (3 years)
- Phase 4: Ongoing (time defined for each receptor).

The number of teams accounted for the following factors:

- co-mobilisation of common scopes (i.e. the ability of one team to implement multiple monitoring components)
- shift hours (12-hour or 24-hour operations) and rotation of field teams (e.g. 14 days on/off).

Up to four equipment suppliers were identified for each equipment type, with their name, number of items available, lead time for equipment to be ready to mobilise from the location, location, and contact number.

5.2 Existing Capability Compared to Estimate

CAPL's capability to implement the ABU OSMP (Ref. 3) for an incident on the NWS draws on internal (CAPL and corporate structure) and external (contractor) resources. Capability is maintained in a central register; internal personnel capability is updated quarterly, while external capability is updated every 6 months.

The combined internal and external capability is compared to Phase 1 estimated requirements to ensure sufficient resources are available to support the initial response, while allowing time for scaling up for prolonged events.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym/ Abbreviation	Meaning
~	Approximately
°C	Degrees Celsius
4WD	Four-wheel drive (vehicle)
ABU	Australian Business Unit
AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
AODN	Australian Ocean Data Network
APPEA	Australian Petroleum Production and Exploration Association
ArcGIS	An integrated collection of GIS software products developed by ESRI that provides a standards-based platform for spatial analysis, data management, and mapping
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Avifauna	Birds of a particular region
BIA	Biologically Important Area
Biogenic	Produced or brought about by living organisms
Bombora	Raised, dome-shaped, limestone feature, >1 m high, often formed by coral of the genus Porites.
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals 1979
BTEX	Benzene, toluene, ethylbenzene, and xylene compounds
CAMBA	China–Australia Migratory Bird Agreement
CAPL	Chevron Australia Pty Ltd
Cetacean	Various aquatic (mainly marine) mammals of the order Cetacea, (including whales, dolphins and porpoises) characterised by a nearly hairless body, front limbs modified into broad flippers and a flat notched tail
Commonwealth Waters	Waters stretching from three to 200 nautical miles from the Australian coast.
CSIRO	Commonwealth Scientific and industrial Research Organisation
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
Demersal	Living on the seabed or just above it
DMP	Former Western Australian Department of Mines and Petroleum (2009–2017); now Department of Mines, Industry Regulation and Safety
DMS	Document Management System
DomGas	Domestic Gas
DoT	Western Australian Department of Transport
DPIRD	Western Australian Department of Primary Industries and Regional Development

Acronym/ Abbreviation	Meaning
DWER	Western Australian Department of Water and Environment Regulation
EDMS	Environmental Data Management System
EMBA	Environment that May be Affected
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Finfish	A term used to distinguish fish with fins and gills, from shellfish, crayfish, jellyfish, etc.
Foraminifera	Microscopic, single-celled organisms with shells
FSSMP	First Strike Sampling and Analysis Plan
GIS	Geographic Information System
HES	Health, Environment, and Safety
HMAS	His Majesty's Australian Ship (during World War II)
HSK	Ship of the German Navy (during World War II)
IAA	Impact Assessment Area
I-GEM	Industry–Government Environmental Metadata
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IPIECA	International Petroleum Industry Environmental Conservation Association
IS	Information Systems
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
KEF	Key Ecological Feature
km	Kilometre
km^2	Square kilometre
LNG	Liquefied Natural Gas
m	Metre
m/s	Metres per second
m^3	Cubic metre
MEQMP	Marine Environmental Quality Management Plan
MNES	Matters of National Environmental Significance, as defined in Part 3, Division 1 of the EPBC Act
MOF	Materials Offloading Facility
N/A	Not applicable
Nekton	The aggregate of actively swimming organisms at the sea's surface
NH_3	Ammonia
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NO_x	Oxides of nitrogen (NO and NO_2)
NWMR	North-West Marine Region
NWS	North West Shelf

Acronym/ Abbreviation	Meaning
NWSJEMS	North West Shelf Joint Environmental Management Study
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OSMP	Operational and Scientific Monitoring Plan
PAH	Polycyclic Aromatic Hydrocarbon
Pelagic	Living in the open sea rather than in coastal or inland waters
pH	Acidity or basicity of a solution
Photic Zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be greatly affected by turbidity.
PSU	Practical Salinity Units, equivalent to parts per thousand
QA/QC	Quality Assurance / Quality Control
Ramsar Wetland	A wetland of international importance, recognised globally under the Ramsar Convention. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands; it recognises the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SCI	Scientific monitoring
SME	Subject Matter Expert
SQL	Structured Query Language (Microsoft)
State Waters	The marine environment within three nautical miles of the mainland of Western Australia or its islands
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TPH	Total petroleum hydrocarbon
Trophic	Pertaining to food or nutrition
TVI	Thevenard Island
WA	Western Australia
WAFIC	Western Australian Fisheries Industry Council
WAMSI	Western Australian Marine Science Institution
WAODN	Western Australian Ocean Data Network

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2023 *Description of the Environment*. Chevron Australia, Perth, Western Australia.	ABU-COP-02890
2.	Chevron Australia. 2017. *Operational and Scientific Monitoring Plan: Environmental Monitoring in the Event of an Oil Spill to Marine Coastal Waters*. Rev. 6.0. Chevron Australia, Perth, Western Australia	ABU130700448
3.	Chevron Australia. 2018. *ABU Oil Spill Protection Prioritisation*. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
4.	Chevron Australia. 2018. *Chevron ABU – Oil Properties and Dispersion Application Applicability*	ABU180501458
5.	Chevron Australia. 2020. *ABU Operations: Environment Plan Changes Tracking Register*	ABU180500351

Appendix B Guidance Note and Standard Operating Procedures – Operational Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Operational Monitoring

Document ID:	ABU150300650
Revision ID:	4.0
Revision Date:	25 May 2020
Next Revision Due	25 May 2025
Information Sensitivity:	Company Confidential

Contents

Tables

Figures

1 Introduction

1.1 Purpose

The Operational and Scientific Monitoring Plan (OSMP): Operational Monitoring Guidance Note (this Guidance Note) describes the implementation for operational monitoring if an emergency condition results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on operational monitoring only, as set out in the OSMP (ABU130700448; Ref. 1).

The OSMP splits operational monitoring into individual components (Figure 1-1); each represents a particular assessment or study, with tailored initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for operational monitoring purposes, not scientific monitoring. Therefore, some of the design and methodology cannot be prescriptive and must focus on rapid data collection for response decision-making rather than long-term studies to determine impact.

1.2 Scope

This Guidance Note focuses on the implementation of operational monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs (OPS) is part of the OPEP processes and is not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at Chevron Australia, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

The geographic scope of the implementation of the OSMP, including this document, is described in Section 2.3.1 and shown in Figure 2-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for operational monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures (SOPs) for required sampling, including providing standard field sheets and checklists.

1.4 Target Audience

Personnel fulfilling operational monitoring roles within the Environment Unit (Figure 2-1) of the Emergency Management Team (EMT) will use this Guidance Note.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a baseline understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft), and/or events beyond CAPL's control can be accommodated. The potential survey areas occur in a remote region with limited logistical capability, and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity) may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more OMPs as described in this document. If this occurs, CAPL will take measures and/or reprioritise its monitoring programs to ensure the objectives of this document are met.

This document provides a framework for finalising program design so that it is appropriate to the nature and scale of the event. This document provides more details for OPS that must be implemented immediately by CAPL. External environmental specialists, engaged to support other OPS, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required by the EMT.

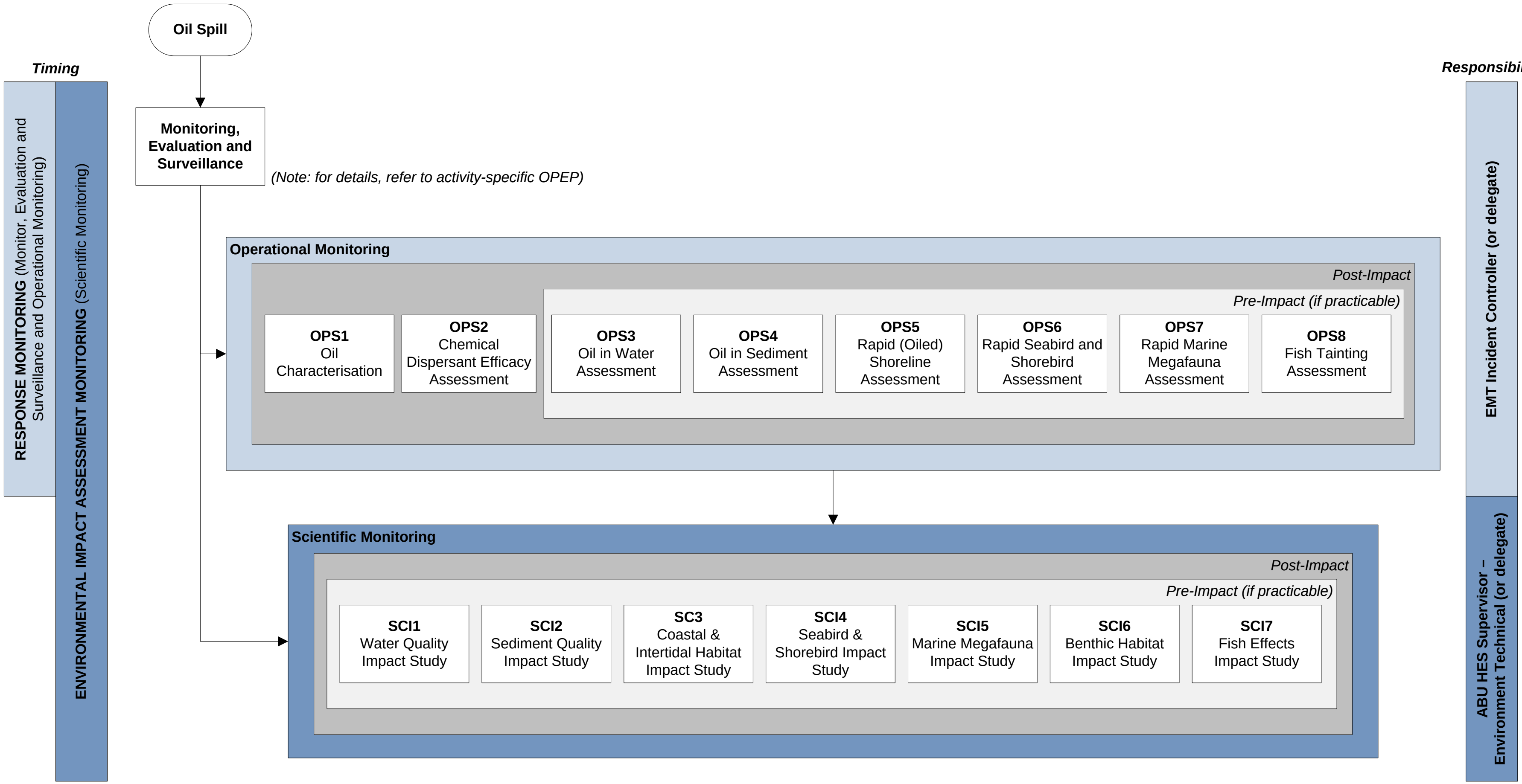


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

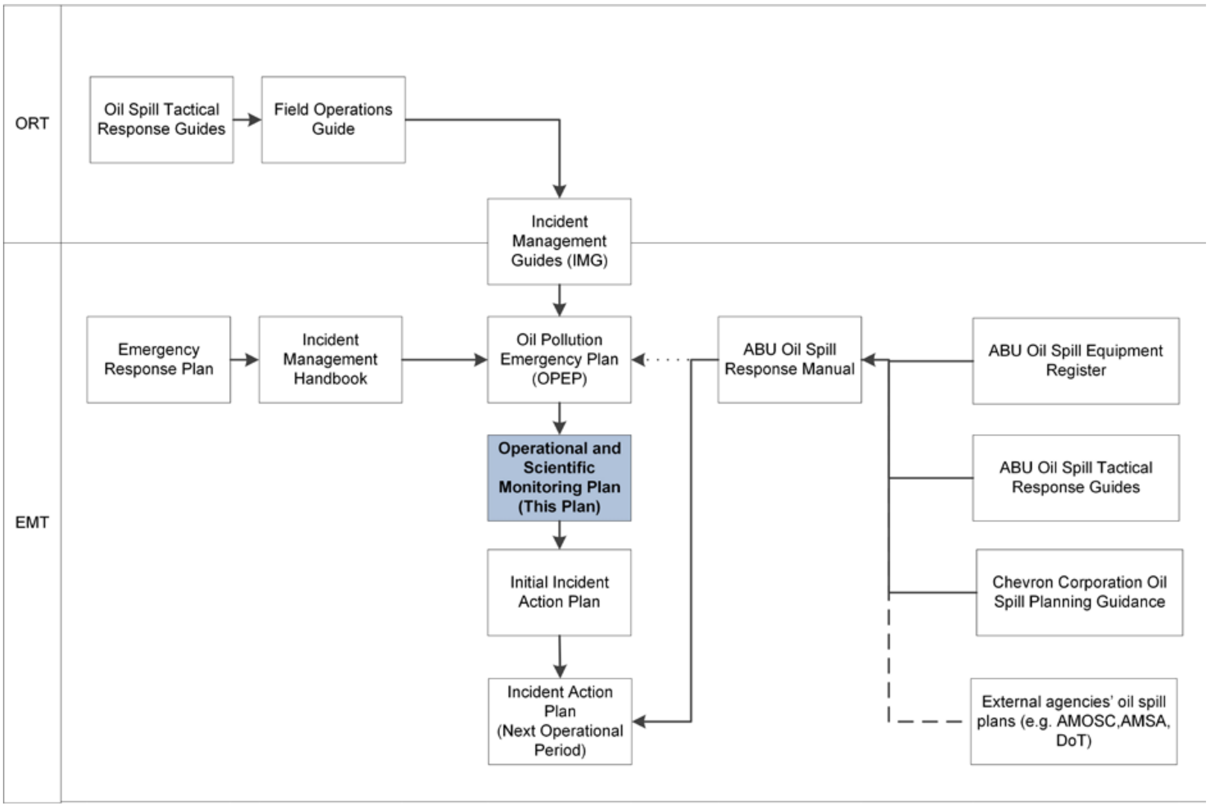


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 12 defines the acronyms and abbreviations used in this Guidance Note.

2 Implementation Strategy

Operational and Scientific Monitoring is a key element in effectively responding to oil spill incidents and CAPL's process for this activity is described in the ABU OSMP (Ref. 1). This Guidance Note is one of the key supporting procedure documents that support the OSMP.

2.1 Roles and Responsibilities

The roles and responsibilities outlined in Figure 2-1 apply to all phases of the monitoring process. The EMT Incident Commander (or delegate) will be responsible for ensuring the implementation of the operational monitoring components. Several specific monitoring roles (see shaded cells in Figure 2-1) will also be required.

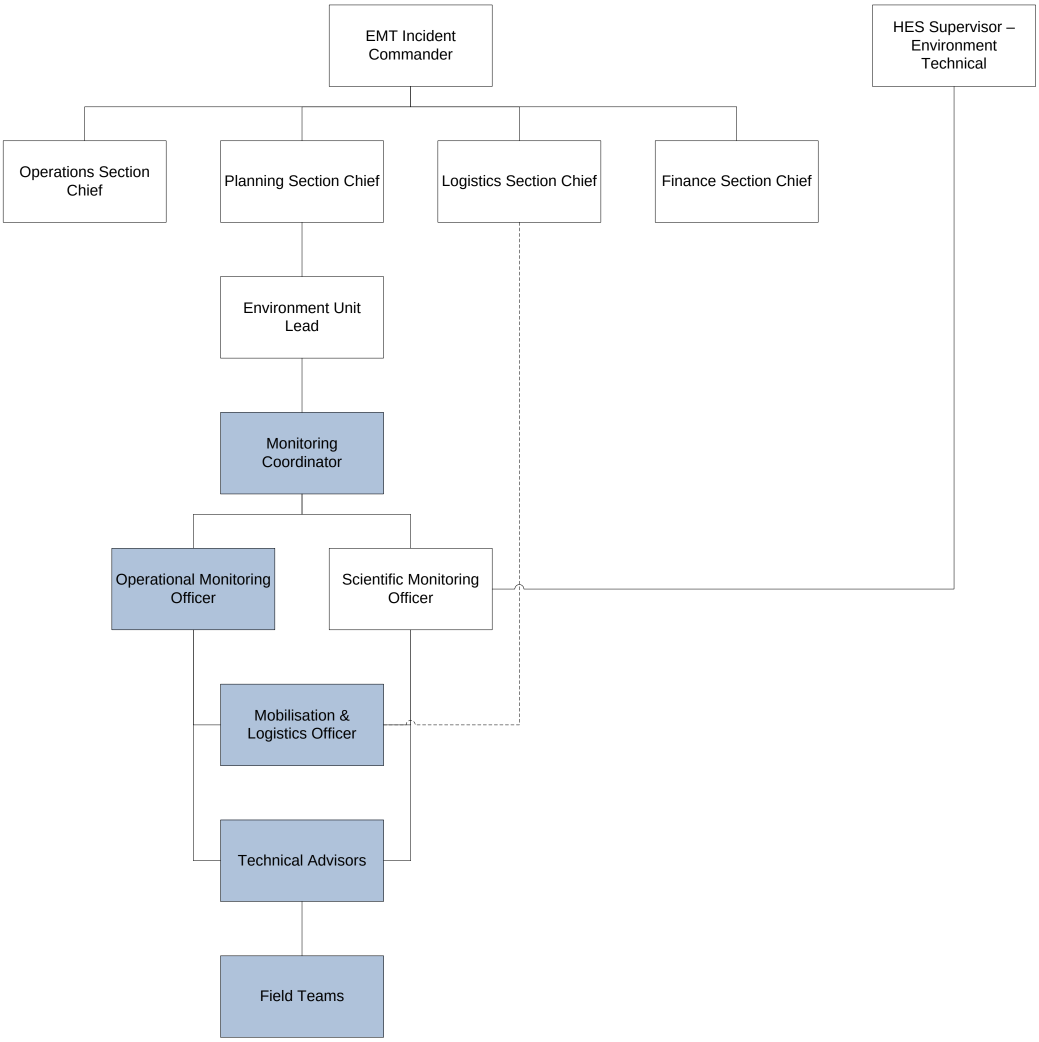


Figure 2-1: Roles Associated with Operational Monitoring

Note: Shaded cells refer to roles associated with this Guidance Note.

Table 2-1: Operational Monitoring Roles, Responsibilities, and Rationale for using this document

Role	Responsibilities	Reason for using this document
EMT Incident Commander (or delegate)	Ultimately responsible for ensuring that operational monitoring is implemented in accordance with the OSMP (Ref. 1).	Is aware of this document but does not directly implement each OPS
Environment Unit Lead (EUL)	Key position for relaying information between the EMT and the Monitoring Coordinator.	Refers the Monitoring Coordinator to this document for use by the monitoring team
Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • contact point with the EMT (through EUL) • providing overarching technical advice • financial tracking and management (in consultation with Finance Section in EMT) • logistics tracking (in consultation with Logistics Section in EMT) • engaging with required third-party contractors including consultants and laboratories • supporting the EUL in ensuring that: – relevant OPS components are implemented in line with the descriptions in the OSMP (Ref. 1) – necessary monitoring roles are defined as appropriate to the nature and scale of the event • ensuring operational monitoring components are implemented within the times defined in Section 2.2.	• Communicating monitoring activities to the EMT • Acquiring personnel to fulfil roles and ensure responsibilities are met
Operational Monitoring Officer	Operational Monitoring Officers are the technical leads for each of the monitoring types. Responsibilities include: • understanding the data metrics that would be collected in the event of a spill • advising the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time or logistics) are encountered • facilitating activation of contractors if necessary • overseeing data analyses and interpretation • managing data including spatial data • presenting data in an appropriate and informative format to allow for timely decisions.	• Design of OPS programs • Ensuring SOPs are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted and reported back to the EUL

Role	Responsibilities	Reason for using this document
Mobilisation and Logistics Officer	The Mobilisation and Logistics Officer is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable and in accordance with CAPL processes. This position also liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams. If required, this position is also responsible for facilitating procurement of any necessary vessels or sampling equipment.	• Understanding resources required (resource lists for each OPS) • Understanding requirements to mobilise people and equipment for monitoring tasks
Technical Advisors	Technical Advisors will be assigned to monitoring scope(s) as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include: • overseeing and advising on the collection of data • advising the Operational and Scientific Monitoring Officers on data collection methods • ensuring sampling and analysis plans (where required) are completed before mobilisation • ensuring quality assurance/quality control (QA/QC) and interpreting data • preparing reports.	• Design of OPS • Verifying SOPs • Ensuring QA/QC in data collection and reporting
Field Teams	A Field Team will include a Field Team Lead, who will be the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for: • understanding the details of monitoring methods • having adequate field data collection sheets and survey-specific equipment readily available • ensuring awareness and understanding of QA/QC procedures • assisting with report preparation if required • implementing relevant health, environment, and safety (HES) protocols.	• SOPs for each OSMP • Resource lists

2.2 Timing Commitments

Implementation times were committed to and are provided in the OSMP (Ref. 1).Implementation times for the Operational Monitoring Components are directly linked to the initiation criteria which are found in Section 4 of the OSMP. Implementation times must be adhered to.

2.3 Mobilisation Times

2.3.1 Operational Areas

The operational areas of CAPL are shown in Figure 2-2; these areas also represent the geographic scope of the implementation of the OSMP (Ref. 1), including this document. Indicative mobilisation times for these areas is provided in Appendix A.

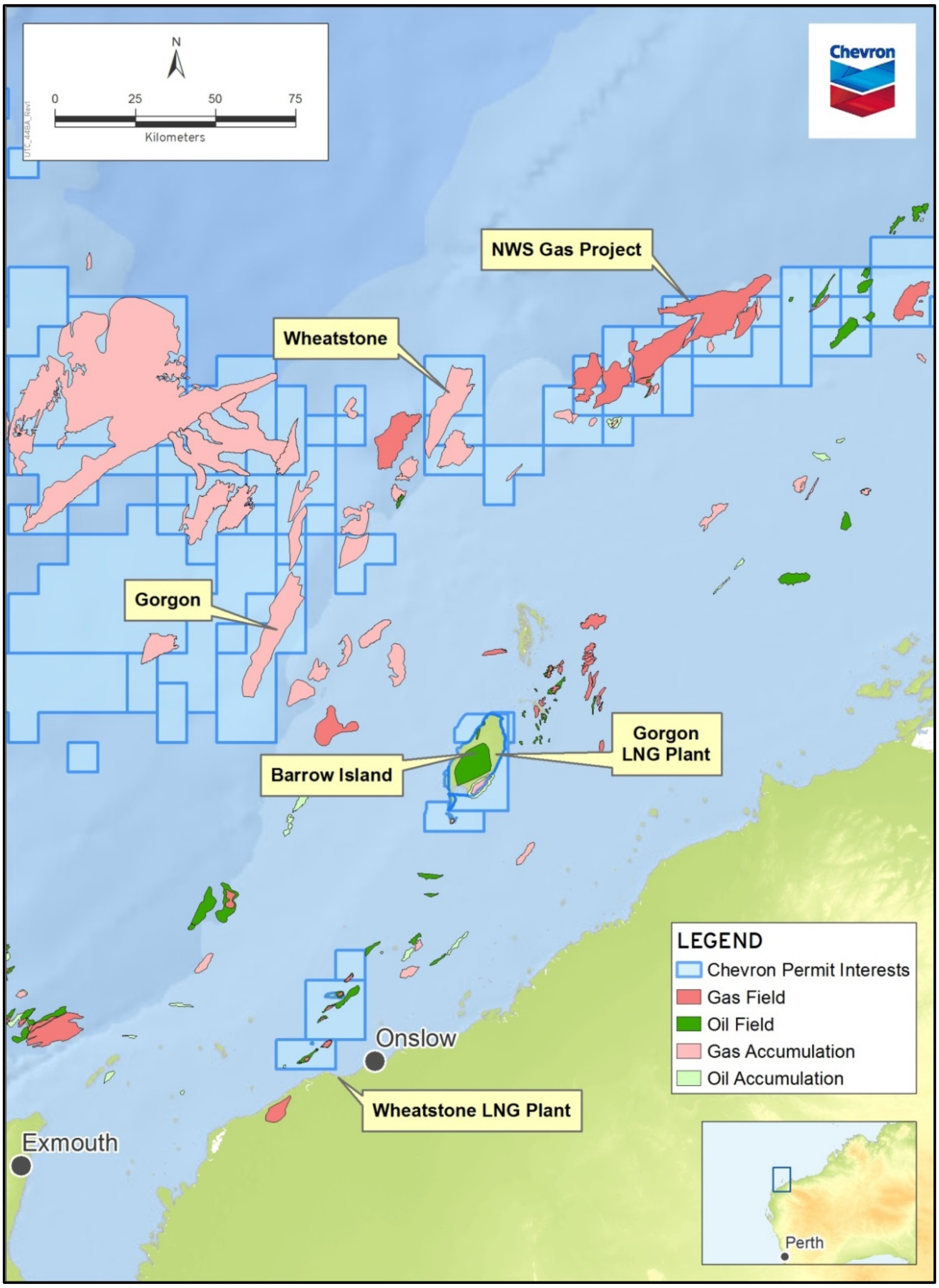


Figure 2-2: CAPL Operational Areas

2.3.2 Non-operational Areas

For areas not under CAPL operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and WA Department of Parks and Wildlife (Parks and Wildlife) for locations managed by the Marine Parks and Reserves Authority (MPRA).

2.3.3 Permits

Individual operational monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required where biological samples are collected from the water column or seabed, or where an exemption is required to use a specific type of sampling gear. For operational monitoring, this applies to OPS8: Fish Tainting Assessment, under which live and dead fish specimens will be collected. Several different permits or exemptions will be required from different government departments, depending on where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 2-2 outlines the permits required and issuing authority. outlines the likely permits required for each monitoring component. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 2-2: Permits Potentially Required to Support Operational Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required For	Legislative Requirement
Parks and Wildlife	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles	Conducting scientific research (including filming and photography) in a State Marine Protected Area (MPA) in State Waters out to three nautical miles	*Wildlife Conservation Act 1950* (WA) and Regulations – Regulation 17
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nautical miles. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and associated Regulations

2.4 Safety and Health

Safety and health is paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with operational monitoring are listed in Table 2-3. This information may be used to develop a Job Safety Analysis (JSA) before undertaking operational monitoring activities. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 2-3 are not exhaustive.

Table 2-3: Potential Hazards Associated with Operational Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas • Appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Manual handling training • Weights clearly marked on labels • Lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Appropriate footwear • Non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. volatile organic compounds [VOCs]), H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Air monitoring • Site entry • Respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration, inability to undertake assigned duties	• Premedication as needed
Aerial Operations		
Motion Injury from aircraft on airfield taxiing or starting engines	• Impact injuries • Possible fatalities	• Flight crew safety instructions and pre-flight briefings • Designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• HUET and/or BOSIET training for all aerial observers • PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Communications plan • Flight crew briefing regarding simultaneous operations (SIMOPS)

Hazards	Impacts	Mitigation Measures
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck • Rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Vessel crew training • Navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Transfer procedures • Follow Vessel Master's instructions • Awareness of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Alarm systems • Firefighting equipment on board • Emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Regular work breaks to cool down or warm up • Appropriate clothing and PPE • Hydration • Sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Vessel engines stopped or in neutral during deployment • On-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms)	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE • Over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Regular work breaks • Appropriate clothing and PPE • Hydration • Sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Awareness of sea state and conditions • Use PFDs

2.4.1 Personal Protective Equipment (PPE)

The work described in this document must be performed in compliance with minimum PPE requirements as defined in the ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 24). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23). For operational monitoring activities, conduct a risk assessment to determine the PPE required and consider items listed below as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater, worn under overalls or high-visibility clothing)
- over-ankle reef booties (not dive booties; should have grip on the sole)
- protective gloves suitable for entering water during intertidal work. Consider long lycra gloves, latex gloves, dishwashing gloves or a combination (without causing cross-contamination of samples)
- consider duct-taping PPE to wrists and ankles when contacting sea water.

2.4.2 Washdown for Marine Stinger Safety

Following exposure to marine stingers, particularly Irukandjis (i.e. exposure to salt water), clothing and equipment is to be washed down before disrobing. Vinegar washdown provides the greatest measure of protection. Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until these surfaces have been treated with fresh water for at least ten minutes. See Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) for the Vinegar Washdown procedure.

3 Operational Monitoring

Operational monitoring is undertaken to:

- collect information about the oil spill and enhance situational awareness
- aid planning and decision-making in executing spill response or clean-up operations
- assess the impact on sensitive resources
- assess the effectiveness of response options.

Operational monitoring typically finishes when the spill response is terminated, usually because response objectives have been met and/or scientific monitoring has been initiated.

The primary objective of operational monitoring is to provide information that can be used in planning or carrying out a current spill response operation. The characteristics of operational monitoring are:

- results are generally required quickly
- lower requirement for statistical strength (e.g. smaller requirement for replicates at sampling locations and fewer locations)
- lower requirement for identifying control sites or demonstrating baseline conditions
- includes monitoring required before response activities will be approved by regulatory agencies (e.g. use of chemical agents, such as dispersants, or bioremediation agents)
- includes monitoring to help predict environmental effects or define the sensitivity of resources to guide spill response activities.

3.1 Designing the Monitoring Program

The text in this Section is from the Australian Maritime Safety Authority's (AMSA) Oil Spill Monitoring Handbook (Ref. 4); refer to that Handbook for more information. Appendix C contains an extract of the Oil Spill Monitoring Handbook that describes program design.

3.1.1 Setting the Objectives of the Study

Setting objectives is the first step in defining what a monitoring program needs to deliver. In its simplest form it is a statement of what the monitoring program seeks to measure (e.g. descriptive; measurement of change; determination of cause and effect), and defines the parameters to include in monitoring. When setting objectives it is important to understand how monitoring information will be used in the decision-making process. Some key aspects to consider when setting objectives are:

- What specific question(s) needs to be answered?
- Have knowledge gaps been identified and addressed?
- Have the limitations of not having information been evaluated?
- Will the information gathered address major stakeholders' needs?
- How will the information be managed and communicated?

- Do specific objectives:
  - Clearly and concisely communicate the purpose of monitoring?
  - Specify what the monitoring will achieve?
  - Indicate when the monitoring is complete?

3.1.2 Responsibility for Setting Objectives

For OPSs, primary objectives will generally be determined by the CAPL EMT Incident Commander or other nominated person within the EMT. Responsibility for designing or developing a monitoring program is assigned to the EUL who manages the monitoring team. The monitoring team(s) will collect the information needed to meet the set objectives.

3.1.3 Determining the Scale of the Program

It is important that the monitoring program reflects the scale and potential effects of the spill, and addresses key environmental issues relevant to the spill. The appropriate scale for a program will be determined largely by the specific objectives of the program. If variability is high, the time and resources required to reliably detect an impact may require a large monitoring effort. The need for such effort must then consider whether the objective of the study is of sufficient importance to justify the monitoring needed, i.e. the time and resources required may be considered ‘unreasonable’ unless the objective of the study is of high importance.

3.1.4 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study will depend primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives; usually set by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up options.

The boundaries should also be sufficient to cover representative areas of each:

- type of substrate
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

Compromise and constant review of priorities may be necessary as OPSs are usually designed and executed during an emergency situation where time and resources are likely to be limited.

3.2 Data Management

Sampling data, and assessments of that data, need to be conveyed to the appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that information is presented appropriately and on time. Field data collected can be obtained in various forms:

- results from field sampling and observations
- forms
- photographs
- videos
- maps
- notebooks and logs
- portable global positioning system (GPS)/geographic information system (GIS) units
- verbal transmission
- Chain of Custody forms
- laboratory reports
- samples (biological, sediment, or oil).

Photographic and video evidence ranging from coastlines to detailed quadrats are a useful operational monitoring tool. Photo documentation has the advantage that skilled interpretation of data can be done later, remotely, and be centralised; such documentation is a fast and relatively inexpensive data collection process.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any OPS will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive, well organised, and appropriately analysed.

Appendix D is an extract from the AMSA Oil Spill Monitoring Handbook (Ref. 4) that provides a guide to data management.

3.3 Laboratory Analysis

Hydrocarbon analysis will be undertaken by an appropriate laboratory, with (where possible) National Association of Testing Authorities (NATA) accreditation for the analytes of interest or a robust QA/QC program. It is the responsibility of the Operational Monitoring Officer to ensure correct laboratory requests, deliveries, and reports are obtained.

3.4 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 25; see also Appendix F).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in Chain of Custody Form.
4. The Chain of Custody Form (Appendix F) should stipulate that the report is sent to the Monitoring Coordinator and EUL.

Services can be directly engaged by CAPL personnel or by selected Environmental Contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 26).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies, as outlined in Table 3-1. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

Table 3-1: Surcharge Rates for Expedited Turnaround Times for CAPL Contracted Laboratories

Turnaround Time Surcharge	ALS	ChemCentre
Same day	100% sample cost	Not available
1 day	40% sample cost	100% sample cost

Turnaround Time Surcharge	ALS	ChemCentre
2 day	25% sample cost	50% sample cost
3 day	none	none

3.5 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for operational monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by these consultants in relation to OPS1–OPS8 are:

- skills and expertise available within the organisation to execute the plan
- resources available, including the number of personnel with skills within the organisation for field deployment and office/laboratory support
- access to the required equipment for quick activation
- ability to mobilise teams on short notice.

4 OPS1: Oil Characterisation

4.1 Rationale

OPS1 provides quantitative information on the chemical properties of the oil, which helps the EMT select the most effective response option(s). It requires samples of the oil to be collected and analysed.

Operational monitoring for the nature and behaviour of oil during a response is essential to:

- allow ongoing assessment of the effectiveness of, and any negative side-effects of, specific treatments that are applied, such as chemical dispersion or shoreline cleaning techniques
- provide in-field information on the oil properties, behaviour, and weathering of the spilt oil to assist in spill response operations.

Oil characterisation helps quantify the physical and chemical properties of the oil, which determine how the oil will behave in, and interact with, its receiving environment. This information helps the EMT select the most suitable response options.

Depending on the nature of the spill, ongoing oil characterisation sampling may be required throughout the spill. For this Guidance Note, standard processes will focus on the first-response sampling. Further oil spill characterisation sampling may be required (e.g. vertical water column profiling), which will be supported by external environmental consultants.

This monitoring component will be co-mobilised with OPS3: Oil in Water Assessment in most instances and will be the first operational monitoring component implemented when the OSMP is initiated.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Monitoring Design

This monitoring activity requires a sample of the spilt oil to be collected, and in-field observations made. The appropriate design of this activity will vary between situations depending on:

- Size of the spill
- Knowledge of the source of the spill
- Location and access to the spill
- Weathering rate of the oil
- Potential environmental and economic consequences of the spill
- Requirements to test specific response methods that may affect oil or be sensitive to the oil properties (e.g. Testing chemical dispersants)
- Requirements to inform the public or other stakeholders
- The availability of human resources, suitable vessels, and other logistics

- Capacity for transporting samples from the site (e.g. By helicopter or vessel)
- Safety considerations.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Move sampling locations, as required. Because the primary objective of this monitoring program is to assess changes in the properties of the oil over time, move sampling locations with the slick and/or plume based on the MES activities of aerial surveillance, visual observations, and oil satellite tracking buoys.
- Plan the number of locations and samples to be collected, taking into account level of effort, potential logistical limitations, weather conditions, etc. that may compromise sample integrity.
- Contact the laboratories that will receive the oil samples for analysis to ensure they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- Adjust the sampling strategy, as required. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- When sampling in remote areas with limited shipping capabilities, plan to make sure that the integrity of samples is not compromised by ensuring that the processing laboratory receives the samples within their recommended holding time. It may take several days for shipments from remote areas to reach a laboratory facility. This last stage is the most important and requires due diligence until the samples are safely delivered. (Ref. 20).
- Collect floating oil using an oleophilic sampling device that selectively collects oil, or carefully skim with a narrow-neck flask to minimise mixing with the water immediately below the slick, which may contain soluble hydrocarbons or other components that would contaminate the floating oil sample.
- Take multiple samples, as required. The sample taken should be representative of the oil. If the slick varies in appearance, or if more than one oil may be present, then multiple samples need to be taken.
- Consider the size of the slick, source of spill (number of potential oils present), and distribution (number of locations) of slick.
- Determine the type of containers and the amount of the sample needed (see Appendix E). The total volume of sample and the containers required should be determined before field activities commence. It is better to divide a single

sample than to take multiple samples from a slick, particularly if more than one oil could be involved or the oil is highly variable.

- Decide the platform to sample from (response/other vessel, shoreline).
- Consider the potential for contamination from response vessels (e.g. bilge outlets, exhausts), logistics, weather, and other safety considerations (staff training and experience) (Ref. 4).
- Measure the physical parameters of the water in the vicinity of the oil slick; this will provide important information on the behaviour of the oil in water. See OPS3 for measuring the physical water parameters.
- Sampling at depth may be required for subsurface oil slicks. This can be achieved using a Niskin bottle or similar device that allows remote opening and closing. Alternatively, samples can be pumped from defined depths using a hose suspended vertically.
- Collect at least three replicates (three complete samples) to allow assessment of local variability in oil properties and to allow for QA/QC.
- Prepare and transport discrete samples within holding times (there is potential to increase time frames if solvent extracts are prepared) to a suitable NATA-accredited laboratory for analysis.

Visual indicators of the floating oil properties should also be taken and recorded on Form 4 (in Appendix F), and should include:

- The colour and optical effects generated by surface films—indicating the local concentration of oil that is present—judged using the standardised Bonn Agreement Oil Appearance Code
- The general flow properties at ambient temperatures indicated by the tendency to spread and flow freely (pour point > ambient sea temperature) or to clump and solidify (pour point < ambient sea temperature)
- The formation of water-in-oil emulsions (referred to as mousse) revealed by a characteristic change in colour (typically to a brown/orange colour), sometimes with a foamy appearance
- The formation of solid sheets or balls indicating that the more volatile components have evaporated from the slick, leaving a waxy residue
- Evidence of submergence indicating that the oil film is at a similar or greater density to the ambient sea water.

4.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

4.5 Standard Operating Procedure – Field Sampling

Sampling techniques will vary depending on the type and location of the oil to be collected. Some considerations are consistent across all techniques:

- All sampling and storage equipment should be stainless steel, Teflon, glass or other non-plastic material.
- Avoid plastics as plasticisers may mimic the anolytes in analysis and give false results.
- Use clean equipment at each sample site to avoid cross-contamination. If equipment requires cleaning, wash with a detergent and triple rinse with distilled water.
- Unless prescribed differently by the laboratory for specific analyses, each oil sample should contain 10 mL to 200 mL of oil, and jars are not be filled more than ¾ full to allow room for liquids to expand with temperature changes. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss (see Ref. 5)

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
1	Confirm all required resources are available and ready to use.	☐
2	Familiarise team members with sampling design and allocate tasks required to be completed, such as sample collection, data recording, photography.	☐
3	Conduct safety assessment of task and JSA	☐
4	Commence data entry into the Oil Sampling Form (Form 4 in Appendix F)	☐
5	Using the sample jar or other sampling device, take samples from the thickest part of the slick or film. This is usually the 'leading edge' of the slick.	☐
6	If sampling from a vessel, use a grab pole or similar to take a sample from the bow, or at least to the forward, of the vessel and avoid contamination from vessel engines.	☐
7	Collect three replicate samples from each site (i.e. Site 1; samples A, B, and C), record the location with a GPS and mark the collection site on the sampling form (Section 4.7)	☐
8	For films/sheens, use a piece of sorbent material to soak up the oil film. This can be passed through the film several times. Place a piece of unoiled sorbent in a sample jar as the control and label accordingly (this is additional to the three replicates). For thin slicks and sheens, collect water samples (at least 1 L) and samples using oleophilic materials. Depending on the thickness of the slick, it may be more appropriate to use sorbents and Teflon swabs to sample the slick. Both materials will repel water and adsorb hydrocarbons when moved through the water. The material should then be placed in the sample jars with an unused piece of the material in a separate jar to be sent as a control to analysis. Chemically treated sorbent pads should not be used to sample slicks (Ref. 5).	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
	 **Figure 4-1: Example of a Sheen** *Source: Ref. 5*	
9	Shoreline sampling of stranded oil is relatively simple; however, it is important to try to limit the amount of non-oiled material in a sample. Do not fill sample jars more than ¾ full. Methods include directly scooping oiled sand into the jar using the jar itself or by scraping oil off sediment and debris using a wooden scraper or metal ruler. Use a clean scraping tool for each sample to avoid cross-contamination. Place oiled debris such as small stones and some vegetation directly into the jars. Sampling field team members are not to handle dead or live oiled animals. Immediately contact the EUL to arrange for oiled wildlife responders to address the issue. (Ref. 5)	☐
10	Place samples into laboratory-provided jars/bottles and seal. Fill the sample to approximately ¾ full if the oil is heavy or weathered. Expansion of the sample should not be a problem if samples are chilled properly. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss.	☐
11	Label jars/bottles immediately with: • sample number or code • sample description (oil, debris, thick slick, film etc.) • time and date (24-hour clock and DD/MM/YYYY) • location (GPS coordinates; place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sample is for legal purposes)	☐
12	Record the above information on a sample log (Form 4 in Appendix F). Reference any photographs taken or other observations on the log. Take photographs throughout the sampling process of: • the sampling area • the sampling site • the sampling jar before the sample is collected • the sampling process • the sample jar with contents and being sealed • the sealed and secured sampling jars in the case • the completed paperwork • the sealed and secured case on completion of the sampling. If samples have been given to a Vessel Master, a photograph should be taken of the samples in the Master's possession. Keep a log of what photographs were taken to assist with compiling the documentation at a later time. (Ref. 5)	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
13	Place samples in a small esky with frozen ice pack. Transfer to refrigerator if possible for storage at 4 °C.	☐
14	Complete Chain of Custody forms (Appendix F)	☐
15	Send samples to the laboratory as soon as possible (within 24 to 48 hours if possible). Preservation techniques and sample holding times are listed in Appendix E.	☐

4.6 Reporting

- All data collected is to be analysed within the Planning Unit to achieve the OPS1 objectives.
- All data collected is to be collated for the Planning Officer for integration into the Incident Action Plan (IAP).
- All data collected is to be made available to the Monitoring Coordinator for initiation of the Scientific Monitoring (if applicable).

4.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS1:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 3 – OPS1: Oil Characterisation – Oil Sampling Form.

5 OPS2: Chemical Dispersant Efficacy Assessment

5.1 Rationale

OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil. Note: This OPS is only for the full-scale efficacy assessment of dispersant and does not cover any laboratory or shipboard (e.g. 'shake jar test') field-testing. CAPL personnel would be likely to conduct Tier 1 Special Monitoring of Applied Response Technologies (SMART) Monitoring Protocol in the first instance. Tier 2 and 3 monitoring will be conducted by external agencies, and will be implemented based on the size and nature of the spill, the effectiveness of Tier 1 monitoring, and the need for more accurate analysis of dispersant efficacy

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Design

5.3.1 Surface Dispersant Application

The SMART protocol is a field tool for monitoring the effectiveness of dispersants. The SMART protocol suggests three tiers of monitoring (Note: the SMART tiers are NOT related to the tiered concept of oil spill response) (Ref. 6) and are described in Table 5-1.

Table 5-1: SMART Protocol for Dispersant Efficacy

Tier	Description
Tier I	This monitoring is usually performed after the 'shake jar test'. If the shake jar test is effective, then a 'test spray' is done before full-scale deployment of dispersant spraying. Tier 1 involves visual monitoring (refer to the Visual Observation Dispersant Monitoring Handbook [Ref. 6]), which gives rapid results until additional resources and equipment are deployed to conduct Tier II and III monitoring.
Tier II	Combines visual monitoring with on-water teams conducting real-time water column monitoring (using the fluorometer) at a single depth and collecting water samples for later analysis.
Tier III	Expands on the Tier 2 water monitoring to meet the information needs of the incident. This may include monitoring at multiple depths (using the fluorometer) and also taking water quality measurements or more extensive water samples.

(Source: Ref. 6)

Note: CAPL personnel would only be required to undertake Tier 1 Monitoring, which includes visual observations only. Tiers 2 and 3 Monitoring will be undertaken by trained and experienced third parties because specialised equipment is required.

The SMART tiers may merge during a response. For example, personnel may monitor at multiple depths without taking samples if no laboratories are available to analyse samples.

The Tier 1 SMART Monitoring Protocol involves visual observation from an aerial or vessel platform (whichever is available) to determine whether applying dispersant to the spill appears effective. Table 5-2 lists some of the advantages and disadvantages for each platform.

Table 5-2: Suitable Platforms for Tier 1 Visual Monitoring: Advantages and Disadvantages

Platform	Advantages	Disadvantages
Fixed installation or vessel	• Assets are relatively readily available	• Using a vessel or installation to survey from provides a very limited field of view
Fixed-wing aircraft	• Faster transit times than a helicopter • Longer endurance than a helicopter • Less expensive than a helicopter • More seats available than on a helicopter (per unit cost) • More readily available	• Depending on position in aircraft, view could be obstructed
Helicopter	• More manoeuvrable than fixed-wing aircraft • Fly slower and able to loiter, unlike fixed-wing aircraft • Ability to land 'off airport' • Unobstructed visibility	• Short endurance

(Source: Ref. 6)

5.3.2 Subsea Dispersant Monitoring

Subsea dispersant injection is an effective and efficient response option; however, some of the oil may still rise to the surface and therefore the SMART Monitoring Protocol will continue to be used in conjunction with subsea dispersant monitoring methods.

Subsea dispersant application and monitoring will be undertaken by third-party support agencies with expertise in this response method. Development of the subsea dispersants monitoring plan will be undertaken in consultation with Chevron Corporation Worldwide Emergency Response Resources. The subsea dispersants monitoring program must align with the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7).

Subsea dispersant monitoring will include these monitoring 'phases':

- Phase 1: Assessment of subsea dispersant effectiveness and reduction in surface VOCs
- Phase 2: Characterisation of dispersed oil concentrations in the water column
- Phase 3: Assessment of potential for ecological effects.

Phases 2 and 3 will follow the methods outlined in the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7). Phase 3 will rely on data obtained in OPS1 and OPS3. The ecological effects will be assessed by comparing water quality data obtained in these operational monitoring components (including, but not limited to, total petroleum hydrocarbons [TPH] and dissolved oxygen [DO]) to toxicity benchmarks, which, when combined with the distribution of sensitive of receptors and forecast oil movement, will be used to determine the extent of any adverse environmental effects of using subsea dispersants versus leaving oil to disperse naturally. This information will be fed into an operational NEBA assessment used for decision-making regarding the continuation or termination of subsea dispersant use.

Initially, the hydrocarbon plus dispersant ecotoxicity benchmark will be based on:

- Lethal concentration for 50% of the test species (LC50) = 10 ppm TPH
- No Observed Effect Concentration (NOEC) = 1 ppm TPH.

Threshold data sourced from the United States Environmental Protection Agency (Ref. 27).

The benchmarks are based on best-available literature and may be updated if new information becomes available. Note: These benchmarks will only inform the area/receptors likely to be impacted under different response scenarios (and inform NEBA) and will not trigger a termination of subsea dispersant injection.

During an uncontrolled release, toxicity testing of hydrocarbons and/or hydrocarbons plus dispersants will be used to validate assumptions made when determining literature-based toxicity benchmarks, or to refine these benchmarks where appropriate.

Measurements of DO will be assessed against an ecotoxicity benchmark of:

- 4.6 mg/L, which corresponds to a 90% species protection
- median lethal oxygen concentrations for 50% of species (LC50) = 2mg/L.

Data sourced from Vaquer-Sunyer and Duarte (Ref. 28).

Note: DO concentrations naturally vary with depth and may occur below 4.6 mg/L, typically in mid-water (mesopelagic zone) environments (e.g. at depths ~300–500 m [Ref. 29]). Therefore, in an Operational NEBA assessment, DO concentrations measured at a potential impact zone would need to be considered against natural DO concentrations (e.g. using controls or available literature) when determining adverse environmental effects.

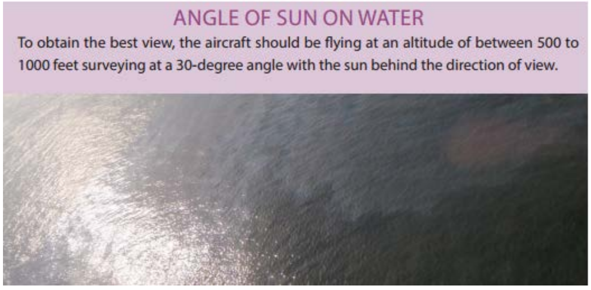
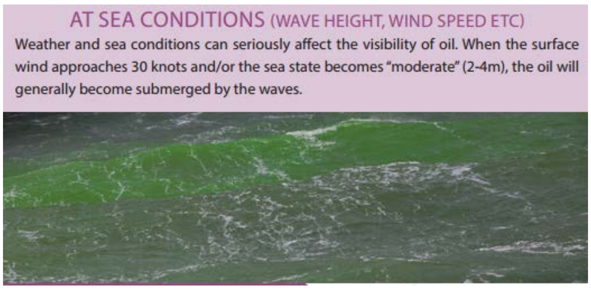
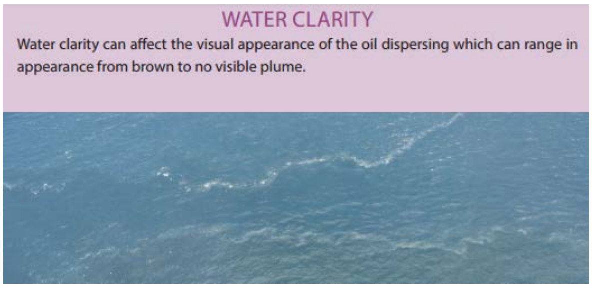
5.4 Resources

5.4.1 Tier 1 Surface Dispersant Efficacy Monitoring

Item (per team)	Check
Sampling platform (vessels must be in survey for commercial use)	☐
Specialist sampling team (2 to 3 people) – if using CAPL personnel, one or more Oil Spill Offshore Specialists should be included in this team	☐
Digital camera and/or video recorder	☐
Handheld GPS	☐
Compass (may be useful to orientate when in flight)	☐
Spare batteries	☐
A method of communication with the crew (vessel/aircraft, including spray vessels/aircraft)	☐
Stopwatch	☐
High-visibility jacket/vest may be required on the airfield (once in flight, remove to minimise glare; it is also advisable to wear clothes that are dark or neutral in colour)	☐
Form 5 (Surface Dispersant Monitoring Form) and Form 6 (Visual Dispersant Monitoring Form) in Appendix F	☐

(Source: Ref. 6)

5.5 Standard Operating Procedures – Tier 1 Surface Dispersant Efficacy Monitoring

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Receive tasking information. This information may be provided verbally or on a form, and include the purpose of the mission (e.g. to determine through visual observation whether dispersant application appears to be effective or not). Although this seems like a relatively straightforward task, several factors or natural phenomena may confuse the pictures at monitoring sites such as: • Angle of the sun on water  • Weather  • Sea state  • Water clarity  • Dispersant dosage rates • Time between application and monitoring
2.	Conduct a pre-mission briefing to provide operational details, such as: • location of the area of operation

<table>
<tr><th>No.</th><th>SOP – Field Sampling for Oil in Subtidal Water Assessment</th></tr>
<tr><td></td><td>

- objective of the flight
- roles and responsibilities of each of the survey crew
- radio frequencies used in the area and on the response
- call signs of other aircraft that are operating in the vicinity
- locations of any temporary or permanent exclusion zones
- health and safety points of note for the vessel or aircraft being used

</td></tr>
<tr><td colspan="2">NOTE: Wherever possible, and as soon as it can be made available, fluorometry and/or particle analysis should be used in support of the Tier 1 observation. This equipment can help quantify the effectiveness of the spray operation by determining whether the ratio or amount of suspended oil particles in the water column has increased significantly following dispersant application. Expert external personnel will undertake this monitoring as per the Tier II and III SMART Monitoring Protocol.</td></tr>
<tr><td colspan="2">Conduct Visual Dispersant Effectiveness Monitoring</td></tr>
<tr><td>3.</td><td>

Record all observations on the Visual Dispersant Observers Log Form (Form 6 of Appendix F)

OIL APPEARANCE POST DISPERSANT APPLICATION

Described as '3' on the Visual Dispersant Observers Log Form.

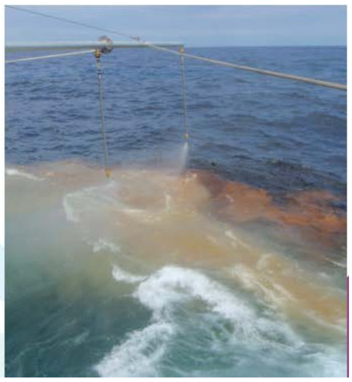
Indications of effective dispersant operations

Visual indicators that show the dispersant is effective:

- yellow/coffee/grey colour plume present in the water (the exact colour will vary with original colour of the oil)
- oil spill surface area reduced
- oil rapidly disappearing from the surface
- oil in some areas being dispersed to leave only sheen on the surface.

NOTE: Colour changes may not been seen immediately; allow time (e.g. 10 to 40 minutes) for dispersion to occur, particularly for more viscous oils.





Indications of ineffective dispersant operations

OIL APPEARANCE POST DISPERSANT APPLICATION

Described as '1' on the Visual Dispersant Observers Log Form.

A milky white plume will be present if:

- too much dispersant is applied (overdosing)
- there is poor targeting of the spill area
- if the spilt oil is heavy or emulsified, the dispersant may not penetrate the oil running off into the unoiled water
- dispersant is washed off the black oil as a white, watery solution leaving oil on the surface
- quantity of oil on the sea surface is not altered by dispersant

</td></tr>
</table>

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment

Applying too little dispersant (underdosing) will make the spray run ineffective and there will be no visible effect on the oil other than possibly temporary herding.

Underdosing is recognisable through:

- some surface activity (oil appearance altered)
- droplets of oil seen rapidly rising back to the sea surface, but overall quantity appears to be similar to that before dispersant spraying.

OIL APPEARANCE POST DISPERSANT APPLICATION

Described as '2' on the Visual Dispersant Observers Log Form.

Oil will remain on the sea surface in its normal state. Careful observations must be made as the effect from a bow wave and herding of the dispersant may be misleading and give false impressions (negative or positive) of effective application.

False Negatives: Where it is wrongly concluded that little or no dispersion is occurring.

DISPERSED PLUME UNDER REMAINING SLICK

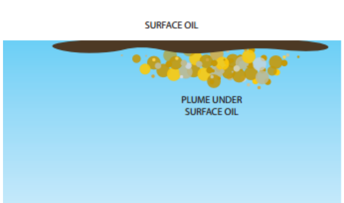
The dispersed oil plume may be hidden by the remaining surface oil giving the impression that the dispersant application has no effect. This is unlikely to persist for any prolonged period.

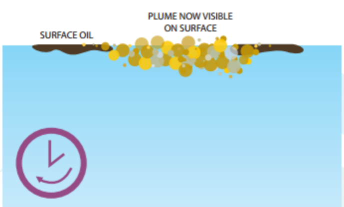
DISPERSED PLUME REQUIRES TIME TO FULLY DEVELOP

It may be several hours after the application of dispersant before it begins to be visibly effective. If emulsification occurs a visible plume may not be present, although the emulsion may be seen to "break" (turn from a thick chocolate mousse consistency to visually darker and less viscous substance).

POOR VISIBILITY CONDITIONS

The dispersed plume is not highly visible and can be obscured by haze or fog.





No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
	False Positives: Where it is wrongly concluded that dispersion is occurring. OIL APPEARANCE POST DISPERSANT APPLICATION Described as '4' on the Visual Dispersant Observers Log Form.  HERDING The oil is displaced by the dispersant spray/ application platform, resulting in a clear patch behind the vessel or aircraft. This occurs predominantly in the case of oil sheens being sprayed by dispersants and results in little oil being dispersed.   LACING This appears as a sheen of oil with holes in it. The holes are caused by small drops of dispersant resulting in small scale herding. The 'lace' is usually visible only from the surface and not from the air. 

(Source: Ref. 6)

Key points

- Ideally aerial support is needed to help locate areas near the spill that will be targeted for chemical dispersant and areas that are clear of surface oil.
- Ensure that the oil thickness, oil condition etc. are recorded by the Aerial Surveillance Specialists as per the Bonn Agreement Oil Appearance Code.
- The dispersant may take 10 to 40 minutes to affect the oil and may continue working for up to an hour afterwards.
- Communication with the dispersant application platform is essential to ensure that the monitoring vessel is positioned in the correct location.
- Record data using:
- GPS with waypoints (to mark positions of dispersant application)
- photographs (ideally georeferenced) for all stages of monitoring
- Visual Dispersant Monitoring Observer Log (Form 6 of Appendix F)

(Source: Ref. 6)

5.6 Reporting

Report (to incident command):

- unit/individual log

- location of the dispersant application (use a GPS to record the latitude and longitude)
- degree of weathering and thickness of the oil before dispersant application
- weather and sea state (dispersants require a degree of turbulence to promote mixing with the oil, although this can be created using the wake of a vessel)
- method of dispersant application
- time when dispersant was applied and time when any notable chemical dispersion was observed
- anything that has been or may be impacted by the oil or dispersant application such as marine mammals, fish coral reefs, etc.

5.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS2:

- Form 5: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
- Form 6: Visual Dispersant Monitoring Observer Log.

6 OPS3: Oil in Water Assessment

6.1 Rationale

OPS3 provides the EMT with ongoing information on the water quality, in particular the distribution of oil in the water column, within the response areas. This information will help verify MES predictions and data.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be confirmed before field sampling starts, as per the OSMP (Ref. 1). Ongoing sampling during operational monitoring will also use these sample collection methods.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations; this is determined by the Operational Monitoring Officer in the design of the monitoring program.
- For intertidal monitoring, sediment (OPS4) and water quality samples (OPS3) should be taken concurrently.
- Water quality monitoring will involve taking water samples for laboratory analysis, and recording in situ physical water quality parameters using a water quality probe. The physical water quality parameters will also feed into OPS1 to allow determination of oil behaviour in ambient water conditions. A defined sampling strategy must be in place before conducting fieldwork. The objective of water quality monitoring will be determined based on the nature of the spill and may include sampling reference sites, delineating the extent of hydrocarbons in water, determining the maximum concentration of

hydrocarbons in water, or determining the change in hydrocarbon concentrations over time.

- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics.
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.
- Plan the number of areas and samples to be collected at each area, taking into account level of effort, potential logistical limitations, weather conditions, and other issues that may compromise sample integrity.
- The number of sampling locations and number of sites per location needed will be determined based on the sampling objectives.
- For water samples, sampling 'areas' can be defined as:
  - waterbodies with defined boundaries (such as lagoons, bays, or river mouths)
  - distances downcurrent from the release site (such as 0–5 km, 5–10 km)
  - waterbodies expected to have similar oil exposure based on observations or models (particularly plume models).
- Depending on the water depth, water samples may need to be collected at different depths. Generally, near-surface samples should be prioritised if the sampling effort is limited by logistics or other factors. In shallower water (<5 m), samples should be collected at just one near-surface depth. (Note: Do not exceed the depth rating of the instrumentation).
- Contact the laboratories that will be receiving field samples for analysis and confirm they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- The sample volume required, along with the container type and required analysis, is listed in Appendix E
- Shoreline visualisation tools (e.g. GIS maps, satellite images, Oil Spill Response Atlas [OSRA; Ref. 30]) should be used to develop a sampling strategy and estimate distances, number of sampling sites, intertidal zone width, etc. before going into the field. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- Consult appropriate OPS guidelines (such as OPS4: Oil in Sediment or OPS1: Oil Characterisation) for the concurrent collection of other environmental media and biota when water sampling. If observed during water sampling, tar balls, sheens, or other oil residues can be collected opportunistically for chemical analysis and fingerprinting.
- The number of sampling locations and sites should be determined based on the nature of the spill. As a minimum, three sampling sites per location should

be used. In addition, at least one triplicate sample (three complete samples) should be taken at a minimum of one site per location.

(Source: Ref. 20)

Table 6-1 summarises the monitoring to be undertaken for each location. Water quality physical parameters only need to be recorded once per location, while hydrocarbon analysis should be undertaken at each site within a location. For a complete list of analysis, including sample volume, containers, and holding times, refer to Appendix E.

Table 6-1: Summary of Oil in Water Assessment Monitoring to be Undertaken in the Event of an Offshore Hydrocarbon Spill

Monitoring Component	Parameter	Location	Survey Method
Water Quality	Physical parameters: • salinity • temperature • DO • pH • total dissolved solids (TDS)	Subtidal	Probe
	Hydrocarbons: • Total recoverable hydrocarbons (TRH) • suites of VOCs and semi-volatile organic compounds (SVOCs)—SVOCs include polycyclic aromatic hydrocarbons (PAHs), phenols, phthalates, and chlorinated hydrocarbons • benzene, toluene, ethyl benzene and, xylenes (BTEX)	Subtidal and offshore	Niskin bottles
		Intertidal	Manual bucket or grab pole

6.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

6.5 Standard Operating Procedures – Field Sampling for Oil in Water Assessment

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an ‘actual’ GPS location to mark the sampled location
Survey physicochemical parameters	
4.	Prepare the water quality probe (e.g. YSI 6600 v2) for use, including battery check and calibration
5.	Holding the display, lower the probe into the water

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
6.	Position the probe end near the bottom (0.5 m above sediment) for the first reading
7.	Wait for the reading on the display to stop changing rapidly (1 minute) and record a reading for each of these parameters: salinity, temperature, DO, pH, and turbidity
8.	Raise the probe to 0.5 m below the surface level for another reading
9.	Wait for display to equalise (1 minute) and record a reading for each of these parameters: salinity, temperature, pH, and turbidity
10.	Sample at only one site per location unless the water seems highly variable
11.	At each subsequent location, triple-rinse all equipment submersed in water with site water before sampling
Collect water samples for laboratory analysis	
12.	Place vessel in neutral to avoid contaminating samples with hydrocarbons from the vessel's exhaust
13.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • depth of sample • time of collection • collector's name
14.	For sampling at depth, thread a Niskin bottle onto a hydrographic line following the instruction manual for the device
15.	Ensure that stoppers on both ends of the bottle are held open and that the release mechanism works before deploying overboard. Ensure the weight used to trigger the stoppers to close on the bottle is manually held on board around the tether
16.	Using measurements on the line to guide the depth of the bottle, lower the bottle using the tether until the bottle is at the desired depth
17.	When the bottle is at the correct depth, straighten the line and then drop the weight straight down the line to trigger the stoppers of the bottle to close
18.	Retrieve the bottle using the line and neatly coiling the tether as it comes on board
19.	Once the bottle is on board, rinse the glass laboratory bottle to ensure all surfaces are washed. Empty bottle. Rinse three times.
20.	Once rinsed, fill the laboratory bottle with sample water
21.	Complete the sample collection data sheet/Chain of Custody forms (see Appendix F)
22.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
23.	At one site per location, collect at least one triplicate (three complete samples)
24.	Sample at least three sites per location
25.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C)
26.	Once finished at the site, store the equipment safely and move to next site
27.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
28.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

No.	SOP – Field Sampling for Oil in Intertidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an 'actual' GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)
Collect water samples for laboratory analysis	
4.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • time of collection • collector's name
5.	Using a decontaminated bucket, wade in and carefully collect water from a depth of about 0.5 m (within the zone between low and high tides), then transfer the bucket to the beach
6.	Rinse the glass laboratory bottle/s to ensure all surfaces are washed. Empty bottle. Rinse three times.
7.	Once rinsed, fill the laboratory bottle with sample water and ensure there is no debris stopping the thread from sealing tightly
8.	Complete the sample collection data sheet / Chain of Custody forms (see Appendix F)
9.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
10.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C).
11.	Once finished at the site, store equipment safely and move to next site
12.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
13.	Sample at least three sites at each location.
14.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

6.6 Reporting

- Record and report the results to the Monitoring Coordinator for integration into IAP development.
- Record results and handover to the Monitoring Coordinator for initiation of the SMPs (if applicable).

6.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS3:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form

- Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form.

7 OPS4: Oil in Sediment Assessment

7.1 Rationale

OPS4 provides the EMT with ongoing information on the sediment quality, in particular the oil content, within the response areas. This monitoring is undertaken to better design shoreline clean-up methods, determine adverse effects from clean-up (e.g. shoreline washing/mechanical clean-up on shorelines), formulate priorities, and/or measure the effectiveness of clean-up activities.

Key considerations for oil in sediment assessment:

- oil may enter intertidal/subtidal sediment
- oiled sediment may release oil over time
- sediment often contains sensitivities of high value (biological, human uses, cultural, commercial)
- sediment is susceptible to oil impacts
- sediment may be directly impacted by response actions (e.g. shoreline washing operations including sediment reworking, high- and/or low-pressure washing).

CAPL personnel are likely to conduct surface and intertidal sediment sampling; however, offshore sediment monitoring will be performed by external agencies. This Section provides guidance for internal and external monitoring teams.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be influenced by the nature and scale of the spill and will be confirmed before field sampling starts, as per the OSMP (Ref. 1).

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, consider these points:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations.
- Sediment (OPS4) and water quality (OPS3) samples should be taken concurrently.
- The analytical parameters for sediment, along with the sample volume, container types, and holding times are listed in Appendix E.
- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.

Determining the survey method depends on the purpose of the survey. The AMSA Oil Spill Monitoring Handbook (Ref. 4) is used to provide guidance on the selection of survey methods. Figure 7-1 shows the decision tree for four onshore sediment sampling methods and Figure 7-2 is a copy of Methods S.8.1 to S.8.4, as outlined in the AMSA Oil Spill Monitoring Handbook (Ref. 4). Figure 7-3 lists subsurface sediment sampling guidelines from the Handbook (Ref. 4).

These guidelines can be used by the Operational Monitoring Officer when designing an appropriate operational monitoring program for subsurface and intertidal sediment sampling.

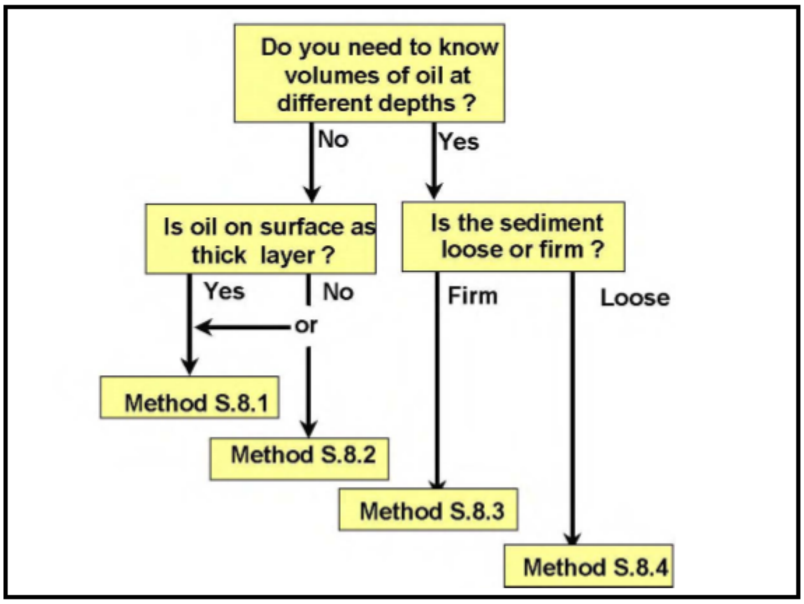


Figure 7-1: Selection of Sediment Sampling Methods

(Source: Ref. 4)

GUIDELINE FOR OBTAINING SEDIMENT SAMPLES	S.8

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for obtaining sediment samples.

Methodology

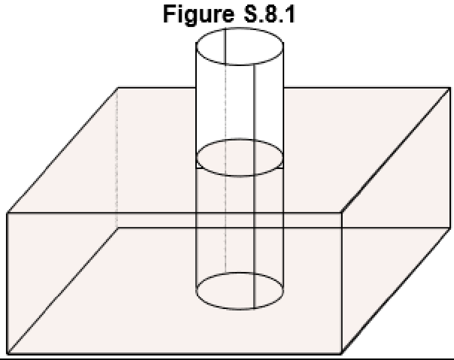
S.8.1 Push Core Sampling A

This method of sampling involves pushing a clean plastic tube down into the substrate and extracting a column, or "core" of sediment. It is suitable for most sediment conditions, but particularly when:

- *Oil is present on the surface as a thin layer (coat, stain, film).*
- *Oil penetrated to a fairly shallow depth (e.g. < 10 cm).*
- *Accurate measures of the amount of oil at various depths are not needed*

1	Push plastic tube into sediment. Generally the depth of sampling should not be more than two thirds of the length of the tube.
2	Seal the top of the tube and extract. A gentle gyration may be applied to facilitate this but avoid bending the tube.
3	If the sediment is wet or loose, or does not stick to the inside of the tube when extracted, it may be necessary to dig down beside the tube and block the bottom opening before removing the tube from the sediment. Alternately sealing the top of the tube with a bung can facilitate extraction of the core.
4	The core of sediment should be transferred immediately to a clean glass container.

Figure S.8.1



Equipment

The sampling tube can be constructed from a piece of PVC tubing. This should be split along its length so that it can be pulled apart and the core easily removed. The tube diameter should be about 5 cm (2"), giving a surface area of about 20 cm^2 and a core volume of 200 cm^3 for a 10 cm deep sample. Tubes should be cut to at least 30 cm lengths.

S.8.2 Push Core Sampling B

This method is essentially the same as Method 1, but is used when it is necessary to differentiate between surface oil and subsurface oil. This may be needed if attempting to determine, for example:

- *The amount of oil that could be removed by tidal action (i.e. surface oil) in low energy shores and oil likely to persist (i.e. subsurface oil).*
- *The rate of degradation of the oil. In this case the presence of relatively large amounts of surface oil could mask any observation of changes in subsurface oil (or visa versa).*

1	Scrape surface oil from a given area prior to pushing in the sampling tube.
2	Transfer this “surface sample” to a clean storage jar and record the area cleaned (square centimetres) and approximate depth of sediment removed (if possible).
3	Proceed as per S.8.1.

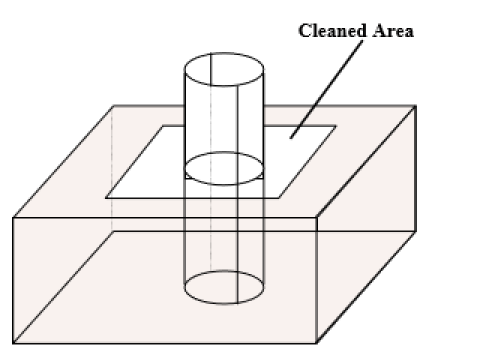


Figure S.8.2

Equipment

	A clean wooden or stainless steel scraper will be required.

S.8.3 Sediment Block Extraction

This method of sampling is used when an accurate measure of the amount of oil at various depths is needed. It is useful only for firm, and preferably dry, sediments. The method can be modified for wet consolidated sediments but some hydrocarbons will be lost with water draining from the samples.

1	If fluid oil is present on the surface it should be removed by scraping the oil from a measured area of sediment. This area should be slightly more than a 30 cm x 30 cm square.
2	With a flat spade, make a “U” shaped cut into the mud. The depth should be no more than 30cm (spade blade depth).
3	Place the spade in the bottom cut (base of the "U" shape) and lever up the block of sediment. Note a wedge may need to be cut below the base of the "U" and a pivot object used to facilitate the leverage.
4	The open edge of the "U" should break free. This is the uncontaminated edge of the core. Because this side has not been cut, no oil has been pushed along it from the surface, i.e. it is uncontaminated.

5	Samples from various depths can be taken by slicing into the back from this open edge. Care should be taken not to sample close to the three cut (contaminated) sides
6	Note: If water percolates down the core, the core can be laid on its side so that water, and associated oil, drains along the core gradient not down the gradient.
7	Place sediment samples into labelled clean jars.

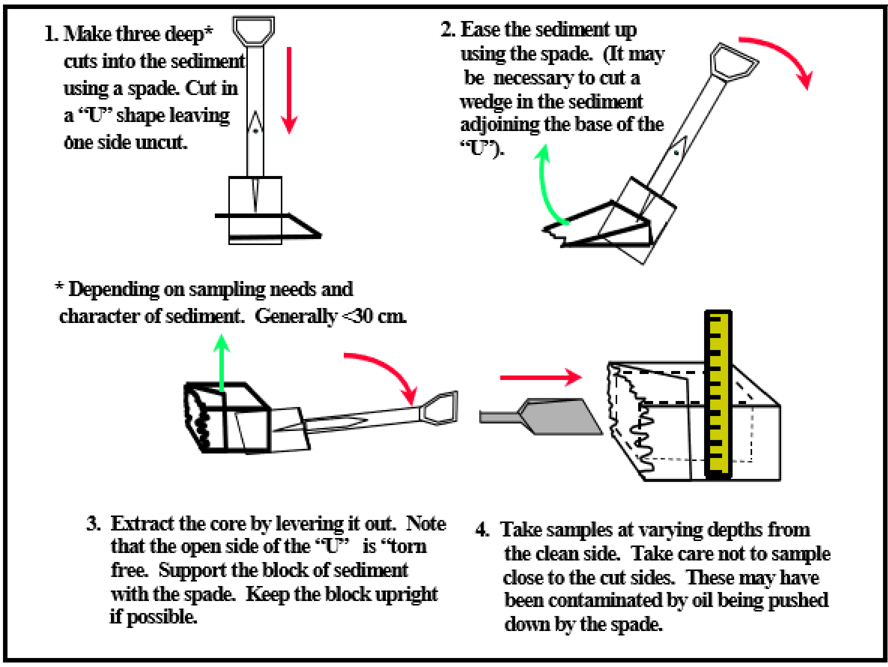


Figure S.8.3

S.8.4 Loose Sediment Extraction	
This method can be used in loose sediments such as gravel, pebbles or wet muds, where, if Method 2 is used, the core of sediment would likely collapse. It can also be used when or where the sediment particle size is too large for Method S7.1, S7.2 or S7.3.	
1	A metal perimeter is pushed into the sediment (surface oil can be left or removed as per earlier methods).
2	Sediment is then removed from inside the perimeter. This can be done as a composite sample, or layer by layer, depending on whether data from different depths are required.
3	The perimeter prevents the sides of the excavated pit from collapsing and contaminating lower sediment layers with upper sediments, and also limits the seepage of oily water or liquid oil from the upper layers of sediment.
4	The size of the perimeter should be large enough to allow an adequate working area, but not require the removal of too much sediment. A 30 cm x 30 cm square should Suffice.

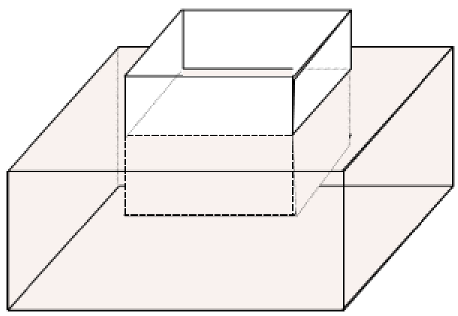


Figure S.8.4

Figure 7-2: Onshore Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR SAMPLING OF SEABED SEDIMENTS	M.9

Rationale

Oil can become incorporated into offshore sediments through natural processes or due to shoreline cleanup methods. If this accumulates to a significant extent then alternative cleanup strategies may be required. This monitoring method is usually only required in shallow waters. Grab Samplers or Drop Corers can be used. The former are suitable for the wider set of sediments and sea conditions. Sample handling is also easier. Sample volume should be consistent between sites and surveys to allow cross comparison.

Methodology

1	Determine the number of samples required. Consider:		
	1.1	Area of possible contamination.	
	1.2	Currents.	
2	Decide platform to sample from (response/other vessel, shoreline). Vessels should:		
	2.1	Be suited to expected weather and other safety considerations (staff training and experience).	
	2.2	Be stable and suitable for expected water depths and sea states.	
	2.3	Provide adequate deck space (vessel should be > 5m).	
	2.4	Have shelter (e.g closed cabin).	
	2.5	Be equipped with communications, GPS and life preservation equipment.	
	2.6	Comply with state boating regulations re safety equipment.	
3	Obtain sampling kits or supplies:		
	3.1	Sample jars (250 ml or other larger size if biological samples are to be taken). Pre cleaned, teflon or aluminium cap or alfoil barrier.	As Required
	3.2	Tape (for sealing jars). 2cm wide.	2
	3.3	Plastic sheeting	>1/sample
	3.4	Sampling equipment (grab or corer: see 5) Note: if biological samples are to be taken samples should be at least 10 cm depth and have a minimum surface area of at least 125 square centimetres	
	3.5	Disposable gloves	
	3.6	Sample identification labels.	
	3.7	Sorbent padding for storage cooler.	
	3.8	Sample Log Sheets.	
	3.9	Sample storage coolers with pre-frozen freezer blocks.	
	3.10	Chain of Custody Forms.	
	3.11	Waterproof plastic envelopes (for forms).	
	3.12	Decontamination equipment (Guideline G.2).	
4	Samplers should be deployed in clean water, not through surface oil. A perimeter may be used to keep the surface clean (see Guideline 7).		

<table>
<tr><td colspan="5">M.9 Methodology Continued</td></tr>
<tr><td>5</td><td colspan="4">Obtain samples:</td></tr>
<tr><td></td><td>5.1</td><td colspan="3">Grab Sampler: Spring loaded (see Figure M.9.1):</td></tr>
<tr><td></td><td></td><td>5.1.1</td><td colspan="2">Lower the grab at a slow, constant speed (about 0.3m/second) to avoid prematurely triggering the grab.</td></tr>
<tr><td></td><td></td><td>5.1.2</td><td colspan="2">Once the seafloor is hit and the grab is triggered, recover the grab slowly.</td></tr>
<tr><td></td><td></td><td>5.1.3</td><td>If sediments are muddy, the grab may be cleaned in surface waters prior to bringing it on deck (Note: This should <u>not</u> be done if surface waters that may be oily).</td><td rowspan="5">
Figure M.9.1 Example of Spring-loaded Grab Sampler
(Photo: Cawthron Inst.)</td></tr>
<tr><td></td><td></td><td>5.1.4</td><td>The Grab Sampler should be opened over a sheet of plastic (but <u>not</u> emptied onto it).</td></tr>
<tr><td></td><td></td><td>5.1.5</td><td>Debris such as seagrass or algae should be separated from the sediment. The presence of this should be logged.</td></tr>
<tr><td></td><td></td><td>5.1.6</td><td>Note: This seagrass and algal material may be required for analysis, e.g. for the presence of entrained oil.</td></tr>
<tr><td></td><td></td><td>5.1.7</td><td>Sediment samples should be removed from the centre of the grab sample (i.e. away from the sides) using clean spatulas or scoop, and placed in clean jars.</td></tr>
<tr><td></td><td></td><td>5.1.8</td><td colspan="2">Label jars with location, water depth, time and date, description.</td></tr>
<tr><td></td><td></td><td>5.1.9</td><td colspan="2">Place unused sediment in bin.</td></tr>
<tr><td></td><td></td><td>5.9.10</td><td colspan="2">Wash Grab Sampler in the sea, then distilled water. (see Guideline G.2).</td></tr>
</table>

<table>
<tr><td colspan="5">M.9 Methodology Continued</td></tr>
<tr><td rowspan="8">5</td><td rowspan="7">5.2</td><td colspan="3">Drop Core Sampler:</td></tr>
<tr><td>5.2.1</td><td>Lower Corer, avoiding twisting of lines. Allow Corer to “free fall” the last 5-6m or so to the seafloor.</td><td rowspan="4"></td></tr>
<tr><td>5.2.2</td><td>Recover Corer at a very slow, regular rate (<0.3 m/second).</td></tr>
<tr><td>5.2.3</td><td>Make sure that the Corer does not strike the side of the vessel.</td></tr>
<tr><td rowspan="2">5.2.4</td><td>Always hold the Corer in a vertical position and seal the ends (with. supplied caps) as soon</td></tr>
<tr><td>as possible Note: The top cap should be clearly marked “TOP” and attached to the correct end of the Corer.</td><td>Figure M.9.1 Deployment of Spring-loaded Grab Sampler
(Photo: Sakhalin Energy Investment Company)</td></tr>
<tr><td>5.2.5</td><td colspan="2">Attach waterproof labels (Tags are easier). Labels should note location, water depth, time and date, description including length of sediment core (samples may settle during transportation).</td></tr>
<tr><td></td><td>5.2.6</td><td colspan="2">Store cores upright.</td></tr>
<tr><td>6</td><td colspan="4">A Sample Log should be maintained (see Guideline G.1).</td></tr>
</table>

Figure 7-3: Subsurface Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

7.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect sediment samples for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (Ref. 36). Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

7.5 Standard Operating Procedures – Field Sampling for Oil in Sediment Assessment

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Pre-work	
1.	Ensure that sufficient sample containers for the analysis being undertaken (as listed in Appendix E), including spare sample containers for ad hoc sampling, are available
2.	Use detergent to wash all equipment that will be used to collect samples and rinse completely with distilled water before use. Equipment to be cleaned includes spatulas, mixing bowls, grabs, etc.
3.	Navigate to site
4.	Use GPS to navigate the team as close to the proposed site as possible
5.	Take an ‘actual’ GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Collect sediment samples **(This SOP may be amended [using guidelines from Figure 7-2 and Figure 7-3] by the Operational Monitoring Officer depending on the site to be sampled and the nature and scale of the spill)**	
6.	Fill out the label on the laboratory bottle (use a permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. sediment) • date and time of collection • analyses to be conducted (e.g. TPH) • location of samplingcollector's name
7.	Place a quadrat on the ground on the sampling site so that all samples are taken within an area of 1 m^2
8.	Prepare the corer by unclipping the top cap of the cylinder
9.	Push the corer into the sediment until the corer is slightly buried, then replace the cap of the cylinder; remove the core from the ground in a vertical motion
10.	Empty the contents of the corer into a Pyrex bowl using Teflon-coated spoons
11.	Repeat the sediment sample collection five times within the quadrat using the corer to retrieve sediments and place into the Pyrex bowl
12.	Homogenise the sediments from the five cores using Teflon-coated spoons until the colour and texture is uniform; however, limit mixing to avoid oxygenation
13.	Fill the labelled jar completely with soil/sediment, then replace the cap making sure the cap cover is tightly sealed
14.	Complete the sample collection data sheet / Chain of Custody forms (Appendix F)
15.	Place the sample in a small esky with ice bricks to maintain a temperature of 4 °C
16.	Return excess sediment to the sea immediately after completing the process
17	Use a field sheet to record activities (see Form 8 in Appendix F)
18.	Once finished at the site, store the equipment safely and move to next site
19.	In each location, sample a minimum of three sites, including one triplicate
20.	At each subsequent site, triple-rinse all equipment submersed in water with distilled water before sampling
21.	Send samples to the laboratory as soon as practicable and within the applicable holding times (see Appendix E for holding times)

7.6 Reporting

- Provide results to the EUL for analysis and integration into IAP development.
- Collate results for use by the Monitoring Coordinator for initiation of the SMPs (if applicable) and overall response impact tracking by the Planning Section Chief.

7.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS4.

- Form 1 – Chain of Custody Form
- Form 3 – Freight Consignment Form
- Form 7 – OPS4: Oil in Sediment Assessment Form.

8 OPS5: Rapid (Oiled) Shoreline Assessment

8.1 Rationale

OPS5 provides the EMT with ongoing information as to the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed to the spill. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone. CAPL personnel trained in oiled shoreline assessment will likely undertake OPS5.

The priority for rapidly gathering oiled shoreline data is to enable the operational response. However, consideration should be given to the scientific data requirements, to inform subsequent scientific monitoring plans.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Design

The design of OPS5 requires judgements to be made about scope, methods, data inputs, and outputs that are specific to the incident response. These judgements must balance the operational needs of the response with the logistical and time constraints of gathering and processing information, and the level of certainty needed. Usually there is a need for information to be collected and processed rapidly to suit response needs, with a lower level of sampling and accuracy needed than for scientific purposes.

OPS5 involves two proposed methods for field surveys:

- Reconnaissance surveys: designed as an initial phase (or further as required) to characterise the distribution, extent, and condition of shoreline habitats before exposure
- Continual monitoring surveys: monitors hydrocarbon spill extent at the shoreline to assess the potential impact, extent of actual impact, and the effectiveness of clean-up.

Reconnaissance surveys, combined with physical monitoring, will monitor shoreline biological communities, concentrating on key habitats or species that are indicators of biological community health. The level of detail required for operational monitoring only needs to be sufficient to describe the distribution and extent of habitats, rather than rigorous and comprehensive data on the condition of biological communities. Appropriate community biological indicators for the shoreline habitats at risk for each individual spill will need to be determined during pre-survey planning (see Section 8.3.1). The OPS5 monitoring design will need to consider:

- Monitoring usually needs to cover a large area and results are required quickly, thus the methods need to be efficient, cost-effective, and relayed back to the EMT as quickly as possible to assist in decision-making.
- The number of sampling sites and replication within sampling sites needs to be sufficient to characterise habitats and validate existing data, but the level of data is not required to provide robust data with statistical power for hypothesis testing.

- The focus is on collecting relevant information for spill response decisions on shoreline habitats at risk and identifying response activities to be approved by relevant regulatory agencies (see the relevant OPEP), rather than identifying reference sites or demonstrating baseline conditions.
- Monitoring needs to help predict environmental effects or define resource sensitivity to guide spill response activities.
- Monitoring should define the resource and logistical constraints to sampling.
- Wherever possible, the monitoring methods used will complement information required for subsequent scientific monitoring.

The reconnaissance survey may use various remote sensing (including aerial surveys) and ground survey methods, which can be used independently or collectively. It aims to gather information on the condition and distribution of shoreline habitats so as to inform the assessment of the potential impact and the development of effective spill responses. The reconnaissance survey may also provide preliminary information, data, and guidance for the subsequent scientific monitoring program.

Reconnaissance surveys will be conducted to:

- characterise pre-impact/post-spill distribution, extent, and condition of habitats within the predicted spill area
- validate that the effects of oil from the spill have reached the shoreline; or
- confirm that the spatial area predicted to be impacted in MES trajectory modelling is relevant.

Detailed statistical analysis of the physical, biological, and chemical data is not required. The locations of all sampling sites will be recorded by GPS and linked to electronic and hardcopy monitoring proforma. The georeferenced data from reconnaissance surveys will be used to update ocean current maps of the study area to further identify the current distribution, extent, and condition of shoreline habitats to help predict environmental effects or to define the sensitivity of resources to guide spill response actions.

Remote sensing includes aerial surveillance and a wide range of airborne and satellite technologies (e.g. infrared thermal imaging, side-looking airborne radar, satellite images). Aerial surveillance is a reliable and rapid method for characterising the distribution and extent of habitats within the spill area, and validating oiled shorelines and habitats at risk from the spill. Photos, videos, maps, and verbal feedback all provide basic information that can be used to define information needs and response priorities. Helicopters can be useful in combining aerial surveillance with ground surveys.

Ground surveys allow more detailed observations of shoreline conditions including the physical structure, ecological character, and human use of shorelines. This monitoring approach can provide comprehensive detail on the resources and activities likely to be affected by a spill, the potential extent of oiling and level of impact, likely recovery, and logistical considerations for different response methods. Rapid shoreline survey methods will be determined by the EMT to ensure the priorities relating to the spill response activities are the primary objective of the ground survey.

Physical monitoring will determine how oil will behave over time, the likelihood that the shoreline can be damaged by oil and clean-up activities, and how the shoreline can most effectively be cleaned. The physical character of the shoreline segment will be described in terms of:

- extent of shoreline habitat and segment boundaries
- substrate type and size
- length and width of shoreline
- form: geomorphological type, processes, dimensions, profile, or gradient
- energy: winds, waves (Table 8-1)
- degree of anthropogenic influence
- photographic evidence and observation of access restrictions.

Table 8-1: General Indicators of Shoreline Energy

Energy	Low →						
Substrate	Mud	Sand	Grit	Pebble	Cobble	Boulder	Bedrock
Form	Swamp	Flats		Beach	Reef	Cliff	
Gradient/Slope	Flat	Gentle Slope		Steep Slope		Vertical	

Oiled Wildlife and Dead Fauna

Dead fauna provide essential information for an impact assessment and wider ecological interest. Marine invertebrates, including bivalves, crabs, sea urchins, and starfish that are washed up dead or moribund and discovered ad hoc during surveys should be recorded in terms of the numbers and species, with photographs and at least some representative specimens taken for later analysis. As far as practicable, individual samples will be labelled (including location and date found). If possible, collected individuals will be received and logged on arrival at a central location then deep frozen. Dead specimens will kept for later reference, evidence, or scientific research and natural history collections.

Continual monitoring relies on rapid and frequently repeated surveys to regularly update the EMT on the level of oiling on shorelines during the operational phase and provides information to determine the effectiveness of response operations. Survey The frequency will vary depending on the characteristics of the spill, habitats/species affected, weather and sea state, and rate of clean-up, and is likely to be iterative.

8.3.1 Pre-survey Planning

A rapid review of the hydrocarbon spill response resource tools will be conducted on shoreline habitats that are impacted or at risk of being impacted as determined by MES. Shoreline habitats will be assessed with regards to their sensitivity to impacts from the Tier 3 hydrocarbon spill and accessibility for clean-up operations. Pre-survey planning includes:

- identifying the shoreline segments
- determining the survey requirements.

8.3.1.1 Identifying Shoreline Segments

The area predicted to be impacted will be divided into discrete management areas by the EMT to plan and implement proposed sampling designs, defined as 'segments'. Shoreline segment identification will be undertaken once the spatial scale of the spill and the area required for survey has been identified. Shoreline segments will be defined using these considerations:

- likelihood of hydrocarbon contact on shorelines, as determined in OPS1
- homogeneity of habitats, physical features, and sediment type to assign location identifiers
- length of segment considering the resolution required to detail the distribution of hydrocarbon; as a guide, segments should be between 0.2 km and 2 km long
- practical aspects that can be used by the EMT for deployment of response (i.e. access and staging locations).

The OSRA (Ref. 30) may be useful for reviewing the distribution of sensitive habitats, species, and protected areas. These information sources will be reviewed to help select impact shoreline segments (in high-risk areas where sensitive receptors are found or are of protection or conservation priority) and reference shoreline segments (where potential impacts can be compared against natural conditions). If delineating appropriate segments is difficult because of insufficient information on habitat type and extent, then the information collected during the reconnaissance survey(s) may be used to refine the segments.

8.3.1.2 Determining Survey Requirements

The scale of the spill and the likelihood/consequence of impact with sensitive habitats/species will determine the level of effort required for OPS5. Survey method planning should consider these questions to specify if the proposed survey is 'reasonable' and 'appropriate' in scope, design, and subsequent cost:

- Will the results be sufficient to guide response action (wherever possible), help quantify the specific impacts, and assess the effectiveness of response actions?
- Is the scope of the program, and speed of obtaining results, the minimum necessary to fulfil the stated objectives?

For the operational phase assessment of most shoreline habitats, broad-scale transects (at the segment level) with recording of observations is recommended, combined with digital photograph quadrats captured at fixed intervals along the transect. The photographs will be reviewed as part of a pilot study for the scientific monitoring program SCI3: Coastal and Intertidal Habitat Impact Study, if required. For more densely populated habitats (e.g. mangroves), selective sampling may be more appropriate. The number of replicate sites needed to provide a representation of the area at risk depends on the scale of the individual spill conditions.

8.4 Resources

Item	Check
Oil Spill Assessment team (3 to 4 people per team, including one trained Oil Spill Assessment Specialist)	☐
Transect tape measure	☐
Flags or stake (to mark location of buried oil)	☐
Trowel and/or shovel	☐
Plastic sediment corer	☐
Dumpy level and staff	☐
Tide table(s)	☐
Clipboards (large enough to fix A4 assessment sheets)	☐
Assessment sheets printed on waterproof paper	☐
DoT Field Guide	☐
Species ID sheet	☐
Several pencils	☐
Radio	☐
First aid equipment	☐
GPS (it is essential to note the system the GPS uses [e.g. WGS 84])	☐
Camera (with polarised filter if available)	☐
Aircraft for reconnaissance (if available)	☐
Vessel/vehicle (depending on location)	☐

8.5 Standard Operating Procedures – Field Surveys

No.	SOP – Field Sampling for Aerial Surveys
Pre-work	
1.	Select and commission aircraft. Aircraft should have downward visibility (helicopter/ fixed-wing aircraft with over-fuselage wing), GPS, slow speed, and be suitable for low altitudes (preferably a helicopter)
2.	Assemble equipment
3.	Obtain information on the predicted shoreline impact area
4.	Time the flight to correspond with the low tide (if possible)
5.	Discuss and confirm the flight pan with the pilot
Aerial survey	
6.	Undertake a high-altitude (up to 500 m) rapid flyover of the shoreline to gain an overall perspective of the extent of oiling. Use this to determine: • length of shoreline to be surveyed during the flight • frequency timing of photographs
7.	Conduct a low-altitude, slow-speed survey of the target shoreline
8.	Record data:

No.	SOP – Field Sampling for Aerial Surveys
	• Take video of still photos at a downward angle of 30° to 45°. Note: Unlike aerial surveillance over water it is not always possible to avoid photographing into the sun. A polarising filter may be used to reduce glare, but use of this filter should be recorded on the photographer log • Mark oil distribution on map (shoreline assessment form). Estimate and mark: – tidal position (upper, mid, or lower intertidal) – band width – percentage cover – shoreline substrate • Mark photo locations and direction on the coastal map using an arrow (direction) and number (sequence) • Backup then clear camera memory after each survey
9.	Note: Separate surveys should overlap shoreline lengths by a few hundred metres or should include an obvious feature (e.g. building, headland, rock outcrop) at the start of the next survey
10.	At the end of each survey: • review and copy photos • label and catalogue photos

No.	SOP – Field Sampling for Ground Surveys
Pre-work	
1.	Identify shoreline segments
2.	Conduct JSA
3.	Develop survey objective in conjunction with the EMT and collect resources to undertake the survey
Ground survey	
4.	Complete shoreline assessment form (see AMSA Oil Spill Monitoring Handbook, Guideline S.5 Figure 8-1 and S.2 Figure 8-2 [Ref. 4])
5.	Record presence/absence of any oiled wildlife
6.	Conduct shoreline geomorphology assessment, including beach profiling if required (see AMSA Handbook, Guideline S.3 Figure 8-3 [Ref. 4])
7.	Collate assessment forms and any other supporting information (such as logbooks of notes), then submit to supervisor for data management

GUIDELINE FOR ASSESSMENT OF OILED SHORELINES: SURFACE OIL	S.5

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for describing oil on shoreline Segments (Guideline S.1). The general distribution of oil over large lengths of shoreline is monitored by using modified aerial surveillance procedures (Guideline S.3).

Methodology

1	Divide shoreline into Sectors and Segments (see Guideline S.1)			
2	Record the following shoreline descriptors:			
	2.1	Length	In metres	
	2.2	Width	In metres, from high tide to low tide.	
	2.3	Gradient	In degrees; approximate or as per Guideline S.3	
	2.4	Energy	High, medium or low as suggested by form	
	2.5	Substrate	Mud, sand, pebble etc. as per Guideline S.2	
	2.6	Form (or type)	Cliff, platform cobble beach etc.	
3	For each Segment, draw a sketch map showing the approximate location of the oil.			
4	Record the following parameters for the oily band:			
	4.1	Length	In km for Sectors or total, in m, for Segments. The distance the oily band extends along the shoreline.	
	4.2	Width	In metres. Average width of the oily band within a Segment or Sector. Measured across a beach from high to low elevations.	
	4.3	% Cover	Visual estimate of the percentage of the band (or average of bands). As per Figure below;	

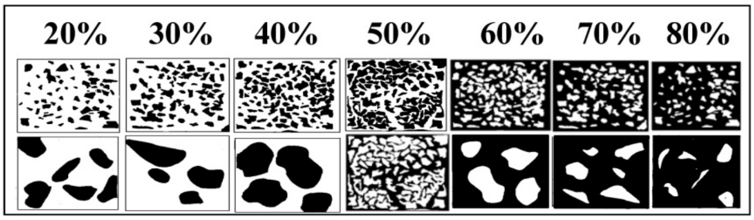


Figure S.5.1

4.4	Oil Thick-ness	Po	Pooled oil. Can be estimated or measured in mm or cm.
		Cv	Cover. In mm, this is measurable (> 1mm thick)
		Ct	Coat. Can be scratched off rock with fingernail. Ct will mask the colour and texture of underlying substrate.
		St	Stain. Cannot be scratched off rock. Texture of substrate is visible through the oil
		Fi/ Sh	Film (Fi) or Sheen (Sh). Transparent. The colour and texture of substrate is visible through the oil
5	If necessary, or requested, classify surface oiling as per Tables overpage.			

Oil Spill Monitoring Handbook

S.5 Methodology Continued

Surface Oil Coverage

	Width of Oiled Band			
% Oil Cover	>6m	3-6m	0.5-3m	<0.5m
51-100	**High**	**High**	**Medium**	**Low**
11-50	**Medium**	**Medium**	**Low**	**Very Low**
1-10	**Low**	**Low**	**Very Low**	**Very Low**
<1	**Very Low**	**Very Low**	**Very Low**	**Very Low**

Surface Oil Classification

	Surface Oil Coverage			
Ave. Thickness	High	Medium	Low	Very Low
Pooled/Thick	**Heavy**	**Heavy**	**Light**	**Light**
Cover (>1mm)	**Heavy**	**Heavy**	**Moderate**	**Light**
Coat	**Moderate**	**Moderate**	**Light**	**Very Light**
Stain/Film	**Light**	**Light**	**Very Light**	**Very Light**

Figure S.5.2

(Source Wardrop 2000 as adapted from Owens & Sergy, 1994)

Note: Use Band Width (W) and % Coverage (%) to determine the surface oil cover, and then use oil Thickness (T) to classify the degree of oiling; the Surface Oil Classification.

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Figure 8-1: Surface Oil Monitoring Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR CHARACTERISING SHORELINE SUBSTRATE	S.2

Rationale

Substrate type (particle size) determines the size of the spaces between particles and this in turn influences the depth to which oil will penetrate, and the ease with which wave action will remove the oil. These considerations are important in determining the need for, and type of, shoreline cleanup.

Methodology

Type	Abbr.	Descriptive Terms	Explanation
Bedrock or Rock	**R**	• Porous/non-porous • Broken/not broken (crevices/no crevices).	Porosity and crevices increase the likely persistence of the oil.
Boulder	**B**	• As above.	>256mm diameter: Larger than a head.
Cobble	**C**	• Porous (e.g. coral, pumice)/non-porous.	64 – 256mm: Fist or brick to head-sized
Pebble	**P**	• Or use “shingle” if flattened.	4 – 64mm: Pen diameter to fist sized.
Granules/ Gravel	**G**	• Rounded/flat. • Compacted/loose.	2 – 4mm diameter.
Sand	**S**	• Fine to coarse.	0.06 – 2mm diameter.
Mud/Silt/ Clay	**M**	• Note organic matter (debris/ fauna/ flora). • Consolidated/loose. • Dry (e.g. mud cliffs).	<0.06mm diameter. Field Test: Mix with water: If it “clouds up” it is silt/mud. If it sinks/clears it is sand.
Earth/ Soil	**E**	• Generally only applicable to cliffs and seawalls.	
Ice	**I**	• Likely only in the Antarctic territories.	
Shellgrit	**Sh**	• Wet/dry.	Usually with sand (Sh/S).
Coral(1)	**Co**	• Rubble/Boulder/ Cobble (e.g. Co-C).	Use to describe dead coral areas, e.g. coral cobble.
Concrete(2)	**Cc**	• Rubble; rip-rap.(2)	Artificial substrates/forms should be described and marked on segment maps.
Wood	**W**	• Debris/logs; pilings.	Debris can overlay other substrates.
Metal	**Mt**	• Pilings, sheeting.	Usually artificial structures.

1. *If corals are live, the shoreline should be described as coral noting its biological character and substrate type.*
2. *The abbreviation “A” can be used to designate artificial structures when they are not otherwise easily described, e.g. A-B would describe artificial boulder shoreline (i.e. rip-rap).*

	Page 1 of 1	S.2

Figure 8-2: Shoreline Assessment Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR DETERMINING BEACH PROFILE (GRADIENT)	S.3

Rationale

Physical cleanup methods can alter the elevation or profile of sand, pebble or cobble beaches. This may lead to erosion of beach or back beach areas. Shoreline profile may need to be monitored during cleanup, particularly if heavy machinery is used.

Methodology

S.3A Use of Marker Stakes

This is the simplest method and is suitable for low energy shores where manual rather than mechanical cleanup is used. It detects changes in sediment distribution but does not allow an accurate profile of the beach to be determined.

1	Hammer wooden or steel stakes into the beach at a number of locations and at various tidal elevations.
2	Measure the distance between the top of each stake and the sediment surface (H in Figure S.3.1).

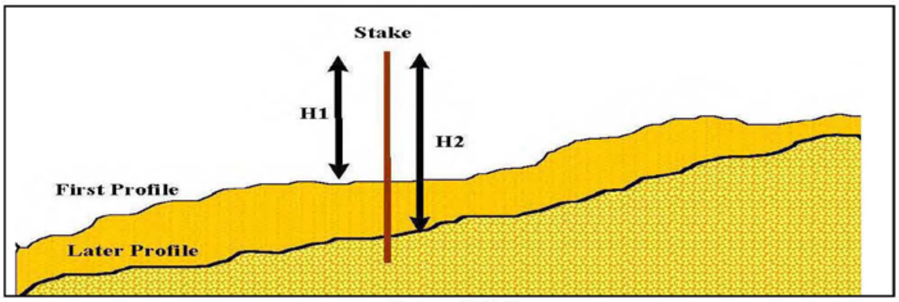

Figure S.3.1

S.3B Pole and Horizon Method 1

This method is suitable for all "soft" sediment shoreline types, i.e. those that allow a stake to be pushed or hammered into the surface.

1	Fix stakes (the "back stakes") along the beach above the high tide mark (i.e. in the Supratidal Zone).
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the top of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The back stake is used to measure changes in sediment height; i.e. changes in the distance between the tape level and the top of the stake (H in Figure S.3.2).
5	This procedure can be repeated at regular intervals along the transect.

S.3B Pole and Horizon Method 1 Continued

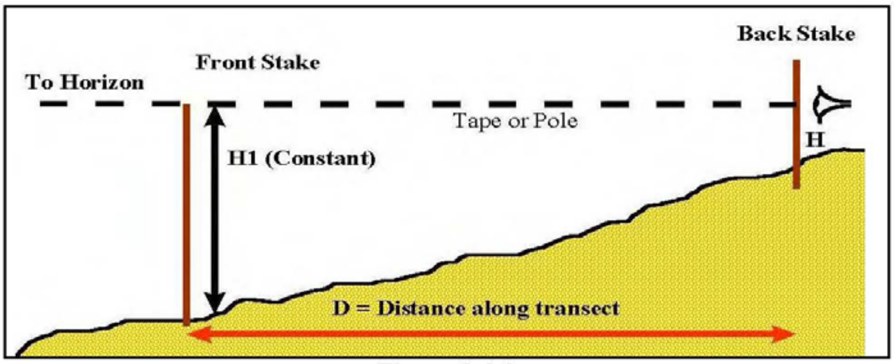

Figure S.3.2

S.3C Pole and Horizon Method 2	
This is similar to Method 2.3B except that it does not require the front stake to be pushed into the surface.	
1	Fix stakes (the "back stakes") along the beach above the high tide mark.
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the <u>top</u> of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The height between the sediment and the tape/pole at the front stake is measured (H1). The drop from the back stake to the front stake is H1-H0 (H0 is the height of the back stake, see Figure S.3.3)
5	This procedure is repeated at various intervals along the transect. Note if the "front stake" is left in place, measurements down-beach can be referenced from this point. This is an advantage if a pole (2-4 metres) is used to align stakes.

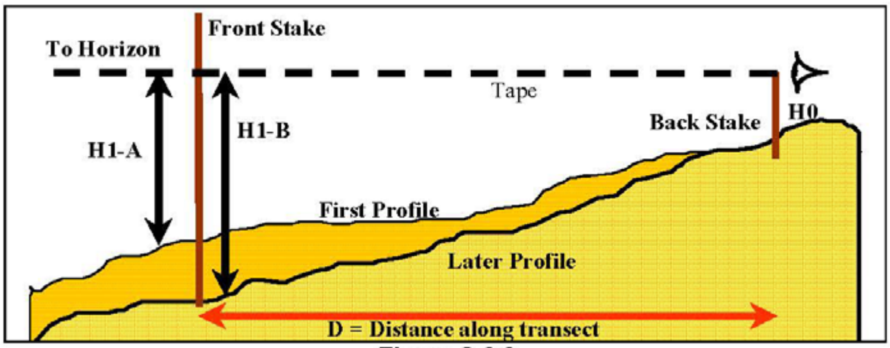

Figure S.3.3

Figure 8-3: Guidelines for Determining Beach Profiles from the AMSA Oil Spill Monitoring Handbook Guideline

(Source: Ref. 4)

8.6 Reporting

- All data on shoreline habitats and spill impacts are to be sent to the EMT each day.

- Results are to be provided to the EUL for analysis and integration into the IAP development.
- Results are to be collated for use by the Monitoring Coordinator to initiate scientific monitoring programs (SCIs) (if applicable) and overall response impact tracking by the Planning Chief.
- All raw data collected should be disseminated into geospatial format for subsequent use in the Emergency Response GeoHouse tool and/or OSRA WMA.
- A final report will be prepared at the completion of the spill response activities, which will include all data collected and its interpretation.

8.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS5:

- Form 9 – OPS5: Rapid (Oiled) Shoreline Assessment Form.

9 OPS6: Rapid Seabird and Shorebird Assessment

9.1 Rationale

OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill. CAPL personnel trained in oiled shoreline assessment will likely undertake the shorebird component of OPS6, at the same time as OPS5 (Rapid Shoreline Assessment).

The objectives of OPS6 are to:

- identify shorebird and seabird populations and habitats at risk from the spill
- undertake a rapid assessment of known shorebird and seabird populations to help determine appropriate management and response actions during the oil spill event so as to manage the potential impacts to, and inform long-term scientific monitoring of, shorebirds and seabirds
- identify appropriate response strategies to minimise threats to shorebirds and seabirds, based on spill characteristics, modelling outcomes, habitats, and quantified shorebirds and seabirds at risk.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Design

Occasionally, the study area may be small enough to comprehensively search the entire area within a reasonable time. However, selective searches may be required if the study area is too large to search it completely within a reasonable time. In such cases, rapid shoreline assessments will use key baseline data on the distinct habitat types and common alongshore distributions of ecologically significant species known to inhabit the area to concentrate the search effort within favoured habitat and known distributions. Priority will be given to areas of known occurrence or favoured habitats of breeding seabirds and shorebirds. However, other areas or habitats will not be completely excluded from survey designs in case relevant information is identified outside areas of known occurrence or favoured habitats.

The operational field study will cover rapid assessments of known breeding colonies for seabirds and important foraging areas for shorebirds to provide single measures of diversity and abundance of birds. The rapid assessments provide important information that will be communicated by the Field Teams to the EMT to mitigate, as far as practicable, impacts from hydrocarbon on the identified locations and bird species. The information from these rapid assessments will inform:

- the shoreline protection efforts
- the oiled wildlife response team
- the scientific monitoring program for seabirds and shorebirds (SCI4 – Shorebird and Seabird Impact Study).

These methods detail how this seabird and migratory shorebird assessment will be implemented for hydrocarbon spills for the Project, as adapted from the Survey Guidelines for Australia's Threatened Birds (Ref. 31):

- aerial and/or vessel-based surveys to verify the presence and abundance of seabirds at identified significant breeding colonies of seabirds within the known and predicted trajectory of the hydrocarbon spill
- aerial, vessel, and/or ground surveys to verify the presence and abundance of shorebirds at identified important foraging areas within the known and predicted trajectory of the hydrocarbon spill
- records of observed oiled or dead seabirds and shorebirds.

The timing and frequency of implementation of the survey activities will be confirmed by the EMT, or delegate. Priority will be given to aerial shoreline assessments because they can capture the most data within the shortest time. Vessel-based and/or aerial surveys may also be used to detect and count pelagic seabirds offshore; however, these surveys will have a lower priority due to their low efficiency in detecting birds.

On-ground shoreline assessments may also be conducted opportunistically with OPS5 – Shoreline Habitat Rapid Assessment. Before implementing the on-ground survey activities, the EMT (or delegate) must ensure that field personnel have the appropriate qualifications (e.g. Fauna Handling), or work under the guidance of those with appropriate qualifications, to capture and respond to oiled birds in the field.

Operational activities and surveys on shorelines may disrupt the breeding cycles of birds if not conducted with adequate care. However, the option to disrupt and shift the colony will be considered during operational planning as a potential strategy to minimise threats of hydrocarbon impacts on migratory shorebirds and seabirds.

9.4 Resources

The specific skills required to complete this OPS are:

- shorebird and seabird observers with appropriate experience in:
  - shorebird and seabird identification
  - familiarity with shorebird and seabird behaviour
  - familiarity with shorebird and seabird associated habitats
- oiled wildlife responders with appropriate experience in:
  - oiled wildlife response
  - fauna handling
  - fauna euthanasia.

Item	Check
Assessment team (3 to 4 people), including one trained Fauna Handler and/or one trained Oiled Wildlife Responder	☐
Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration	☐

Item	Check
Field guides to help identify shorebirds	☐
Notepad and pen	☐
Handheld GPS	☐
Binoculars, ideally 8x30 to 10x50 i(smaller or larger binoculars are inappropriate for bird watching)	☐
Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification	☐
Logbook/observation sheets	☐
Measurement tools	☐
Gloves	☐
Refrigerator or eskies with ice	☐
Sample bags	☐
Camera	☐
Aircraft for reconnaissance	☐
Vessel/vehicle (depending on location)	☐

9.5 Standard Operating Procedure – Shorebird and Seabird Rapid Assessment Surveys

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
Vessel-based survey techniques *		**Aerial survey techniques**
Pre-work		
1.	Use MES to establish the boundaries of the study area. Once priority areas for monitoring are determined, gather background information on the study area (including habitat type and ecologically significant birds known to occur there).	
	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification.	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Selected to maximise ease of detecting and identifying birds detection and minimise the risk of colliding with ground structure of airborne birds (Ref. 8)
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Bird observations:	Bird observations:

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
	Vessel-based survey techniques *	**Aerial survey techniques**
	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables, as far as practicable, including location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)	Record other variables, as far as practicable, including location, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas
10.	Record the presence of other vessels within the survey area, as these vessels may affect the behaviour of the birds	Record the presence of vessels or other aircraft within the survey area, as they may affect the behaviour of the birds
11.	Count individuals following the vessel only once	

** Note: Access to a dedicated vessel for seabird surveys may not be possible in the event of a spill. However, data on seabirds may be gathered opportunistically on board a response vessel working in the spill area.*

9.5.1 Shoreline Surveys

Shoreline surveys are effective for detecting the presence and abundance of many breeding shorebird and seabird species. The rapid surveys undertaken for this program will examine shoreline plots of predetermined sizes based on information obtained from MES. The rapid surveys will include known seabird breeding colonies and shorebird foraging sites to confirm the presence of bird aggregations, and will be undertaken at islands identified and prioritised to be at risk of impact from the hydrocarbon spill, as far as practicable. Note: The ability to detect birds that are present varies with the time of day, season, and between years. For example, the areas of coastal habitat occupied by many shorebird species may vary over the course of the day in relation to tidal cycles (Ref. 8; Ref. 9; Ref. 10). Further, many birds present are migratory and may use only part of their range at any particular time of the year (Ref. 11; Ref. 12; Ref. 13; Ref. 14). Changes in abundance and highly irregular movement patterns may also occur in relation to variable environmental conditions such as cyclonic events (Ref. 15, Ref. 16). For tidal areas, these guidelines will apply, as far as practicable:

- Spatial coverage should be conducted of the entire habitat thought to be used by the same population of shorebirds, and the entire area of contiguous habitat where shorebirds may occur. This may include multiple discrete roosts and feeding areas.

- Surveys for roosting shorebirds should be conducted as close to high tide as practicable and no more than two hours either side of high tide (unless local knowledge indicates a more suitable time).
- Surveys for foraging shorebirds should be conducted as close to low tide as practicable and no more than two hours either side of low tide (unless local knowledge indicates a more suitable time).
- Surveys should not be undertaken during periods of high rainfall or strong winds.
- Surveys should not be undertaken when activities that disturb the birds, such as shoreline clean-up, are taking place.
- For large sites or for sites where large numbers of birds are expected, it is recommended that at least two people undertake the counts and agree on the number of birds and the number of species present.

Counting shorebirds may be done by directly counting individuals of each species present or by estimating if numbers are large. It is recommended to estimate the total number of birds first. If the birds being counted take flight, this ensures knowledge of the total number, and possibly some idea of the proportions of each species, has been obtained. Estimating proportions of species is a secondary priority.

9.5.2 Aerial Shoreline Surveys

Aerial surveys allow rapid coverage of large areas of land and/or water and can cover areas that are difficult to access on the ground. Aerial shoreline surveys provide information on taxon presence and their quantity, and also reveal the location of particular habitat types or nest sites for follow-up ground surveys. Aerial shoreline surveys are performed for shorebirds and seabirds using either helicopters or fixed-wing aircraft. Aerial surveys usually involve flying along systematically or randomly-placed straight-line routes (similar to ground-based transect surveys) along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details on procedures for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.3 Vessel-based Shoreline Surveys

Vessel-based shoreline surveys for shorebirds and seabirds usually involve systematically or randomly-placed line transects along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the vessel (Ref. 17). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable.

9.5.4 Pelagic Surveys

Both vessel-based and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel-based surveys have the advantage of providing more time to identify the taxa and record other details such as age, sex, and behaviour. This improves the chances of recording rare, inconspicuous, and diving taxa.

9.5.5 Vessel-based Surveys

Vessel-based surveys include observations and recordings of birds at sea from a moving vessel. Vessel-based surveys may be conducted opportunistically and therefore observers may not be able to specify the vessel's course. The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Pelagic surveys and colony censuses may be useful because the study area supports several species that breed elsewhere and visit Australian waters outside their breeding season; they do not come to land and so would not be detected by colony surveys.

9.5.6 Aerial Pelagic Surveys

Aerial surveys of seabirds are typically performed using either helicopters or fixed-wing aircraft. Aerial surveys involve flying along systematically or randomly-placed, straight-line routes (similar to ground-based transect surveys) at sea where birds may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.7 Recording Oiled and Dead Seabirds and Shorebirds

This rapid survey includes collecting, recording, and scientifically examining a representative sample of live oiled and dead seabirds and migratory shorebirds. The sample size will depend on the resources available to undertake the assessment. As far as practicable, the initial assessment of live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel will collect information on:

- date and location of finding
- identification to species
- details of rings or other markers (e.g. satellite transmitters)
- oiling status of the bird (% oiled)
- external ageing and sexing
- external biometrics (to determine age and breeding population of origin) including:
  - bill length
  - bill shape
  - body mass
  - wing length
  - tarsus length
- internal examination to determine sex and age.

Live oiled and dead seabirds and shorebirds collected by Emergency Response personnel (e.g. shoreline clean-up teams or vessel crews engaged in response) who do not have the appropriate level of experience to conduct the initial assessment, will capture and store the individual birds as soon as possible and mark each bird with information on:

- date and location of finding
- degree of oiling (% oiled)
- species (if known).

The dead seabirds and shorebirds will be stored in appropriate facilities (preferably freezing facilities). Identified live, oiled birds found onshore and at sea will be captured, as far as practicable, using equipment such as nooses, hoop nets, and throw nets and then transported to the staging facility. The number and status of oiled seabirds and shorebirds may also be collected during other operational surveys (e.g. OPS5 – Shoreline Rapid Assessment). Methods for collecting and/or capturing oiled shorebirds are provided in Appendix B of the western Australian Oiled Wildlife Response Plan (Ref. 22).

9.6 Reporting

- All data on shorebird and seabird presence/absence and spill impacts will be sent to the EMT each day.
- A final report will be prepared at the completion of the monitoring plan (as determined by the termination triggers) and will include all the data collected and its interpretation.

9.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS6:

- Form 10 – OPS6: Rapid Seabird and Shorebird Assessment.

10 OPS7: Rapid Marine Megafauna Assessment

10.1 Rationale

OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna (including marine turtles, sea snakes, pinnipeds, cetaceans, sharks, and rays) within the predicted trajectory of the oil spill.

The objectives of OPS7 are to:

- assess, and if possible confirm, the presence of marine megafauna in the environment that may be affected to predict the potential exposure to oil
- assess, and if possible confirm, where marine megafauna are in relation to the spill incident and the predicted spill trajectory to assess the level of risk
- observe, and where possible quantify, actual exposure of receptors to oil or exposure to the incident response measures
- record mortality of marine megafauna in the environment that may be affected.

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Design

OPS7 records and collates observations of marine mammals, reptiles, and large cartilaginous fish within the study area using reconnaissance aerial and/or vessel-based surveys. Rapid and systematic identification (using standardised survey protocols) is required . Given the low precision of data/knowledge on the distribution and abundances of most marine mammals, reptiles, and large cartilaginous fish, and the time available in the event of a spill, quantification of abundance is unlikely. However, qualitative assessment of animal numbers present and any observable impacts to individuals is possible. Methods are principally designed to collect information on presence/absence, mortality, and, if possible, the status of those individuals encountered (e.g. behaviour, oiling etc.).

Flexibility is required when implementing OPS7 so that methods/procedures best suited for collating information to inform the response strategy can be selected. The design outlines several potential approaches, with the decision made at the time of the spill on which aspects will be implemented.

10.3.1 Pre-survey Planning

It is anticipated that the surveys conducted as part of OPS7 will supplement already established distribution information. Data on relevant species, their seasonality, and potential breeding stage will be tabled to determine the scope of surveillance surveys and to establish priorities for data collection.

Information from MES will be overlaid with resource maps for the relevant species, including location of critical habitats. This information will be used to identify the priority species and any specific survey locations that will be considered when determining the geographic area for reconnaissance and scientific monitoring studies (if required). Given the impracticalities of monitoring all potential receptors under the marine mammal, reptile, and large cartilaginous fish groupings, indicator species will be used to provide a method to track the potential impact. Depending on location of the spill and its predicted extent, several potential indicator species for assessing risk to marine megafauna during the operational response have been identified.

The selection of indicators species was based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act] listed species).

Based on these considerations, indicator species recommended for operational monitoring are outlined in Table 10-1.

Table 10-1: Potential Indicator Species for Surveillance Surveys

Baleen Whales	Toothed Whales or Dolphins	Other Marine Mammals	Large Cartilaginous Fish	Reptiles
• Blue Whale • Humpback Whale	• Bottlenose Dolphin • Indo-Pacific Humpback Dolphin • Spinner Dolphin • Australian Snubfin Dolphin	• Dugong • New Zealand Fur Seal	• Whale Shark	• Green Turtle • Flatback Turtle

10.3.2 Monitoring Design

The scale of likely impact will determine the scale of both spatial and temporal monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be adaptable on the day to changes in the predicted zone of impact of an oil spill incident. The priority of resources, receptors, and sites are likely to be different under different spill or weather conditions, the seasonal presence of species, and/or the life stage of the species present. A judgement will need to be made at the time of the spill about the relative value of different sites and resources that are the focus of operational monitoring.

10.3.3 Field Survey Assessment

The study will include rapid surveillance surveys to determine what marine mammals and large cartilaginous fish are present in the predicted spill trajectory pathway and the wider environment that may be affected by the spill. The size of the wider environment that may be affected will be determined based on several factors including: season, life stages of species likely to be observed, geographic range, species residency, and timing in relation to migration. A qualitative visual assessment over and extending beyond the area of the hydrocarbon spill (but within the area of impact) to identify the presence and/or behaviour/activity of the selected marine wildlife is recommended. The standard survey platforms used for assessing marine wildlife at sea and along coastlines are aerial (manned) or marine vessels. Aircraft can survey large and inaccessible areas in a short space of time and reduce the risk of double counting that can potentially occur from vessel-based surveys. Aerial surveillance works well for large marine mammals (principally whales) and where waters have good light penetration and visibility. However, aerial survey methods do not provide robust counts for inshore dolphin populations where shallow waters are turbid. Visual assessments using aerial surveillance may under-report substantially, and species identification can be problematic. In situations where the study area includes shallow coastal waters, vessel-based surveys are more suitable (taking into account safety considerations). The environmental conditions at the time of survey will influence what survey platform is most appropriate. For operational monitoring, aerial surveys are preferred, with vessel-based surveys completed opportunistically.

10.3.4 Vessel-based Surveys

Vessel-based surveys for presence of marine mammals and large cartilaginous fish will occur opportunistically and will depend on vessel access. Observational data will be gathered on species and location of any marine mammals and large cartilaginous fish close to the surface slicks, as well as any unusual behaviour or ill health.

As far as practicable, the observer(s) will be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals.

Double-platform data collection will be implemented, when possible. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location
- species
- group size
- group composition (adults and calves)
- angle to sighting (declination)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.5 Aerial Survey

Aerial surveillance for marine mammals and large cartilaginous fish will, as far as practicable, be undertaken daily in conjunction with MES aerial surveys. The survey will detect presence of visible animals without confidence of estimates of abundance. Visual and photographic/video data should be collected and information on sea state and flight path recorded, as outlined below. Where possible, double-platform line-transect and cue counting will be implemented to limit bias. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location (GPS)
- species
- group size
- group composition (adults and calves)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.6 Shoreline Survey (Marine Turtles)

Track data for marine turtles will be collected using aerial photographic surveillance; however, in poor weather conditions it may be necessary to conduct ground-based track census surveys. Aerial overnight track counts are constrained by tides and sun elevation—overnight tides clear the beach of new tracks below the high-tide line, while tracks cannot be seen past ~10:00 am due to the sun's elevation making them impossible to see clearly. The tracks and other evidence left on the beach after a marine turtle has emerged (crawls) can be used to identify the species. The aerial survey results will be verified by ground surveys, which will also confirm the level of oil contamination at key nesting beaches (which is not always possible from the air). Shoreline surveillance will be conducted in conjunction with OPS5 – Rapid Shoreline Assessment.

10.3.7 Live Stranding and Carcass Recording (Marine Mammals)

Strandings of marine megafauna create an important opportunity for gathering information on the species' biology, pathology, toxicology, population genetics, and natural and human-induced population mortality.

If a fauna stranding is recorded, at least 10 carcasses will be sampled for tissue analysis (providing the criteria for necropsy are met). If fewer than 10 carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

In Western Australia, Wildcare (08 9474 9055; part of DBCA) is the lead stranding organisation. Standardised protocols are available for carcass handling and necropsy procedures; these will be adopted:

- Standardised protocols for the collection of biological samples from stranded cetaceans (Ref. 32)
- Marine Mammals Ashore: A Field Guide for Strandings (Ref. 33)
- Eros *et al.* outlines details on salvage and necropsy procedures for dugong (Ref. 34).

Trained professionals will be involved in handling any strandings encountered. Where carcasses are observed, physical details (species, length, sex, condition, etc.) will be recorded and photographs taken. Basic biological information and tissue samples for laboratory analysis (where appropriate) also need to be collected.

A necropsy should be undertaken by a pathologist to determine cause of death. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of death can be attributed to the oil spill event. The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis, with analysis unlikely on severely decomposed carcasses. Tissue samples are required for hydrocarbon analysis and, where possible, these must be assessed against background reference points for the interpretation to be meaningful.

Immediate necropsy, or appropriate freezer storage of carcasses, is required for the physiological and pathological state to be correlated to any concentration of petroleum products found in tissue samples. For any marine megafauna tissue collected, a basic set of analytical tests will be undertaken as part of the scientific monitoring conducted as part of SCI5.

10.3.8 Oiled, Injured, Diseased, and Dead Fauna Recording

Oiled, injured, diseased, and dead reptiles will be handled by trained personnel. All records will be entered into an Oiled Wildlife Database and include details on species, size, sex, condition, damage, etc. with photographic records made of the body. All dead and oiled/injured animals will be collected—live animals for clean-up and tissue sampling; dead animals for tissue sampling and freezer storage.

Any sea snakes collected will be sent to the WA Museum for identification. Live sea snake observations will be photographed for identification.

10.4 Resources

CAPL has access to a number of environmental professionals based on Barrow Island, at Onslow, and in Perth. The specific skills required to complete this OPS are:

- experience in marine spill response operations
- marine mammal knowledge and field skills to correctly identify marine mammals (Marine Mammal Observer [MMO] certification [essential]; experience in marine mammal surveys from aerial surveys [desirable])
- veterinary and pathology expertise on call for diagnosis of cause of death with experience in record keeping (chain of command procedures) and advising on diagnosis of death

To prevent injury to animals and the people handling them, it is preferable that only experienced people handle wildlife. Any on-site training should include written descriptions of handling and cleaning techniques, and demonstrated compliance with these. Each person should also be provided with a written brief that covers safety, legal requirements, and the importance of recording all data.

Item	Check
Survey platform: Access to rotary or fixed-wing aircraft (recommended AMSA Dornier 318 or CASA 212-400 fixed-wing aircraft; i.e. high-wing aircraft with downward visual capability) or marine vessels	☐
Trained MMO on aircraft	☐
Handheld video camera with date stamp and GPS capability	☐
Digital camera (with GPS) and telephoto lens	☐
GPS device	☐

Item	Check
Binoculars, preferably 8x30 to 10x50	☐
Clinometers	☐
Nautical charts	☐
Logbook/observation sheets	☐
Species field identification guide(s)	☐
Audio recorder	☐

Aircraft are available on Barrow Island and Karratha through Bristow's. The activation time (under ideal metocean conditions) for the helicopter on Barrow Island is two hours (three hours from Karratha or Exmouth). Vessel providers are available from regional port/harbour facilities in Exmouth, Onslow, Dampier, and Port Hedland.

10.5 Standard Operating Procedure – Field Sampling

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
Pre-work		
1.	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 400 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification	Establish strip width for transects each side of the aircraft: • 400 m for whales and dugong • 750 m for Whale Sharks
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot Altitude: approximately 500 ft Beaufort state: <3
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables including, as far as practicable, location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions:	Record other variables including, as far as practicable, location, whether transect is in oil-affected water, and weather conditions: • temperature

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
	• temperature • precipitation • wind strength and direction • visibility (including glare)	• precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas

10.6 Reporting

- All data will be sent to the EMT each day.
- A final report will be prepared at the completion of the spill response activities and will include all the data collected and its interpretation.

10.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS7:

- Form 11 – OPS7: Aerial Survey Log Form
- Form 12 – OPS7: Marine Vessel Survey Log Form.

11 OPS8: Fish Tainting Assessment

11.1 Rationale

OPS8 relates to monitoring undertaken to better manage concerns expressed by fisheries, the public, or the media about the potential effects of the spill or response activities.

Fish tainting assessment (OPS8) will be performed by external agencies possessing this specialised skill set. This Section provides general guidance and expectations for external monitoring teams.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Design

The key component of OPS8 is collecting data on the effects of the spill and response strategies on pelagic and benthic fish species. The assessment will include:

- an adequate and reasonable sample size for both pelagic and benthic species (where applicable to response strategies) for rapid response sampling
- those areas of known importance for commercial fisheries
- requirements to inform recreational and commercial fisheries
- availability of human resources, suitable vessels, and other logistics
- capacity for transporting samples from the site (e.g. by helicopter or vessel)
- safety considerations.

As per wildlife impact monitoring during the Montara oil spill (Ref. 19), samples can be collected from commercial fishers who have landed fish in areas known to have been impacted by oil (refer to MES results to determine). If no commercial fishers have landed catch for areas within the zone of (potential/actual) impact, other operational monitoring vessels and teams can be used for this task. However, if the response depends on the results of this program for decision-making for the next operational period/IAP, then a vessel and team dedicated to the task will be engaged as they become available.

Implementation of OPS8 will focus on rapidly determining fish taint, given the specifics of the spill and the zone of actual impact, thus allowing for appropriate response strategies to continue. The results of OPS8 could also reduce the time that commercial and recreational fisheries are impacted.

Whole fish samples for chemical analysis and examination of fish health will be obtained through field sampling, with the analysis being undertaken at specialist fish health laboratories.

Study design guidance:

- Plastics can contaminate samples, therefore sampling methods and storage containers should avoid plastics.

- As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics relevant to the spilt hydrocarbons (such as various ratios) will be screened to confirm the contaminant's source.
- If fish kill is observed, whole, dead fish must be collected and preserved (frozen) for necropsy. If a large number dead fish are evident, the total number will be estimated, with a reduced number (~20 fish per species) of representative specimens retained for necropsy. The standard procedure for reporting fish kills to the WA DoF will be adhered to (Ref. 35).

11.4 Resources

OPS8 depends on field sampling, thus all vessel-related requirements and logistical considerations are relevant. Chemical analysis of tissue samples will require an extensive list of equipment for extracting tissue samples and examining fish health; a complete list should be developed in consultation with appropriate experts in this field and the ecotoxicologist (biopsy collection and handling), but may include:

- disposable nitrile gloves
- glass vials with PTFE lids
- aluminium foil
- ziplock bags.

11.5 Standard Operating Procedure – Field Sampling

No.	SOP – Field Sampling for Fish Tainting
1.	Contact the Fish Health Laboratories for advice on the preferred options for sampling and shipping. Phone: 08 9368 3286 or 08 9368 3357 Email: jo.bannister@agric.wa.gov.au; phillier@agric.wa.gov.au The three main options are: • Live sick specimens placed in plastic bags filled one-third with water and two-thirds with air (or oxygen if possible), to be delivered within 12 hours. (Use this option, where possible.) • Frozen whole fish and/or very fresh dead or recently killed fish placed in separate, clean, amber glass vials with PTFE lids or wrapped in aluminium foil stored in a ziplock bag, kept at -20 °C, to be delivered within 24 hours. • Small dead fish, with their abdomen slit open, should be placed in 10% formalin (or in methylated spirits in an emergency). If possible, chilled or frozen specimens (as above) should also be supplied. Supply: • a one-litre sample of water from where the fish were collected • an accurate history of the fish, their environment, and any water quality data.
2.	Send samples for diagnosis to: **Fish Health Laboratories** c/o Animal Health Laboratory Department of Agriculture and Food 3 Baron-Hay Court SOUTH PERTH WA 6151

11.6 Reporting

- Record and report results to the EUL for integration into IAP development.
- Record and report results to the EUL for referral to the Public Information Section for dissemination to recreational and commercial fisheries.

- Record results and handover to the Monitoring Coordinator for initiation of the SCIs (if applicable).

11.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS8:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 12 – Fish Tainting Assessment Form.

12 Acronyms and Abbreviations

Table 12-1 defines the acronyms and abbreviations used in this document.

Table 12-1: Acronyms and Abbreviations

Acronym/Abbreviation	Definition
°C	Degrees Celsius
µg/L	Micrograms per litre
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BOSIET	Basic Offshore Safety Induction and Emergency Training
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Hydrocarbon chain length
cm	Centimetre
cm^3	Cubic centimetre
dB(A)	A-weighted decibels
DO	Dissolved Oxygen
DoF	Western Australia Department of Fisheries
DoT	Western Australian Department of Transport
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EUL	Environment Unit Lead
FID	Flame Ionization Detector
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HES	Health, Environment, and Safety
HUET	Helicopter underwater Escape Training
IAP	Incident Action Plan
IMG	Incident Management Guide
JSA	Job Safety Analysis
kg	Kilogram

Acronym/Abbreviation	Definition
km	Kilometre
kn	Knot
L	Litre
LAT	Lowest Astronomical Tide
LC50	Lethal concentration for 50% of the test species
LNG	Liquefied Natural Gas
m	Metre
MES	Monitoring, Evaluation, and Surveillance
mg	Milligram
mL	Millilitre
mm	Millimetre
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NOEC	No Observed Effect Concentration
NWS	North West Shelf
Oleophilic	Oil attracting
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
Parks and Wildlife	Western Australian Department of Parks and Wildlife
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.

Acronym/Abbreviation	Definition
SCI	Scientific Monitoring Program
SIMOPS	Simultaneous Operations
SMART	Special Monitoring of Applied Response Technologies
SOP	Standard Operating Procedure
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia.
SVOC	Semi-volatile Organic Compound
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere.
WA	Western Australia

13 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 13-1: References

Ref. No.	Description	Document ID
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Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required via					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
58	47	7.3	5.3	3.4	2.3	20	-		
67	51	8.4	6.1	3.9	2.7	22	-		
75	73	9.4	6.8	4.4	3.0	31	-		
114	95	14.3	10.4	6.7	4.6	41	-		
-	110	-	-	-	-	47	-		
57	57	7.1	5.2	3.4	2.3	24	-		
187	168	23.4	17.0	11.0	7.5	72	9.3 hours		
-	173	-	-	-	-	74	-		
116	107	14.5	10.5	6.8	4.6	46	-		
113	108	14.1	10.3	6.6	4.5	46	9 hours		
87	87	10.9	7.9	5.1	3.5	37	-		
13	13	1.6	1.2	0.8	0.5	6	-		
65	57	8.1	5.9	3.8	2.6	24	6.7 hours		
-	65	-	-	-	-	28	-		
108	108	13.5	9.8	6.4	4.3	46	-		
57	57	7.1	5.2	3.4	2.3	24	-		
-	70	-	-	-	-	30	-		

1. *Allow ~3 hours to travel from the east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time is based on site information and knowledge and Geohouse*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations*, hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (……)..............................

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix Seal Here

Director : .... (signature) .... (print name) .... (date)

Director/Secretary: .... (signature) .... (print name) .... (date)

Declaration where sole director/secretary (if applicable):

I .... (print name) declare that I am the sole director and sole company secretary of

.... (print company name) .... (signature) .... (date)

Attorney

Attorney under Power: .... (signature) .... (print name) .... (date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee

The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant -** state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought -** give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents -**

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

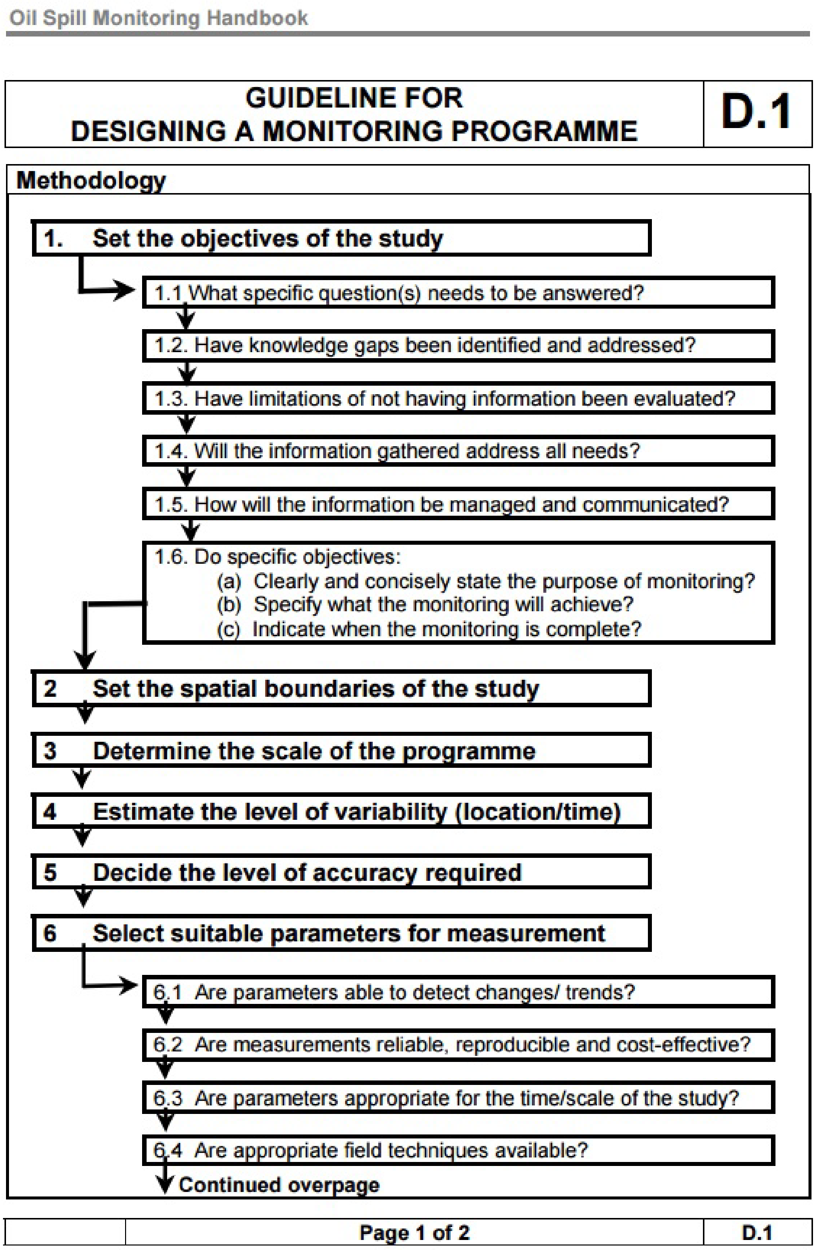
   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.

Appendix C Operational Monitoring Program Design

Extract from AMSA's Oil Spill Monitoring Handbook (Ref. 4)



Oil Spill Monitoring Handbook

GUIDELINE FOR DESIGNING A MONITORING PROGRAMME — **D.1**

Methodology

1. Set the objectives of the study

- 1.1 What specific question(s) needs to be answered?
- 1.2. Have knowledge gaps been identified and addressed?
- 1.3. Have limitations of not having information been evaluated?
- 1.4. Will the information gathered address all needs?
- 1.5. How will the information be managed and communicated?
- 1.6. Do specific objectives:
  - (a) Clearly and concisely state the purpose of monitoring?
  - (b) Specify what the monitoring will achieve?
  - (c) Indicate when the monitoring is complete?

2 Set the spatial boundaries of the study

3 Determine the scale of the programme

4 Estimate the level of variability (location/time)

5 Decide the level of accuracy required

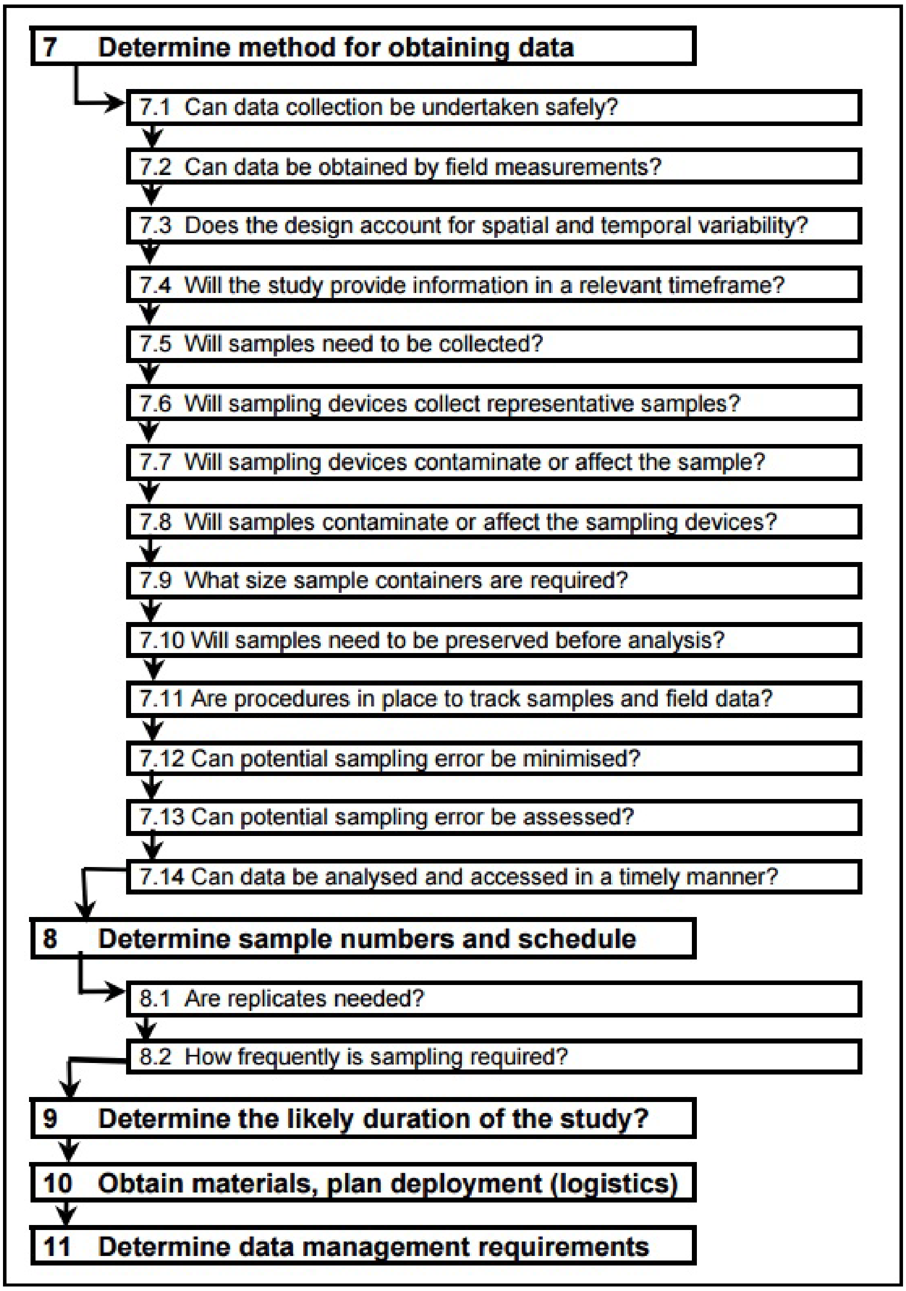
6 Select suitable parameters for measurement

- 6.1 Are parameters able to detect changes/ trends?
- 6.2 Are measurements reliable, reproducible and cost-effective?
- 6.3 Are parameters appropriate for the time/scale of the study?
- 6.4 Are appropriate field techniques available?

Continued overpage

Page 1 of 2 **D.1**

Oil Spill Monitoring Handbook



	Page 2 of 2	**D.1**

Appendix D Guideline for Data Management

Oil Spill Monitoring Handbook

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

	Page 1 of 2	Q.1

Oil Spill Monitoring Handbook

Q.1	**Methodology Continued**			
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

	Page 2 of 2	**Q.1**

Appendix E Oil Characterisation – Analytical Parameters

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present **or** **Oily potential source material**	**Water with sheen or water from underneath slick/spill**	**Oily sediment**			
Total petroleum hydrocarbons (TPH) **C4-C12**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight	**Oily Sample:** 2 x 250 mL glass jar or 100 mL amber bottle (no or limited water content) **Water Sample:** Each analysis needs a 100 mL amber bottle i.e. 10 x 100 mL (or 1 x 1 L amber glass bottle). **Sediment Sample**: 4 x 250 mL glass jar NOTE: Should the oily sample or the sediment sample contain little oily material, larger quantities should be collected (more equivalent to the water sample quantities).	All containers use Teflon lined plastic screw caps/lids. All containers must be completely full with no airspace. All containers kept at or below 4 °C following collection until the time it arrives at laboratory. Holding time for analysis or extraction by lab is 7 days following sample collection. This means that following collection the sample must be received by the laboratory within allowable time for the sample to be analysed or extracted to	
Total recoverable hydrocarbons (TRH) **C6-C40**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH C6-C40 with silica gel clean-up	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH Speciation Aliphatic/Aromatic fractions	CWG 1998	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
Hydrocarbon product identification – GC-FID chromatograms	USEPA3510/8015 GC/FID, chromatogram review (non-NATA). Includes EPA Method 3546/ ASTM D-5765 for sediments.						Written statement by chemist, plus provision of chromatogram

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Full VOC Target Scan, with Select Ion Mode (SIM) reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes: • **Monocyclic Aromatic Hydrocarbon speciation (MAH)** • **Naphthalene** • **Oxygenated Compounds**	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight		make the 7 day holding time (i.e. less than 7 days).	**MAH:** Benzene, toluene, ethyl benzene and, xylenes (BTEX), styrene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, sec-butylbenzene, 1,3,4-trimethylbenzene, tert-butylbenzene, p-isopropyltoluene, n-butylbenzene **Naphthalene** **Oxygenated Compounds:** 2-propanone (acetone), vinyl acetate, 2-butanone (MEK), 4-methyl-2-pentanone (MIBK), 2-hexanone (MBK)
Fuel oxygenates	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Tert-amyl ethyl ether (TAEE), Tert-amyl methyl ether (TAME), tert-butyl alcohol (TBA), diisopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), methyl tert-butyl ether (MTBE)
Solvents	HS-GCMS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Butyl acetate, ethyl acetate, 1-heptane, cyclopentene, cyclohexene, pentane, hexane, heptane, octane, nonane, decane
Full **SVOC Target Scan, with SIM reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes:** • **Phenols** • **PAHs** • **Phthalate esters** • **Nitrosamines** • **Nitroaromatics and ketones**	USEPA 3510/8270 GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			**Phenols:** phenol, 2-chlorophenol, 2-methylphenol, 3 & 4-methylphenol, 2-nitrophenol, 4-nitrophenol,2,4-dimethylphenol, .4-dinitrophenol, 2,4-dichlorophenol, 2,6-dichlorophenol, 4-chloro-3-methylphenol, 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, pentachlorophenol, hexachlorophene, m, o and p-cresol, 2-methyl-4.6-dinitrophenol, dinoseb, 2-cyclohexyl-4.6-dinitrophenol, 2,3,4,6-tetrachlorophenol **PAH:** naphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, N-2-fluorenylacetamide, benz(a)anthracene, chrysene, benzo(b)&(k)fluoranthene, 7,12-dimethylbenz(a)anthracene, benzo(a)pyrene, 3-methylcholanthrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, benzo(e)pyrene, coronene, perylene

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
• **Anilines and benzidenes**							**Phthalate esters:** Dimethyl phthalate, Diethyl phthalate, Di-n-butyl phthalate, Butyl benzyl phthalate, Bis(2-ethylhexyl) phthalate, Di-n-octyl phthalate **Nitrosamines:** N-Nitrosomethylethylamine, N-Nitrosodiethylamine, N-Nitrosopyrrolidine, N-Nitrosomorpholine, N-Nitrosodi-n-propylamine, N-Nitrosopiperidine **Nitroaromatics and ketones:** 2-Picoline, Acetophenone, Nitrobenzene, Isophorone, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, 1-Naphthylamine, 4-Nitroquinoline-N-oxide, 5-Nitro-o-toluidine, Azobenzene, 1,3,5-Trinitrobenzene, Phenacetin, 4-Aminobiphenyl, Pentachloronitrobenzene, Pronamide, Dimethylaminoazobenzene, Chlorobenzilate **Anilines and benzidenes:** aniline, 4-chloroaniline, 2-nitroaniline, 3-nitroaniline, dibenzofuran, 4-nitroaniline, carbazole, 3,3-dichlorobenzidine
Paraffins, Isoparaffins, Aromatics, Napthenes, and Olefins (PIANO)	USEPA 8260 M	mg/L or µg/L					All volatile organic paraffins, isoparaffins, aromatics, naphthenes, olefins. Can be performed by ALS Newcastle.
Asphaltene Content	MA-1221/D3279	as a % of the whole oil					Can be done through labs subcontracting to Intertek Geotech (Petroleum Geochemistry Division).
Metals content (vanadium, Zinc, nickel, cadmium, lead, mercury)	USEPA 6020 ICP/MS (nickel, vanadium, cadmium, lead), ASTM 3112 Hd-B CV/FIMS (mercury)	mg/L or µg/L			**Oily Sample:** Additional 2 x 250 mL glass jar (no or limited water content)		
Sulfur content by XRF	ASTM D4294	%					
Density or Specific Gravity (at 15 °C)	ASTM D1298/D5002/D4052	mg/L					
Viscosity (at 20 °C and 30 °C)	ASTM D445	centistokes (cSt)					
Pour Point	ASTM D97	°C					

<table>
<tr><th rowspan="2">Analytical parameter</th><th rowspan="2">Suggested lab analytical method or field method</th><th colspan="3">Type of spill material sample, including analysis units</th><th rowspan="2">Volume of sample/ Bottle requirements</th><th rowspan="2">Preservation and Holding time</th><th rowspan="2">Comment</th></tr>
<tr><th>Oily/slick materials (limited water), separate phase oily product present
or
Oily potential source material</th><th>Water with sheen or water from underneath slick/spill</th><th>Oily sediment</th></tr>
<tr><td>Water Content</td><td>ASTM 2709</td><td>% of sample</td><td></td><td></td><td></td><td rowspan="3"></td><td></td></tr>
<tr><td>Particle Size Distribution (PSD)</td><td>AS1289.3.6.1 – 2009</td><td></td><td></td><td>g/cm³</td><td rowspan="2">Sediment Sample:
Additional 2 x 250 mL glass jar</td><td>Method by sieving – can be done on wet and dry sediments.</td></tr>
<tr><td>Total Organic Carbon (TOC)</td><td>ASTM D7573 – 09</td><td></td><td></td><td>%</td><td>Method by high temperature catalytic combustion and IR detection.</td></tr>
<tr><td>Water quality physical parameters:
temperature
dissolved oxygen (DO)
salinity/EC
pH
redox potential (Eh)
turbidity
colour</td><td>Suitable calibrated field probe or sample sent to laboratory.</td><td></td><td></td><td></td><td>Water Sample to Laboratory:
250 mL plastic bottle</td><td>If sent to lab then it is likely that the holding time for many of these analyses will be exceeded
6 hours for DO, pH, Eh
2 days for salinity/EC, turbidity and colour
All containers use Teflon-lined plastic screw caps/lids.
All containers must be completely full with no airspace.
All containers kept at or below 4 °C following collection until the time it arrives at laboratory.</td><td></td></tr>
</table>

Appendix F Forms

Form number	Description	Document ID
1.	Chain of Custody forms	
2.	Freight consignment form	
3.	OPS1: Oil Sampling Form	
4.	OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring	
5.	OPS2: Visual Dispersant Monitoring Observer Log	
6.	OPS3: Oil in Water Assessment – Oil Sampling Form	
7.	OPS4: Oil in Sediment Assessment Form	
8.	OPS5: Rapid (Oiled) Shoreline Assessment Form	
9.	OPS6: Rapid Seabird and Shorebird Assessment	
10.	OPS7: Aerial Survey Log Form	
11.	OPS7: Marine Vessel Survey Log Form	
12.	OPS8: Fish Tainting Assessment Form	

Form 1 – Chain of Custody

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

1.0 General Information			
Samples sent to: (contract laboratory)			
Attention:			
Chevron Charge Caption:		or Service Order No.:	

2.0 Sample Information			
Samples From:		Sampled by:	
Sample Type:		Date Sampled:	

	Description of sample	Analysis required
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

☐ Additional samples overleaf ☐ Preserved at 4°C

3.0 Tracking			
☐ **Copy 1** To Contract Lab with Sample - Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative. - Lab to mail this **original** copy to EH&S representative with completed results.			
☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.			
☐ **MEJ number must be included prior to analysis of samples.**			
Acknowledge receipt signature:		**Date:**	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

Chevron

Chain of Custody Form
Environmental Sample Submission Sheet

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre EXPERT SOLUTIONS

GOVERNMENT OF WESTERN AUSTRALIA

ChemCentre, Building 500 Resources and Chemistry Precinct,
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

Off Conlon Street, BENTLEY WA 6102

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:				**NOTES**		ANALYSIS REQUIRED						**ChemCentre Job No:**
CLIENT (Billing): ADDRESS: CLIENT P/O No: .... SAMPLED BY: .... RESULTS TO:												**Please indicate if QC results are required:** ☐ **Method QC** ☐ **Batch QC** ☐ **Special LOD (use comments section)** *Method QC data refers to results from a lab blank and a lab verification standard. *Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.
LAB ID	**SAMPLE ID / DESCRIPTION**	**Sample Type**	**Depth**	**DATE COLLECTED**	**TIME COLLECTED**							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ **Normal Turnaround**	☐ **Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

Chevron

CVX Advanced Shipping Notification (ASN)

Order Ref No:	
Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
Sl No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Oil Sampling Form

Sample Sheet _____ of _____

Sampling Location Sketch

(State location and site references)

Sample Sheet _____ of _____

OIL SAMPLING FORM FOR OPS1					
Incident Name:			Ref No.		
Sampling Team					
Sample Number Unique number (as shown on sampling location sketch)					
Date (dd/mm/yyyy)					
Time 24 hrs					
Location/Reference Site reference and GPS coordinates					
Tide, current and weather					
Colour and optical effect (Bonn Agreement)					
Flow properties at ambient temp					
Water-in-oil emulsion (mousse)?					
Formation of solid sheets or balls?					
Evidence of submerged oil?					
Container Type	Glass jar				
	Bottle				
	Other				
Comments General observations, sampling method, variation on collection procedure etc.					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C	Held By:				

(Based on DoT Oil Sampling Form)

Form 4 – OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring

Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring	
Incident	
Incident name:	Ref No.:
Reporting Details	
Assessment team leader:	Position/Organisation:
Team members (Name/Organisation):	
Date completed:	Time completed (24 hrs):
Reporting to:	Position/Organisation:
Date received:	Time received (24 hrs):
Location Details	
Wind:	
Sea state:	
Water temp:	
Visibility/cloud cover:	
Dispersant used:	
Application method:	
Oil condition and type:	
Activity Log	

Comments should include:

1. *Where and when dispersant was applied*
2. *Perceived effectiveness:*
   a. *No obvious dispersion – Dispersant being washed off the black oil as white watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.*
   b. *Slow or partial dispersion – Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.*
   c. *Rapid dispersion – Oil rapidly disappearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on water.*

   Ensure photos are taken to demonstrate the observations – include the photo number that you are referring to and if possible the direction the photo was taken in.
3. *Operations – was the dispersant applied appropriately in the correct dosage?*
4. *Sensitivities – note potential ecological impacts, the presence of marine mammals, coral reefs etc.*

Time	**Actions/Events**

Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
Evidence collected e.g. photos
 Observation of oil prior to dispersant application
 Observation of oil post dispersant application
 Observation of oil post dispersant application
Recommendations: (e.g. the dispersant appears to be effective on fresh oil)

(Source Ref. 6)

Form 5 – Visual Dispersant Monitoring Observer Log

VISUAL DISPERSANT MONITORING OBSERVER LOG

Incident		Date		Observers	
Aircraft Type		Call Sign		Area Of Survey	
Survey Start Time		Survey End Time		Average Altitude	
Wind Speed (knots)		Wind Direction		Notes	
Cloud Base (feet)		Visability (nm)			
Time High Water		Time Low Water			
Current Speed (nm)		Current Direction			

SLICK	TIME UTG	OIL POSITION (CENTRE)		SLICK ORIENT Degrees	OIL SLICK LENGTH			OIL SLICK WIDTH			AREA km^2	AREA COVERAGE %	OILED AREA km^2
		LATITUDE NORTH	LATITUDE EAST/WEST		G/SPEED	TIME Seconds	DISTANCE km	G/SPEED	TIME Seconds	DISTANCE km			
A													
B													
C													
D													
E													

SLICK	OIL APPEARANCE Post Dispersant Application%				Log Photo Reference Number (and direction photo taken)	OIL APPEARANCE - Post Dispersant Application	
	1	2	3	4			
A						1	No obvious dispersion - Dispersant being washed off the black oil as white, watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.
B						2	Slow or partial dispersion - Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.
C						3	Rapid dispersion - Oil rapidly disapearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on.
D						4	Other observations - Such as herding or lacing.

(Source Ref. 6)

Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form

Sample Sheet _____ of _____

OIL IN WATER SAMPLING FORM FOR OPS3					
Incident Name:			Ref No.		
Sampling Team					
Location Name					
Date (dd/mm/yyyy) / Time					
Tides, currents and weather					
Coordinates for physical water quality sample.					
Probe readings:		Bottom	Surface	Bottom	Surface
• Salinity					
• Temperature					
• Dissolved Oxygen					
• pH					
• Turbidity					
Site Number					
Site Coordinates					
Sample Depth					
Replicate/Triplicate Samples					
Container Type	Glass bottle				
	Glass Jar				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., evidence of hydrocarbons (e.g. odour, sheen)					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C (if required)	Held By:				

(Based on the DoT Oil Sampling Form)

Form 7 – OPS4: Oil in Sediment Assessment Form

Sample Sheet _____ of _____

Sampling location sketch

Sample Sheet _____ of _____

OIL IN SEDIMENT SAMPLING FORM FOR OPS4					
Incident Name			Ref No		
Location Name					
Personnel Sampling					
Date / Time					
Weather conditions Wind speed/direction, sea state, cloud cover, rainfall					
Site Coordinates					
Site Number					
Container Type	Glass jar				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., sediment characteristics (colour, odour, grain size)					
Photos taken	Held By:				
Replicate A	Held By/Ref no.:				
Replicate B	Held By/Ref no.:				
Replicate C	Held By/Ref no.:				

(Source: DoT Oil Sampling Form)

Form 8 – OPS5: Rapid (Oiled) Shoreline Assessment Form

Shoreline Assessment Form					
Incident					
Incident name:				Ref No.:	
Reporting Details					
Assessment team leader:		Position/Organisation:			
Team members (Name/Organisation):					
Date completed:		Time completed (24 hrs):			
Reporting to:		Position/Organisation:			
Date received:		Time received (24 hrs):			
Location Details					
Sector:		Segment:			
Name of beach or location:					
Description (e.g. slope):					
Topography/other map (No.):				Map reference:	
Access via:	☐ Foot	☐ Road	☐ 4WD	☐ Boat	☐ Helicopter
Hazards:					
Timing					
First assessment:	☐ Yes	☐ No	Last assessment:	☐ Yes	☐ No
Timing:	☐ Pre-Impact	☐ Post-Impact Before Clean-up		☐ Post-Impact After Clean-up	
Time since:	Impact (days/hrs):		Last clean-up (days/hrs):		

Assessment				
Parameter	**LITZ**	**MITZ**	**UITZ**	**Supratidal**
Shoreline Description				
Shoreline type*				
Substrate type				
Length of shoreline				
Width of shoreline				
Biological character				
Oil Distribution and Character				
Oil Band Length				
Oil band width				
% cover in oil band				
Surface oil thickness				
Oil appearance/character				

Shoreline Assessment Form				
Depth of buried oil (from surface)				
Buried oil bands (min-max m/cm)				
Description of buried oil				
Other				
Un-oiled debris				
Oiled debris				

Sketch Map (Include North point and a scale)

Notes:

Photo Numbers:

(Based on DoT Oiled Shoreline Assessment Form)

Form 9 – OPS6: Rapid Seabird and Shorebird Assessment

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General site description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife description:	(type/species present, abundance, behaviour)	
Oiled wildlife description:	(type/species present, abundance, behaviour)	

Photographs:	Looking along transect from start: ☐ Looking along transect from end: ☐ Note any additional photos taken at site (e.g. vegetation, fauna, access etc.):

Form 10 – OPS7: Aerial Survey Log Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife observations:	(type/species present, abundance, behaviour)	
Video and Photographic record:	Looking along transect from start: ☐ Looking along transect from end: ☐	

Form 11 – OPS7: Marine Vessel Survey Log Form

BLUE PLANET MARINE

Gorgon LNG Project
Marine Fauna Observations

Chevron

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page ____ *of* ____

Form 12 – OPS8: Fish Tainting Assessment Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Location description:		
Site condition of tainted fish:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description of fish:		
Fish observations:	(type/species present, tainting observations/records)	
Other records:	Notes as necessary	

Appendix C Guidance Note and Standard Operating Procedures – Scientific Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Scientific Monitoring

Document ID:	ABU151200658
Revision ID:	4.0
Revision Date:	25 May 2020
Next Revision Due	25 May 2025
Information Sensitivity:	Company Confidential

Contents

Tables

Figures

1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP): Scientific Monitoring Guidance Note (this Guidance Note) describes the implementation of scientific monitoring if an emergency event results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on scientific monitoring only, as set out in the Operational and Scientific Monitoring Plan (ABU130700448; Ref. 1).

The OSMP (Ref. 1) splits scientific monitoring into individual components (Figure 1-1). Each component represents a particular assessment or study, with initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for scientific monitoring purposes, not operational monitoring.

1.2 Scope

This Guidance Note focuses on the implementation of scientific monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs is part of the OPEP processes and not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for scientific monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures for required sampling, including providing standard field sheets and checklists
- describe potential sampling and analysis design for each component, taking into consideration existing baseline data and current monitoring techniques.

1.4 Target Audience

This Guidance Note is for environmental personnel implementing scientific monitoring scopes, including those fulfilling scientific monitoring roles within the Environment Unit (Figure 1-3) of the Emergency Management Team (EMT).

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft and/or events beyond CAPL's control) can be accommodated. The potential survey areas occur in a remote region, with limited logistical capability and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity), may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more scientific monitoring programs (SCIs) as described in this document. If this occurs, CAPL ensures the objectives of this document are bet my taking measures to alter designs and/or reprioritise its monitoring programs.

This Guidance Note provides a framework for finalising program design so that it is appropriate to the nature and scale of the emergency event. It provides details for SCIs that must be implemented by CAPL. External environmental specialists, engaged to support SCIs, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required as determined by the Health, Environment, and Safety (HES) Supervisor and/or the EMT.

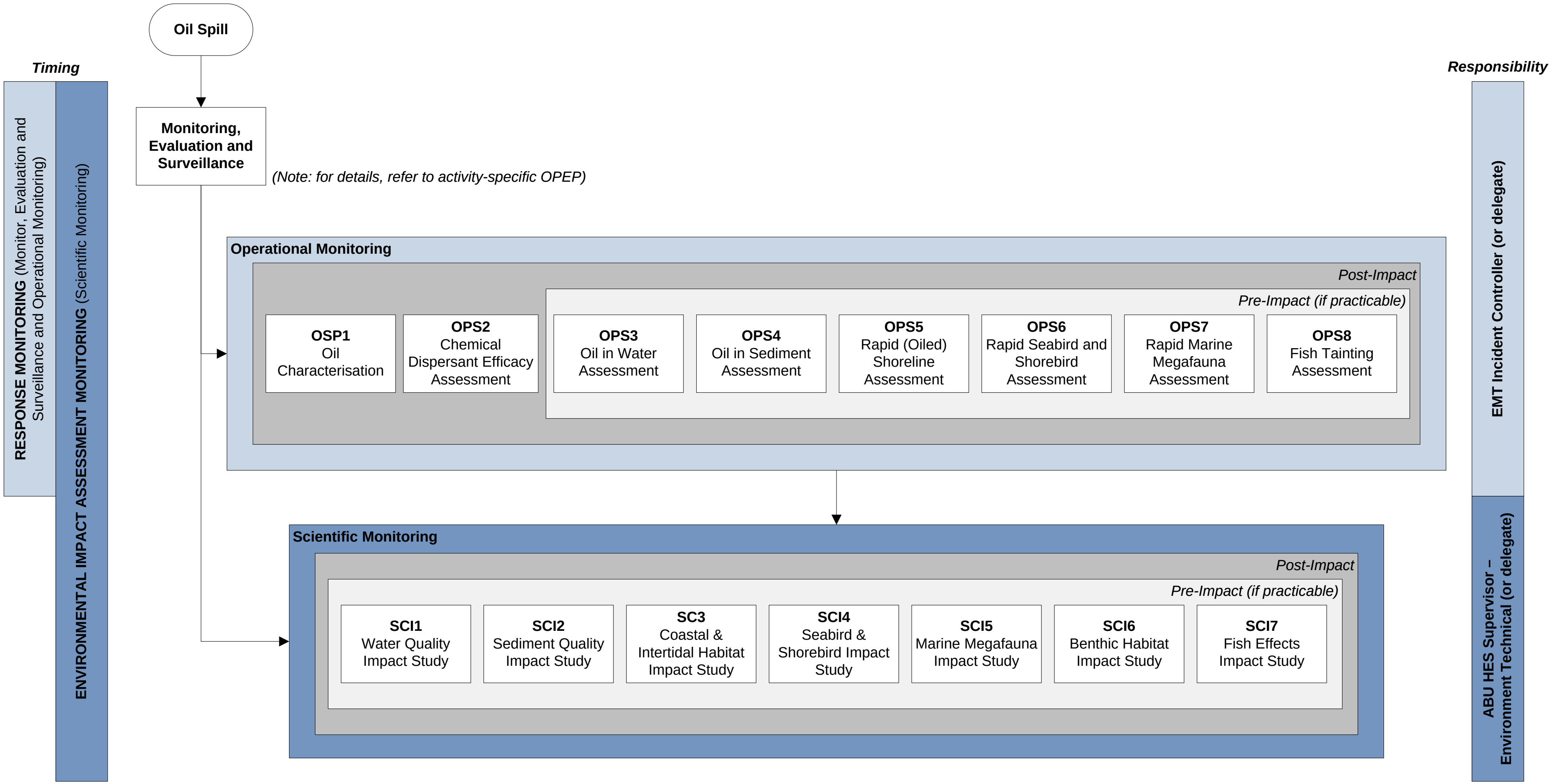


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

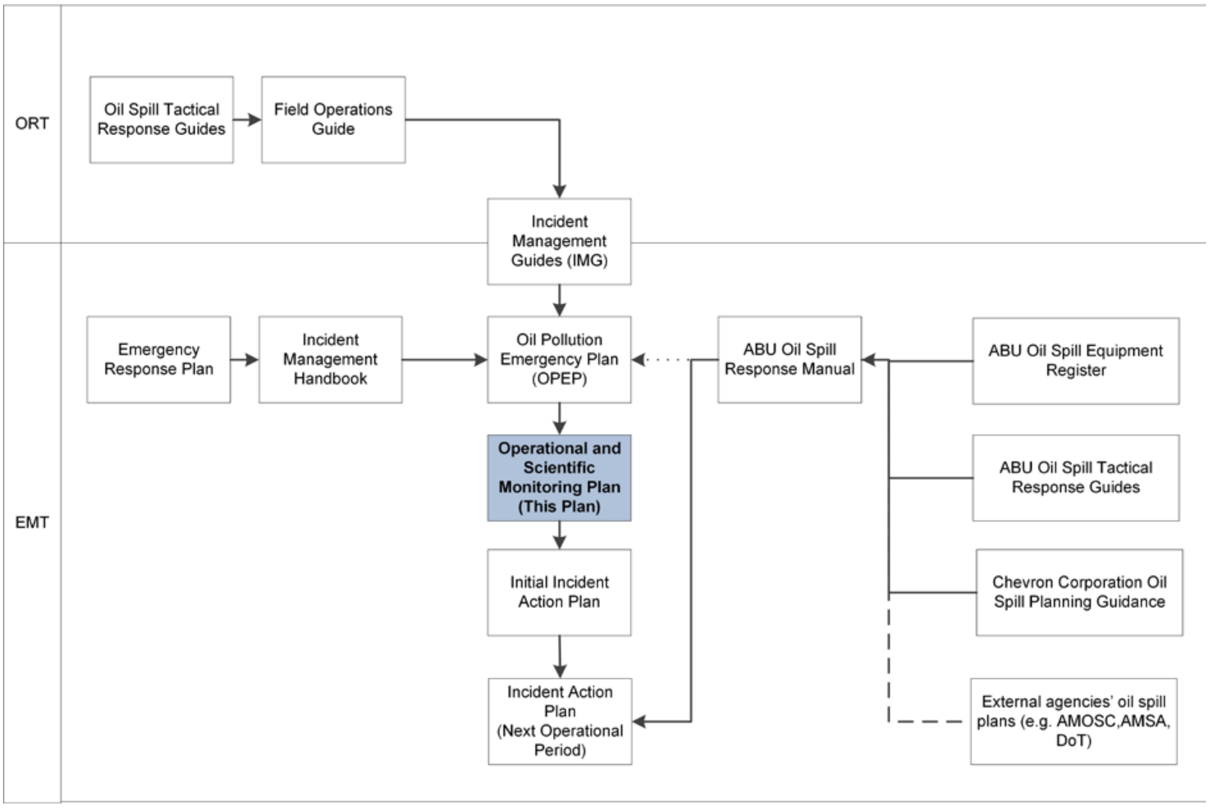


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review the OSMP (Ref. 1) every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 14.0 defines the acronyms and abbreviations used in this Guidance Note.

1.8 Roles and Responsibilities

The roles and responsibilities outlined in Figure 1-3 apply to all phases of the monitoring process. The HES Supervisor (or delegate) is responsible for ensuring the implementation of the scientific monitoring components; however, in the short term (during the event), the EMT will be closely consulted. Several specific monitoring roles (see shaded cells in Figure 1-3) will also be required.

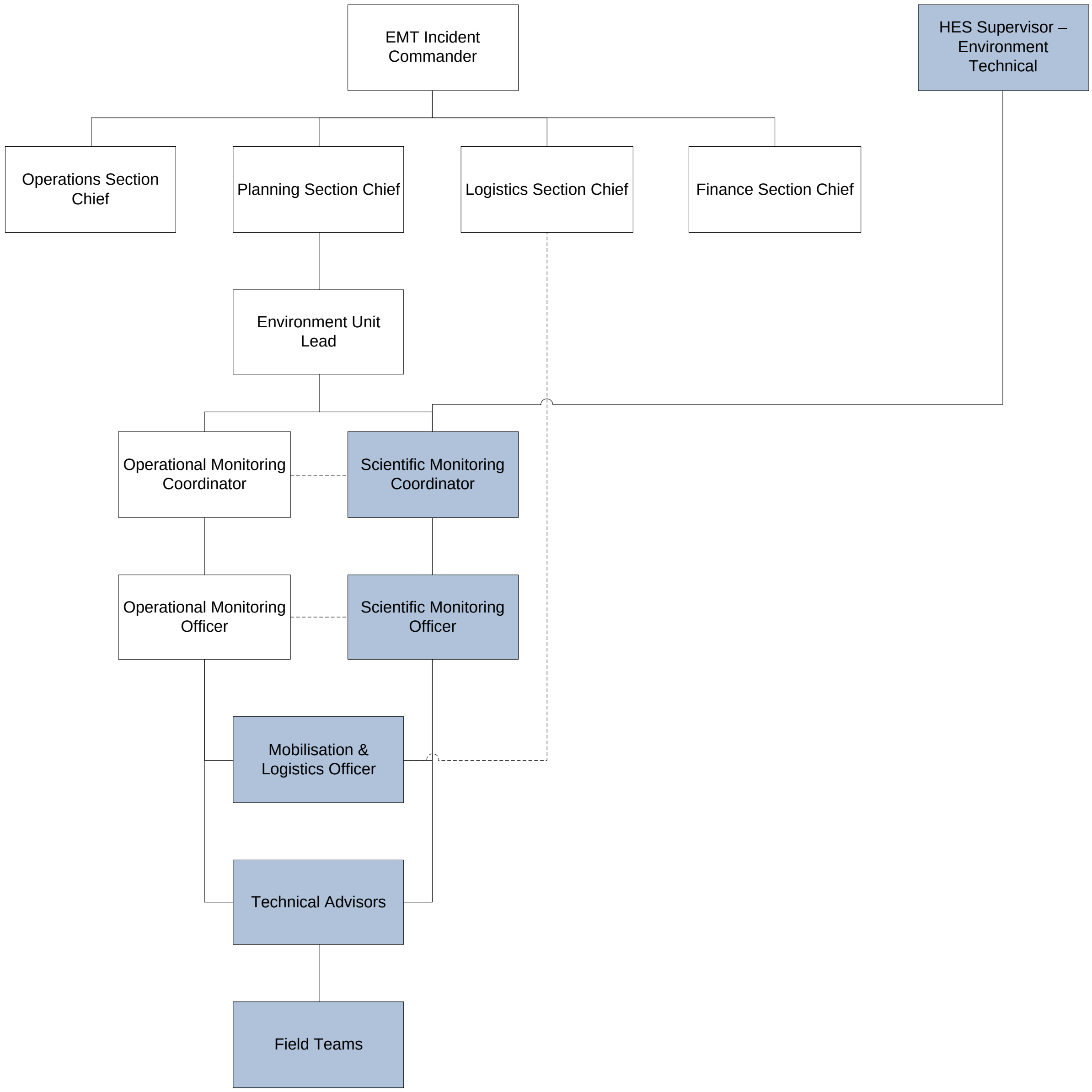


Figure 1-3: Roles Associated with Scientific Monitoring

Note: Shaded cells refer to roles related to this Guidance Note.

Table 1-1: Scientific Monitoring Roles, Responsibilities, and Rationale for using this Document

Role	Responsibilities	Reason for using this document
HES Supervisor – Environment Technical (or delegate)	Ultimately responsible for: • Ensuring that scientific monitoring is implemented in accordance with the OSMP (Ref. 1). • Setting the objectives for the scientific monitoring programs.	• Is aware of this document but does not directly implement each SCI • Refers the Scientific Monitoring Coordinator to this document for use
Environment Unit Lead	Key position for relaying information between the EMT and the Scientific Monitoring Coordinator.	• Ensures communication between Operational and Scientific Monitoring Coordinators for sharing of resources/data etc.
Scientific Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • Contact point with HES Supervisor and the EMT (through the Environment Unit Lead) • Ensuring relevant SCI components are implemented in line with the OSMP (Ref. 1) and this Guidance Note • Providing overarching technical advice • Financial tracking and management (in consultation with HES Supervisor – Environment Technical and EMT [through the Environment Unit Lead] as appropriate) • Logistics tracking (in consultation with Logistics Section in EMT as appropriate) • Engaging with required third-party contractors including consultants and laboratories.	• Communicating monitoring activities to the HES Supervisor – Environment Technical and Environment Unit Lead as appropriate • Ensuring initiation and termination criteria are met • Acquiring personnel to fulfil roles and ensuring responsibilities are met
*Scientific Monitoring Officer	Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • Understanding the data metrics that would be collected in the event of a spill • Advising the Scientific Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, or logistics) are encountered • Facilitating activation of contractors if necessary • Overseeing data analyses and interpretation • Managing data including spatial data • Presenting data in an appropriate and informative format to allow for timely decisions * The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability).	• Design of SCIs • Ensuring Standard Operating Procedures (SOPs) are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted

<table>
<tr><th>Role</th><th>Responsibilities</th><th>Reason for using this document</th></tr>
<tr><td>Mobilisation and Logistics Officer</td><td>Responsibilities include:
Ensuring field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, in accordance with CAPL processes and the initiation criteria outlined in this Guidance Note
Liaising with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams
Facilitating procurement of any necessary vessels or sampling equipment, if required.</td><td>Understanding resources required (resource lists for each SCI)
Understanding requirements to mobilise people and equipment for monitoring tasks</td></tr>
<tr><td>*Technical Advisors</td><td>Technical Advisors will be assigned to monitoring scopes as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include:
Overseeing and providing advice on collecting data
Advising the Operational and Scientific Monitoring Officers on data collection methods
Ensuring sampling and analysis plans (where required) are completed before mobilisation
Undertaking quality assurance/quality control (QA/QC) and interpreting data
Preparing reports.
* The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability etc.).</td><td>Designing SCIs
Verifying SOPs
Ensuring QA/QC in data collection and reporting</td></tr>
<tr><td>Field Teams</td><td>A Field Team will include one Field Team Lead, who is the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for:
Understanding the details of monitoring methods
Having adequate field data collection sheets and survey-specific equipment readily available
Ensuring awareness and understanding of QA/QC procedures
Assisting with report preparation if required
Implementing relevant HES protocols.</td><td>SOPs for each OSMP
Resource lists</td></tr>
</table>

1.9 Mobilisation Times

1.9.1 Operational Areas

The operational areas of CAPL are shown in Figure 1-4; these areas represent the geographic scope of the OSMP (Ref. 1). Indicative mobilisation times for these areas is provided in Appendix A.

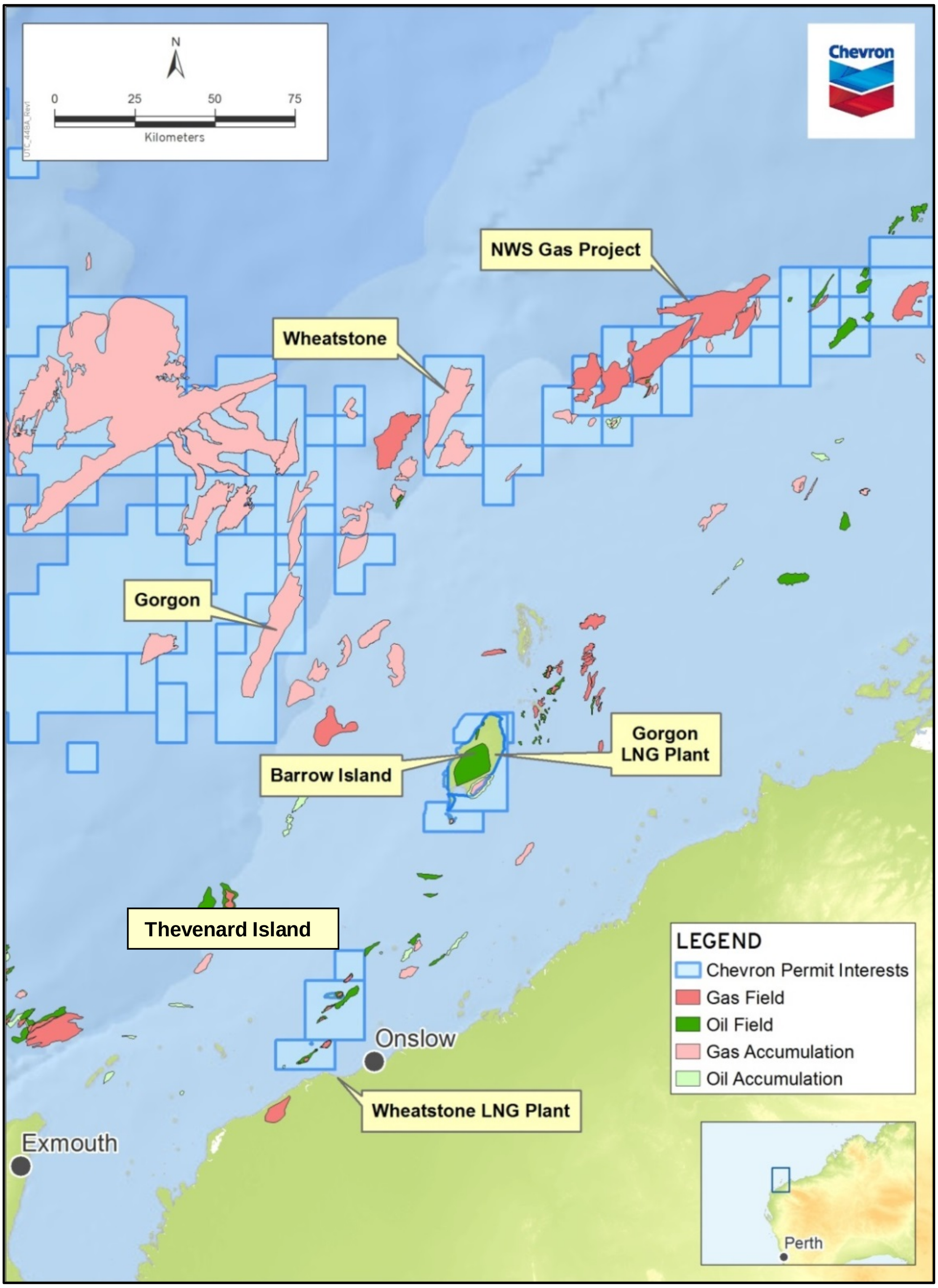


Figure 1-4: CAPL's Operational Areas

1.9.2 Non-operational Areas

For areas not under CAPL's operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and the WA Department of Biodiversity, Conservation and Attractions (DBCA) for locations managed by the Marine Parks and Reserves Authority (MPRA).

1.9.3 Permits

Individual scientific monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required if biological samples are collected from the water column or seabed, or if an exemption requires using a specific type of sampling gear. Several permits or exemptions will be required from different government departments, depending upon where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 1-2 outlines the permits required and the issuing authority, and Table 1-3 outlines the likely permits required for each SCI. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 1-2: Permits Potentially Required to Support Scientific Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
Commonwealth Department of the Agriculture, Water and the Environment (DAWE)	Application for a permit to access biological resources in Commonwealth Marine Protected Areas (MPAs) for non-commercial research	Conducting scientific research in a Commonwealth MPA, including filming and photography	
	The requirement to have a permit for access to biological resources or to kill, take, keep, or injure a listed threatened, migratory or marine species in a Commonwealth area is exempt for actions undertaken to manage or respond to a maritime environmental emergency (such as an oil spill), in accordance with the National Plan for Maritime Environmental Emergencies (Ref. 3)	Collecting any biological specimens from Listed species	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – Part 13 Commonwealth EPBC Regulations 2000 – Part 8a http://www.environment.gov.au/epbc/notices/pubs/140306-section-303a-exemption.pdf.
Commonwealth Department of Conservation, Biodiversity and Attractions (DBCA)	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles (nm).	Conducting scientific research (including filming and photography) in a State MPA in State Waters out to three nm	*Biodiversity Conservation Act 2016*(WA) and Regulations – Regulation 25

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nm. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and Regulations

Table 1-3: SCIs Requiring Engagement with Government Approval / Permit Issuing Authorities to Determine Permit Requirements for Response and Post-response Phase Monitoring (excluding permits required to access Indigenous lands)

Permit	SCI1	SCI2	SCI3	SCI4	SCI5	SCI6	SCI7
DAWE (formally DotEE – 8A and 13 permit)	Exemption for maritime environmental emergencies						
DAWE (formally DotEE – MPA permit)	X	X	X	X	X	X	X
DBCA (within 3 nm)			X	X	X	X	X
DoF permit			X			X	X

** Note: Infauna sampling will be conducted as part of SCI6 and not SCI2.*

1.10 Safety and Health

Safety and health are paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with scientific monitoring are listed in Table 1-4. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 1-4 are not exhaustive.

This information may be used to develop a Job Safety Analysis before undertaking scientific monitoring activities.

Table 1-4: Potential Hazards Associated with Scientific Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas

Hazards	Impacts	Mitigation Measures
		• Supply appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Establish buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Supply hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Attend manual handling training • Clearly mark weights on labels • Use lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Wear appropriate footwear • Provide non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. VOCs, H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Monitor air emissions • Restrict site entry • Supply respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4). • Wear appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration • Inability to undertake assigned duties	• Use premedication as needed
Aerial Operations		
Motion Injury from aircraft on taxiing or starting engines	• Impact injuries • Possible fatalities	• Follow flight crew safety instructions and pre-flight briefings • Use designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• Attend HUET and/or Basic Offshore Safety Induction and Emergency Training (BOSIET) training (all aerial observers) • Supply PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Follow the communications plan • Follow the flight crew briefing regarding simultaneous operations
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck

Hazards	Impacts	Mitigation Measures
		• Use rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Attend vessel crew training • Use navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Follow transfer procedures • Follow Vessel Master's instructions • Be aware of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Comply with alarm systems • Provide firefighting equipment on board • Follow emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Take regular work breaks to cool down or warm up • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Stop vessel engines or place them in neutral during deployment • Follow on-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) • Wear appropriate clothing and PPE • Wear over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Wear appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Wear over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Take regular work breaks • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Be aware of sea state and conditions • Use PFDs

1.10.1 Personal Protective Equipment

The work described in this Guidance Note must comply with the minimum PPE requirements, as defined in ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 5). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice

Guidelines (Ref. 4). For scientific monitoring activities, conduct a risk assessment to determine the PPE required and consider these items as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater), worn under overalls or high-visibility clothing
- over-ankle reef booties (not dive booties; should have grip-on sole)
- protective gloves suitable for entering water during intertidal work, e.g. long lycra gloves, latex gloves, dishwashing gloves, or a combination of these (without causing cross-contamination of samples)
- duct-tape PPE to wrists and ankles when in contact with sea water.

1.10.2 Washdown for Marine Stinger Safety

Following potential exposure to marine stingers, particularly Irukandjis and the sea water where they live, wash down clothing and equipment before disrobing. Vinegar washdown provides the greatest measure of protection (see Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) for the vinegar washdown procedure). Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until they have been treated with fresh water for at least ten minutes.

2 Scientific Monitoring

2.1 Experimental Monitoring Design

It is important that monitoring design and statistical approach are developed concurrently and given adequate consideration to ensure that the data collected can be readily analysed, and where practicable given constraints, achieve appropriate power to detect an important level of impact and meet the Plan objectives. This Section provides guidance on appropriate survey design approaches that may be used within each SCI. Although this Section provides a generalised approach to survey design and statistical methods, each SCI further details which of these approaches applies under different situations to meet the specific Plan objectives, and the level of sampling required associated with the approach.

This Section outlines five general survey approaches likely to apply to each SCI Monitoring Plan:

- Before-After-Control-Impact (BACI)
- Impact versus Control (IvC)
- Gradient of Impacts
- Lines of Evidence
- Control Chart.

The survey design(s) chosen depends on these criteria:

- scale and pattern of potential effects of the spill
- availability of baseline data and/or ability to rapidly obtain baseline data
- time frame available to gather pre- and post-spill data
- availability of Operational Monitoring Program (OPS) data
- availability of appropriate reference sites
- statistical approach proposed for data analysis
- range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

Note: Data collection depends on several constraints (as outlined above), including but not limited to, the type and location of hydrocarbon spill, and site locations and access given logistical and safety constraints. As such, the design that was conceived before implementation of each SCI may not be implemented exactly as intended in situ. For example, there may be inadequate number of control locations because of the size of the spill. Therefore, data collected as part of SCIs may need to be analysed using alternative designs (e.g. data from an expected BACI design may need to be analysed as a Gradient Approach).

2.1.1 BACI Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are available or able to be collected post-spill but pre-impact
- where reference data are also available pre- and post-impact
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map the impact, or examine gradients of effect).

The optimal approach for assessing and inferring whether an effect has caused an impact in a study is generally considered to be a BACI design (Ref. 6). This design involves taking measurements for parameters of interest at one or more potentially impacted sites and one or more control (reference) sites, both before and after an event occurs that could potentially cause an impact (Figure 2-1). The BACI Approach provides a robust and powerful method for detecting a significant change in the parameters of interest and for inferring the cause of that change (i.e. natural factors versus unplanned hydrocarbon spill). If the change that is observed from before to after the event at impact sites is statistically greater than the before-after change observed at control (reference) sites, then the inference is that an impact from the stressor (such as hydrocarbons) has occurred. This design is most applicable when strong evidence exists that the indicator is likely to be impacted by hydrocarbons (either directly or indirectly), and this potential impact can be examined in the context of natural variation by examining natural changes at comparable reference sites.

The simplest BACI design assumes no temporal trends occur in the measured parameters across sample dates in the period before or after the impact. Although the simplest BACI design involves taking measurements at two times (before and after) and two treatments (control and impact), modifications to this design can help improve the ability to detect and infer the cause of change, if data and/or time permit. These modifications include taking samples at multiple times before and after impact in a Multiple Before-After-Control-Impact approach (MBACI; Ref. 7; see also Beyond BACI) (Figure 2-2). This approach will help examine different temporal scales of impact (acute versus chronic impact) and responses (acute versus chronic effect), and help differentiate the potential effects of hydrocarbons from natural fluctuations in the measured parameter through time.

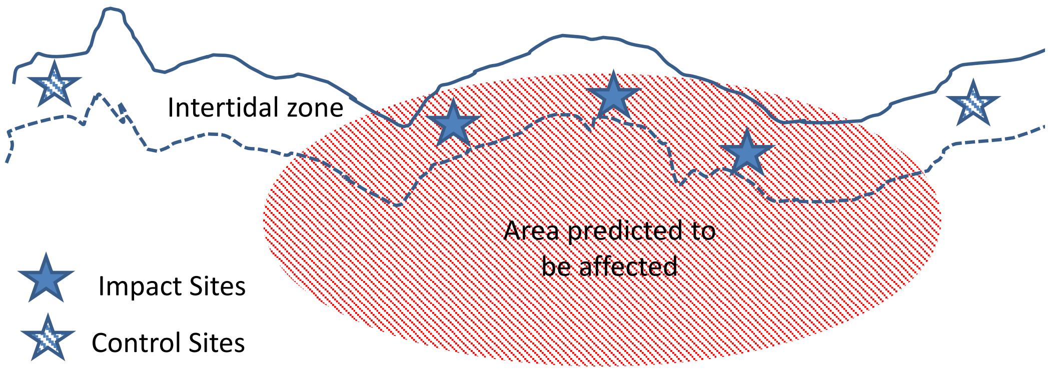
The constraints of the BACI or MBACI Approach are the availability of appropriate control (reference) areas and data collected before impact (baseline data). If an unplanned release affects a wide area, or if a unique or spatially discrete ecosystem or species is the focus of potential impacts, finding suitable controls that are comparable to impact locations may not be achievable. Likewise, the impact area may cover a region or receptor where baseline data do not exist and cannot be readily obtained post-spill, before the impact occurs. In each of these examples, it may be more appropriate to use a Gradient (see Section 2.1.3) or IvC approach (see Section 2.1.2).

If baseline data are available through monitoring programs for other Chevron projects or third-party organisations (e.g. Commonwealth Scientific and Industrial

Research Organisation [CSIRO], DBCA), then the methods used in those baseline data investigations should be repeated (if possible and practicable). Improved methods may be used that result in finer-scale data, the outputs of which can always be scaled back to compare to previously collected data. If suitable pre-existing baseline data are not available, and sufficient time is available, field sampling should be prioritised to allow post-spill/pre-impact baseline data to be collected for regions and sensitive receptors where impacts are likely to occur, to enable a subsequent BACI assessment.

Within each sampling location, sites should be replicated, and, with each site replicate, samples (e.g. transects or quadrats) should be taken into account for different spatial variation scales that may affect the outcome of the assessment. This is called a nested (or hierarchical) sampling design, where successively smaller spatial scales are nested within the scale above (similarly for temporal collections if practicable, noting the time scales of natural change within individual SCIs). Stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

Before Impact



After Impact

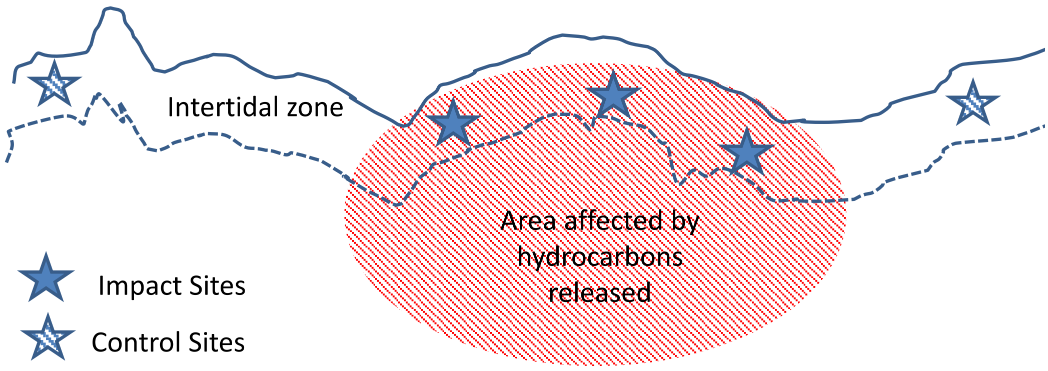


Figure 2-1: Generalised BACI Design

Note: The number of sites is for example only and is discussed in further detail in each SCI plan where this approach is likely to be used.

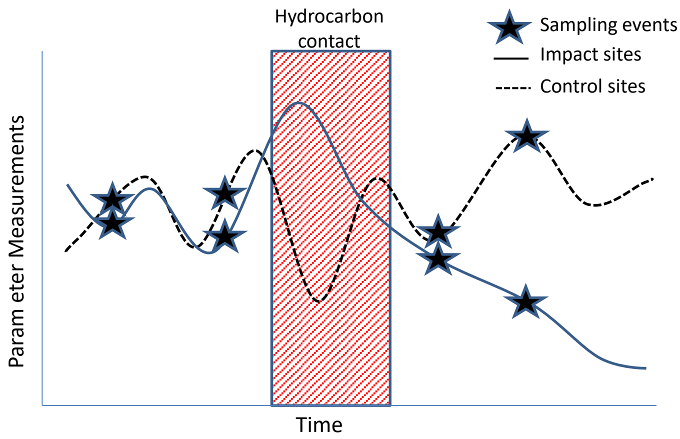


Figure 2-2: Generalised MBACI Design

Note: The number of sampling periods is for illustration only; designs would benefit from as many sampling periods as logistically feasible.

2.1.1.1 Statistical Approach

Multi-factorial analysis of variance (ANOVA)—including permutational multivariate analysis of variance (PERMANOVA) and similar non-parametric tests—that test for an interaction between treatment (impact versus reference [IvR]) and time (before versus after) can be used to test data. Components of variation may help partition a sum of squares into different sources, and describe the importance of factors within tests.

2.1.2 Impact versus Control Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are unavailable and where such data cannot be collected post-spill/pre-impact
- where suitable control (reference) locations are available
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map impacts, or examine the gradients of effect).

For some locations and sensitive receptors it is likely that baseline data does not exist, is not recent and applicable, or was collected using methods that are unrepeatable in the current study. If there is a lack of baseline information that can feed into a BACI design, a simpler IvC approach can be used to assess impacts. However, due to the unknown status of the parameter before impact, there is a higher likelihood of encountering Type I error (falsely concluding that an impact has occurred) with this approach. For example, if the status of the parameter to be measured was already naturally lower at impact sites than reference sites before the impact occurred, but this was not measured, a conclusion may be reached using the IvC approach that an impact has occurred when it may be natural variation. For this reason, sampling designs should always try to collect or use baseline data (i.e. aim for a BACI design), and if an IvC design is used, it is important to ensure that the reference sites are comparable to the impact sites in every way possible except for the presence or absence of the studied effect (hydrocarbon). This may include, but not be limited to: site physical aspect, substrate (where applicable), current regimes, and community composition.

Because of the higher likelihood of Type I error, it is also useful to collect additional data on relevant physical environmental parameters that are likely to be different at impact and reference sites and may affect the conclusion of the assessment (e.g. physical aspect, sediment type). This is similar to collecting data for Lines of Evidence Approach (Section 2.1.4). These parameters can be examined later for any potential co-variance with the observed changes in the parameter of interest, to understand whether hydrocarbons or natural variation affected the outcome. As with the BACI Approach, when using the IvC Approach it is important to understand the scale of natural variation that may affect the outcome of the assessment by replicating sites within sampling locations, and replicating samples within each site. In addition, stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

2.1.2.1 Statistical Approach

Multi-factorial ANOVA (to account for nested data), including PERMANOVA and similar non-parametric tests, test whether the level of variation among treatments (IvC) is greater than the level of variation within treatments. Components of variation may help partition variance into different sources and help infer whether the effect of hydrocarbons or spatial variation was responsible for any detected change.

2.1.3 Gradient Approach

SCI applications:

- where the objective is to quantify the spatial extent of environmental effects; or
- where the objective is to provide data (e.g. water quality, sediment quality) to infer or correlate with changes in other parameters (e.g. infauna abundance); or
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations, but where baseline data are unavailable and suitable reference locations are unavailable.

The Gradient Approach relies on sampling at a set of sites at increasing distance from the source of hydrocarbon impact, or a set of sites that have had different levels of exposure to the hydrocarbon spill. This method is most commonly used in investigations of point source pollution where concentrations of pollutants typically decline with distance from the source, and the level of observed impact also declines. The overall objective of the Gradient Approach is to assess if there is a relationship between distance from source or level of exposure to an impact, and level of detected impact. Such a relationship would imply the presence of an impact, and provide data on the severity, nature, and physical extent of that impact. If thresholds of change are known for receptors (i.e. physiological response of flora/fauna above which mortality occurs), then the scale or severity of an impact may be gauged in the absence BACI or IvC designs. The Gradient Approach also provides a ‘Line of Evidence’ (Section 2.1.4) that the source of potential impact (hydrocarbons) was responsible for the observed effect, rather than natural variation. However, care should be taken to ensure awareness of any natural gradients in the parameter measured and ensure that these do not confound interpretations.

The Gradient Approach can also be used in some instances where a lack of suitable reference sites prohibits using a BACI or IvC Approach. Similar to the description above, sampling should be established along a gradient of predicted effect (based on input of data from OPS or modelling), with sites established at various distances from the source of impact or along a gradient of magnitudes of concentrations of hydrocarbons (if known from OPS or SCI data). The Gradient Approach can also be used in combination with a BACI or IvC Approach to help infer the cause of a detected impact, and describe thresholds of impacts at which a response appears to have occurred.

When designing a study using a Gradient Approach, it is important to include any prior knowledge of the likely direction of any gradient of effect (e.g. is there likely to be an initial gradient of effect mainly in one direction from the release, due to prevailing currents, or 360° from the source as hydrocarbons spread?), as well as the likely magnitude of change with distance (are all observed effects within hundreds of metres of the release or do they extend over greater distances?). Relevant OPS data, SCI data (e.g. water and sediment quality), and modelling should be considered in the design. Prior knowledge or prediction of the likely gradient of effect will greatly improve the efficiency of the sampling design by minimising the collection of data points that provide no additional information in the analysis (e.g. data points showing similar or no effects that do not help to characterise the gradient of effect), though noting these may aid in statistical power of gradient description.

Typically, the level of observed impact will decline exponentially from the source of a hydrocarbon release; therefore, sampling effort can be distributed along the gradient of effect in a way that best characterises the changes in the parameter measured (see Figure 2-3). Generally, sites would be sampled close together (e.g. every few hundred metres) near the source where changes in observed effect are greatest, and would be spaced further apart at the outer limits of the affected areas (e.g. kilometres or tens of kilometres apart) (Figure 2-3). However, the gradient of environmental effects may not always be this simple—the components of the spill and elapsed time since the spill may alter this gradient. For example, hydrocarbons on the surface are likely to accumulate on shorelines, where they may have their greatest environmental effects, rather than having an exponential gradient of environmental effects with distance from the release point. These factors should be considered in each SCI Plan.

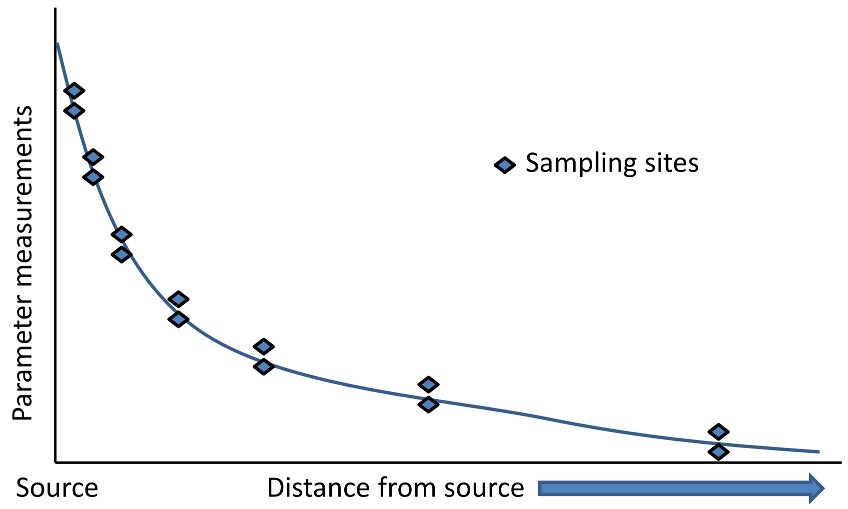


Figure 2-3: Decay in Level of Effect with Distance from Effect Source and Matching Gradient Approach Designed to Characterise the Extent of Environmental Effect

It is also useful (though not essential) to obtain replicate samples within each distance from the source to characterise natural variation and help separate this from potential effects of the release (as was the case for BACI and IvC Approaches). It is recommended that at least two sites are sampled at each distance along the gradient (if logistics and time permit) to provide an understanding of natural spatial variation. Sites should also be sampled at distances at which no environmental effect is predicted or observed, if possible, to characterise the full extent of the effects gradient (Figure 2-4 and Figure 2-5).

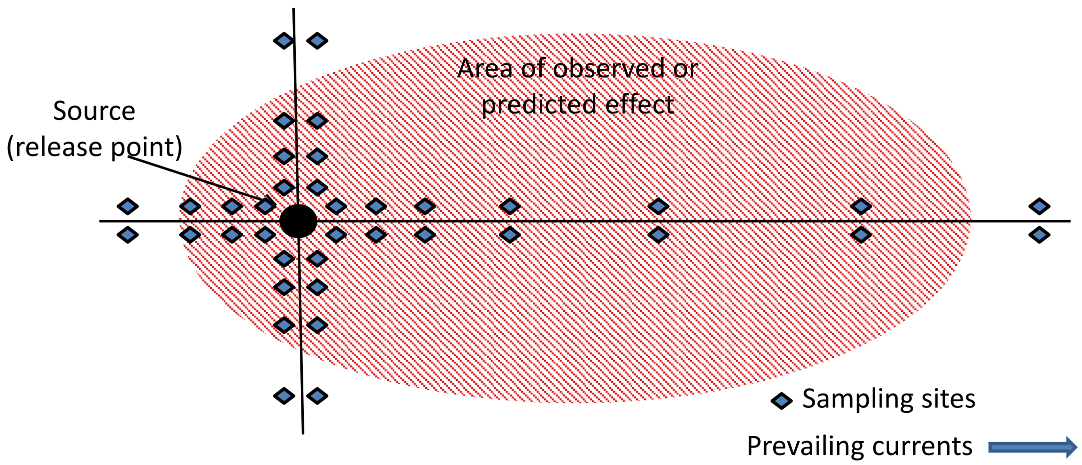


Figure 2-4: Generalised Gradient Approach where the Measured Parameter/Receptor Occurs at all Distances from the Source

Note: The number of sampling points is for illustration only.

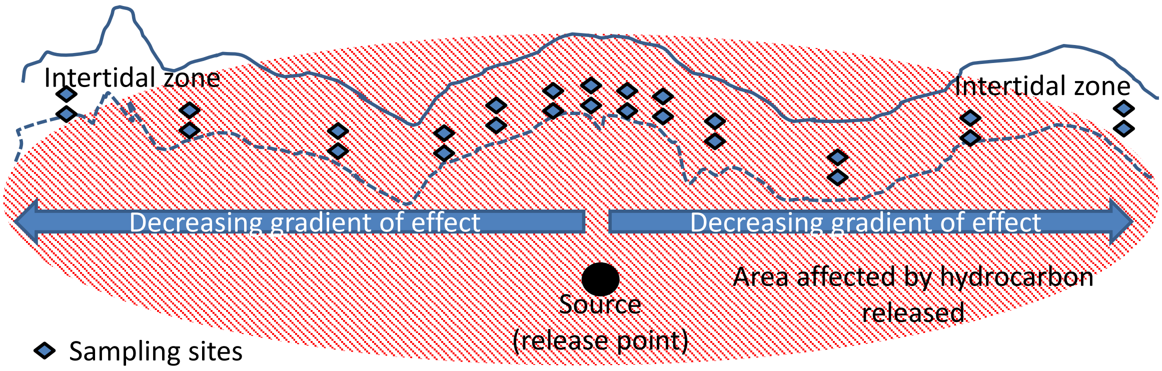


Figure 2-5: Generalised Gradient Approach for Shoreline Habitat where Lack of Baseline or Reference Sites Do Not Permit an BACI or IvR Approach

Note: The number of sampling points is for illustration only.

2.1.3.1 Statistical Approach

Correlation analysis between impact (measurements of hydrocarbon/stress; x-axis) and measurement parameter (biological and non-biological response; y-axis), and associated regression analyses, may include least-squares regression line and hypotheses testing to determine if the trend is significantly different from zero.

Descriptive approach (e.g. illustration) of changes in parameter measured with distance from source to define the spatial extent of impact.

2.1.4 Lines of Evidence Approach

SCI applications:

- can be combined with any of the above designs to provide inferential evidence of an effect
- are useful to support evidence of effect if there are limited (or only one) impact locations
- are useful to support evidence of effect if the effect radiates outward from source
- are useful to infer cause of change if limited or no baseline data exist
- are useful to infer cause of change if limited or no reference sites exist.

Although an optimal sampling design for impact assessment includes BACI or MBACI approaches (Section 2.1.1; Ref. 6; Ref. 7), unfortunately, sampling designs to assess impacts from an unplanned release of hydrocarbons are likely to be suboptimal. This may be due to limited or outdated baseline data, only one rather than multiple impact locations, and a lack of reference sites that are environmentally and ecologically comparable to the impact location(s). When a sampling design is suboptimal, the Lines of Evidence Approach can be used to help infer the cause of an observed change (i.e. attribute change to the hydrocarbon release or to other causes such as natural variation). Within the Lines of Evidence Approach, inference is developed based on carefully structured arguments. A weakness of this method is that the evidence may be largely circumstantial because it is based on correlations (Ref. 8), which does not necessarily imply causation. Each causal argument may be weak independently, but combined they may provide strong circumstantial evidence and support for a conclusion (Ref. 8).

This approach was originally developed in medicine (Ref. 9), but it has been used in more recent ecological studies (Ref. 10; Ref. 11; Ref. 12; Ref. 8; Ref. 13). Hill (Ref. 9) categorised different types of causal argument into nine criteria for studies into the effects of diseases on humans. Table 2-1 lists each causal criterion and how it relates to ecological impact assessment (adapted from Hill [Ref. 9]). With Lines of Evidence, there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Ref. 12; Ref. 8).

Table 2-1: Hill's (Ref. 9) Causal Criteria and Description in the Context of Ecological Impact Assessment

Causal Criterion	Description
Strength of association	A large proportion of individuals are effected in the exposed area relative to reference areas
Consistency of association	The association was observed by other investigators at other times and places
Specificity of association	The effect is diagnostic of exposure
Temporality	Exposure must precede the effect in time
Biological gradient	The risk of effect is a function of magnitude of exposure
Biological plausibility	A plausible mechanism of action links cause and effect
Experimental evidence	A valid experiment provides strong evidence of causation
Coherence	Similar stressors cause similar effects
Analogy	The causal hypothesis does not conflict with existing knowledge of natural history and biology

In the Lines of Evidence Approach, a set of descriptions should be developed for all or some of the causal criteria listed in Table 2-1 before the survey is undertaken (see Ref. 8 for further criteria and examples). Data would then be collected that allows each Line of Evidence to be tested or objectively questioned. The final assessment of whether an impact is likely to have occurred will be based on the 'weight of evidence' from examining multiple Lines of Evidence. Example generalised Lines of Evidence descriptions are provided in Table 2-2. These would be modified and tailored to each SCI Plan and each parameter investigated.

Table 2-2: Causal Criteria and Example Lines of Evidence Descriptions that could be used to Assess whether a Change in a Measured Parameter was due to the Effects of a Hydrocarbon Release

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Strength of association	Larger decline in individuals in areas affected by hydrocarbon than in reference areas	Similar declines in individuals in areas affected by hydrocarbon and reference areas
Consistency of association	Consistent finding of declines in a range of biota in areas affected by hydrocarbon	Inconsistent declines in biota in areas affected by hydrocarbon (e.g. declines in one species but not in other similar species)

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Specificity of association	Number of individuals affected correlates with hydrocarbon concentrations	No correlation between number of individuals affected and hydrocarbon concentration
Temporality	Decline in individuals immediately preceded by contact with hydrocarbon	Decline in individuals occurred before or long after hydrocarbon contact
Biological gradient	Changes in individuals aligned with exposure to hydrocarbon spills or concentrations	Decline in individuals occurs with increasing distance from a hydrocarbon spill or hydrocarbon concentrations
Biological plausibility	Evidence from literature of sensitivity to detected hydrocarbon concentration for species where declines are observed	Evidence from literature suggests lack of sensitivity to detected hydrocarbon concentration for species where declines are observed
Experimental evidence	A valid experiment provides strong evidence of causation	Not applicable (N/A)
Coherence	Evidence of a decline in species abundance, habitat, and food source with increasing hydrocarbon exposure	Evidence of a decline in species abundance, but no other evidence of expected declines associated with exposure
Analogy	Apparent declines in hatchling numbers despite no apparent decline in numbers of adults	Apparent declines in hatchling numbers associated with decreased numbers of adults

2.1.5 Control Chart Approach

SCI applications:

- when long-term (multi-year) datasets exist for the measured parameter
- when a large amount of natural variation exists in the measured parameter
- when predicting the expected range of outcomes from an impact.

One of the causal criteria described in the Lines of Evidence Approach (Section 2.1.4) is ‘Strength of Association’ (Ref. 9), exemplified by a ‘Larger decline in individuals in areas affected by hydrocarbon than in reference areas’. The Control Chart Approach takes this causal criterion a step further and uses rules to establish whether a detected change in a parameter at impact sites is outside what would be expected to occur naturally. This technique requires tracking a parameter over time and determining whether an observed change is within the bounds of what has been observed to occur naturally at that impact site or at control sites.

A control chart has a central line for the mean, an upper control limit (e.g. 3 standard deviations [SD] above the mean), and a lower control limit (e.g. 3 SD below the mean), which are all determined from historical data (Figure 2-6). This can include data from an impact site compared to its own historical data, or data from an impact site compared to the historical data from impact and/or reference locations. By comparing measurements at a given point in time to these lines, broad inferences can be drawn about whether an observed change was consistent with previous observations (in control) or not (out of control). Any inconsistent data are investigated to determine the cause of the change.

In addition, if ongoing data collection is possible following a potential impact, the Control Chart Approach is also used to examine the direction of change and whether this is consistent or inconsistent with historical data. The number of data points above or below the centreline (mean) can be tracked and used to provide a weight of evidence of a directional change in a given parameter.

The Control Chart Approach is only useful if there is an adequate historical knowledge of natural variability in a given parameter. However, if this information exists (e.g. data from the Long-term Marine Turtle Monitoring Program [Ref. 14]), the Control Chart Approach can be a powerful tool for detecting impacts for systems that are naturally highly variable.

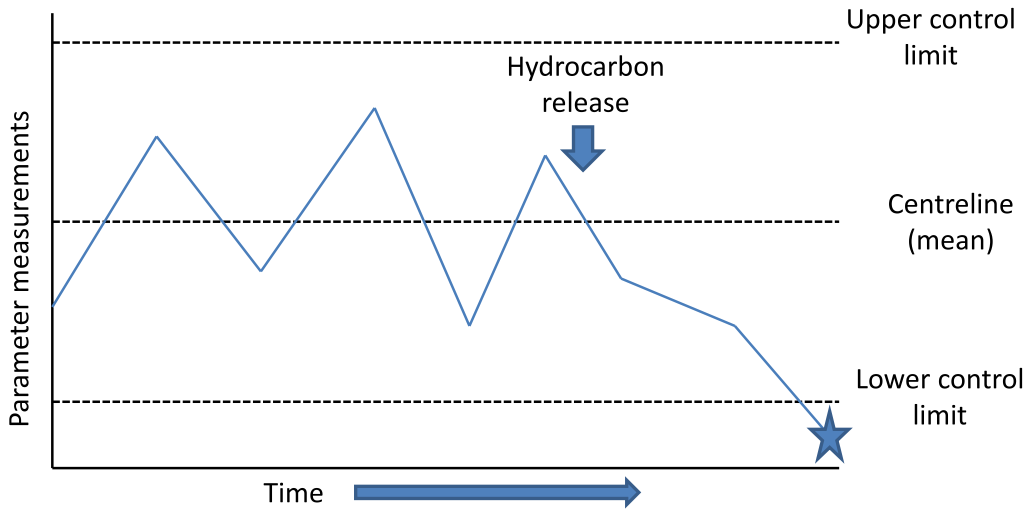


Figure 2-6: Example Control Chart showing Centreline (mean), Upper Control Limit (3 SD above mean), Lower Control Limit (3 SD below mean), and Measurements

Note: The star represents an 'out of control' measurement that needs to be investigated.

2.1.5.1 Statistical Approach

The statistical approach for Control Charts is:

- calculate the historical mean for the centreline
- calculate the upper and lower control limits from historical data, e.g. two or three SD above and below the mean (Ref. 15)
- calculate the mean (ongoing) for an impact site to compare against the control chart.

2.1.6 Effect Size and Power

Power is measured in terms of the probability of detecting an impact of a certain effect size, if an impact has actually occurred. Effect size is the magnitude of difference in a measured variable between impact and control samples, taking into account natural variation. It is important to know the power of a sampling design before commencing a study to ensure that there is a likelihood of detecting a biologically or ecologically important effect size. A study that has insufficient power can be a waste of time and effort, if statistical testing is to be used to infer impacts, as important impacts may not be detected statistically and the objectives of the study to determine significant differences (with an estimated power) may not be achieved.

The power of statistical designs and tests is largely driven by sample size, e.g. the number of sites sampled or the number of replicates within a site. Various statistical techniques are available to undertake power analysis in a study's design stage to calculate the level of replication required to detect a specified effect size. Power analysis used to determine the required level of replication depends on these inputs:

- the effect size (the desired magnitude of change to detect; this should be a biologically or ecologically important level of change)
- the population variance
- alpha (α) (the acceptable level of Type I error; the chance of falsely detecting a change that is not real; usually set at 0.05)

Generally a moderate level of power of 0.8 or higher is desired (Ref. 16) but may not always be achievable, depending on the effect size to be detected and the level of sampling that is logistically feasible. The effect size should relate to the study's objectives and should be a level of change that is biologically or ecologically meaningful, taking into account natural variability. For certain parameters, effect size may also need to consider a level of change that is meaningful to stakeholder values, such as fisheries or tourism. Natural change of varying magnitudes across temporal and spatial scales at impact and reference sites make detection of small effect sizes difficult. However, small changes due to impacts from an unplanned release are unlikely to be considered to be biologically or ecologically significant if dwarfed by large-magnitude natural variability. Therefore, the effect size chosen should take into account what is known of natural variability in the parameter to be measured, such as that observed in baseline studies or known from the literature. For example, it may be trivial to be able detect an effect size of 20% in the benthic cover of tropical seagrasses, which vary naturally from season to season by up to 100%. Detecting such an effect size may also be extremely difficult to achieve in such a highly dynamic community without a logistically unfeasible level of replication. However, detecting an effect size of 20% in a coral community, which is generally more stable over time, is important because changes of this magnitude may be outside the natural levels of change, and the coral community may take longer to recover from such a change because of its greater population stability.

Population variability can be estimated from data collected during previous studies (e.g. baseline). If these data are unavailable, natural variability may have to be estimated from published studies elsewhere that use the same parameters and similar sampling methods, or through pilot data collected during the OPS (if available), or through data collected during the initial SCI that will then need to feed back into revisions of the sampling design (i.e. increased or decreased replication based on initial findings).

Alpha—the probability of falsely detecting a change that is not real (Type I error)—is typically set at 0.05, although other values are acceptable. Although the level of Type I error (and alpha) should be kept as low as possible to avoid falsely detecting an impact, the lower the level of alpha (e.g. α=0.01), the lower the likelihood that that the null hypothesis will be rejected and hence, the lower the likelihood of a conclusion that an impact has occurred.

2.1.7 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study depends primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives, usually by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up strategies.

The boundaries should also be sufficient to cover representative areas of each:

- substrate type
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

2.2 Data Management

Data need to be conveyed to appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that data are presented appropriately and on time. The data can be collected in several ways:

- field data, including:
  - results from field sampling and observations
  - forms
  - photographs
  - video
  - maps
  - notebooks and logs
  - portable global positioning system (GPS)/geographic information system (GIS) units
  - verbal transmission
  - Chain of Custody (CoC) forms
  - laboratory reports
  - samples (biological, sediment, or oil).

Photographic and video evidence, covering coastlines to detailed quadrats, is a useful scientific monitoring tool, because collecting such evidence is fast and relatively inexpensive. Skilled interpretation of photos/videos can be done later.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any scientific monitoring program will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive and well organised.

Appendix B is an extract from the Australian Maritime Safety Authority (AMSA) Oil Spill Monitoring Handbook (Ref. 17) that provides a guide to data management.

2.3 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 18).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in a CoC Form (see Appendix C).
4. The CoC Form (see Appendix C) should stipulate that the report is sent to the Monitoring Coordinator and Environment Unit Lead.

Services can be directly engaged by CAPL personnel or by selected environmental contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 19).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

2.4 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for scientific monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by CAPL's environmental consultants in relation to scientific monitoring are highlighted below:

- skills and expertise available to execute the plan
- resources available, including the number of people with skills for field deployment and office/laboratory support
- access to the required equipment for quick activation
- marine scientific expertise.

3 SCI1 – Water Quality Impact Study

3.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI1 – Water Quality Impact Study (SCI1) is to describe the influence of hydrocarbon exposure (level, duration, and type) on the water column. This information will inform other scientific monitoring programs (SCI2 – Sediment Quality Impact Study [Section 4.0], SCI3 – Coastal and Intertidal Habitat Impact Study [Section 5.0], SCI4 – Seabirds and Shorebirds Impact Study [Section 6.0], SCI5a – Marine Megafauna Impact Study: Marine Reptiles [Section 7.0], SCI5b – Marine Megafauna Impact Study: Pinnipeds [Section 8.0], SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna [Section 9.0], SCI6 – Benthic Habitat Impact Study [Section 10.0], SCI7a – Fisheries and Aquaculture Impact Study [Section 11.0], and SCI7b – Fish Effects Impact Study[Section 12.0]).

The objectives of SCI1 are to:

- quantify the temporal and spatial distribution of hydrocarbon compounds and dispersants both on and in marine waters
- assess hydrocarbon/dispersant content of water samples against accepted environmental guidelines or benchmarks to predict potential areas of impact.

Comparing data collected under SCI1 with baseline data (where available) and operational monitoring data will allow for a comprehensive interpretation of spatial and temporal trends. Therefore, the data collected during the scope of SCI1 should be as comparable as possible (in sampling methods and analysis) to baseline data and operational monitoring data.

3.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

3.3 Data and Information Requirements

Table 3-1 lists the inputs relevant to planning for the implementation of SCI1, once the notification to commence is initiated.

Table 3-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated database, including exceedances of benchmark levels.

SCI1 will likely inform other SCI studies, and as such outputs from it will be required by those plans.

3.4 Design

3.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, as determined through OPS3. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 3-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate	Monitoring Design[1]	Replicate Sites Required[2]
Spill Extent		
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC, or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)
Spill Depth	**Sampling Effort**	
Surface spill	Surface spill involving light hydrocarbons: • water column profile to 50 m (or depth indicated by other information) • minimum two water sample depths (surface 0 to 0.5 m) and subsurface (~5 to 10 m) Surface spill involving heavy hydrocarbons: • water column profile to full water depth • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • in waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	
Subsurface spill	• Water column profile to full water depth • In waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • In waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

3.4.2 Monitoring Sites

Sampling sites (impact and reference sites) will be selected once the outputs from MES and OPS3 are generated so that the depth and extent of the spill can be incorporated into the survey design. Location of monitoring sites will also consider the requirements of other SCIs.

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water, and weather conditions. For a spill in 300 m water depth or greater, requiring sampling of three depths and assuming 12 hours operations in good weather, it is expected that an average of four to five sites can be sampled each day. This is based on the potential to deploy the profiling equipment separately to the water sampling equipment, download the profiling data, take photographs, and write comprehensive field notes at each site.

3.4.3 Monitoring Parameters

Water column profiles will be collected for the full water depth at all sampling sites, for these parameters:

- temperature (°C)
- conductivity (mS/cm)
- pH
- dissolved oxygen (%)
- turbidity (Nephelometric Turbidity Units)
- Raw Fluorometry Units (RFU).

Water samples will be collected from all sampling sites, from multiple depths depending on the depth of the spill but from at least the surface (approximately 0 to 0.5 m), mid-water, and near-bottom (seabed >5 m). Selection of appropriate sampling equipment depends on water depth and the potential for contamination (equipment that passes through the water column in the open position may be contaminated if surface slicks are present). Samples will be collected using a stainless steel bomb sampler, Van Dorn sampler, or equivalent. Water samples will be analysed for these parameters:

- Total Recoverable Hydrocarbons (TRH)
- Polycyclic Aromatic Hydrocarbons (PAH; only analysed if TRH is detected)
- benzene, toluene, ethylbenzene, xylene (BTEX; only analysed if TRH is detected)
- dispersant compounds, depending on those used during spill response (2-Butoxyethanol, Ethylene Glycol Monobutyl Ether [EGMBE], Dipropylene Glycol n-Butyl Ether [DPnB], Propylene Glycol, Dioctyl sulfosuccinate [DOSS]).

All samples will be compared to the United States Environmental Protection Agency's (USEPA) Water Quality Benchmarks for Aquatic Life (Ref. 20)as detailed in Table 3-3. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

3.4.4 Monitoring Frequency and Duration

Following the initiation of SCI1, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI1 may reach termination criteria but still be required by other SCIs.

During each survey, sampling may be conducted during day and/or night operations.

3.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 3-3. Spare sample containers are required for redundancy.

Table 3-3: Test Parameters for SCI1

Test Parameter	ANZECC Guideline	USEPA Benchmark value (μg/L)*	Storage Container#	Preservation	Holding Time
TRH (C_6–C_{40})	7[1]		100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
PAHs			100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
Acenaphthene		116.1			
Acenaphthylene		640			
Anthracene		43.1			
Benz (a)anthracene		4.64			
Benzo(a)pyrene		1.99			
Benzo(b) fluoranthene		1.41			
Benzo(g,h,i) perylene		0.91			
Benzo(k) fluoranthene		1.34			
Chrysene		4.24			
Dibenz (a,h) anthracene		0.59			
Fluoranthene		14.8			
Fluorene		81.8			
Indeno (1,2,3-cd) pyrene		0.57			
Naphthalene		402			
Phenanthrene		39.8			
Pyrene		21.0			
BTEX			Pair of 40 mL glass vials	Chill to 4 °C	7 days
Benzene		13 500			

Test Parameter	ANZECC Guideline	USEPA Benchmark value (µg/L)*	Storage Container#	Preservation	Holding Time
Toluene		4070			
Ethylbenzene		2010			
Xylenes		1780			
Dispersant compounds			100 mL Amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
2-Butoxyethanol		165			
EGMBE		50[2]			
DPnB		1000 (chronic)			
Propylene Glycol		500 000			
DOSS		40 (chronic)			

1 *ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) low reliability trigger value*

2 *Based on the ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) for freshwater*

Storage containers may vary depending on laboratory

* *Consideration is required of whether laboratory practical quantification limits can meet these guideline values*

3.4.6 Sample Analysis

Water samples will be analysed at National Association of Testing Authorities (NATA)-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is detected.

Water sample analysis will be subjected to laboratory-specific QA/QC procedures and results will be included in laboratory results reports.

3.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.
- Data received from the laboratories (including backups) will be downloaded and stored on the contractor’s computer system. These data are usually received approximately two to three weeks after receipt of that batch of

samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

3.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples to fill containers with low analyte water (ultrapure water). A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during the transport, storage, and analysis, the ultrapure water will be provided by the laboratory in the relevant sample jars and will remain unopened. The water will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Nitrile gloves must be worn at all times when handling water sampling equipment. Gloves need to be changed between each water sampling location or when contaminated.
- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the water sampling equipment.
- No smoking is to occur when sampling is undertaken.
- Avoid possible contamination from the vessel by sampling in as far forward position as possible with the vessel moving slowly up-current and into the wind.
- The insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, vessel, or potentially contaminated surfaces), and if contamination occurs, use a substitute container.
- Take care to avoid sources of airborne contamination (e.g. diesel fumes).
- Take GPS waypoints of all sites sampled from the vessel.

3.7 Mobilisation Requirements

3.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
□	Determine the scale of the study area
□	Select study area sites (including impact and reference sites, if applicable)
□	Select sampling approach and techniques
□	Determine sampling replication required
□	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
□	Develop site-specific health and safety plan

Task	
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check material safety datasheets (MSDSs) and chemical handling procedures
☐	Undertake hazard identification workshops (HAZIDs) as required
☐	Develop site-specific health and safety plan, including Job Hazard Analyses (JHAs)

3.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
☐	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
☐	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
☐	Assemble scientific survey team
☐	Book flights, accommodation, and car hire
☐	Confirm equipment list and availability of items; purchase consumables (as required)
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct a pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

3.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm specialist equipment requirements and availability (Profiler, Van Dorn bottle, or other water sampling devices), and any appropriate duplication of field equipment
☐	Confirm water quality profilers and sensors (including fluorometry sensor) have been calibrated before shipping, have adequate batteries, spares, and specific profiling cables, and download software
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional

Task	
☐	Check if a first aid kit or specialist PPE is required
☐	Confirm freight delivery to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently. Calibration and pre-deployment records should be kept on file.

The hydrocarbon sensor should be calibrated to an appropriate standard before mobilisation. Water samples will be sent to a NATA-accredited laboratory for TRH analysis and the laboratory measurements correlated with the sensor measurements. In this way post-calibration of the sensor to actual hydrocarbon readings can occur and profile data can be correctly adjusted.

3.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 3-4: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Technical Lead	• Develop sampling plan • Analyse statistics analysis and oversee data	• Higher degree in relevant subject • Water quality sampling experience
Water Quality Field Lead	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Manage sample contamination risk • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Water quality profiling and sampling field experience • Tropical Basic Offshore Safety Induction and Emergency Training (TBOSIET) • Offshore medical
Water Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Water quality profiling and sampling field experience • TBOSIET • Offshore medical

3.11 Equipment

This list is not exhaustive, but includes basic items that may be used for water quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Van Dorn sampler (e.g. Niskin bottle or equivalent)
☐	Dyneema or equivalent rope/cable for lowering equipment
☐	Water column profiler with appropriate sensors

Item	
☐	Stainless steel sampling buckets/containers
☐	Boom
☐	Absorbent pads
☐	Pouring jugs to fill bottles
☐	CoC documents
☐	Plastic ziplock bags to place glass jars into
☐	Insulated esky for transporting samples
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook, pens, and waterproof markers
☐	Digital camera with integrated GPS stamp, if practicable
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Fridge of appropriate size
☐	GPS unit
☐	Field laptop
☐	Hard drives for data backup
☐	Spare batteries, cable ties, tape, and other miscellaneous items

3.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- The profiler may require a weighted base that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- The type of sensor on the fluorometer is important—an ultra-violet fluorescent sensor will detect aromatics, whereas an infrared sensor will detect aliphatics.
- The sampler for water quality within the water column should allow remote opening and closing to ensure that the required sampling depth has been reached and there is no contamination as the sampler passes through an oiled area. This can be achieved using a bomb sampler, which is usually made of stainless steel but is limited to shallower depths. If a stainless steel sampler is not available, a Van Dorn sampler or similar device could be used. Choice of equipment with remote opening capabilities may be limited; therefore, the contamination potential when using equipment that is open as it passes through the water column (e.g. bomb and Van Dorn samplers) needs to be considered. Water can also be sampled from various depths using a hose and oil-free pump (depth limited).
- Water collected from each depth should be processed by transferring it into a stainless pouring jug or equivalent container easily decontaminated by

hydrocarbon components, so that the appropriate number of sample jars can be filled directly.

- Sampling equipment must be decontaminated and rinsed in ultrapure water before use and in between sites. Sampling containers that do not contain preservatives must also be rinsed before use.
- Decontamination techniques need to take into account the sensitive nature of probes on the profiler.
- Samples are to be stored in the appropriate sample containers, as provided by the laboratory.
- Nitrile rubber gloves must worn at all times when sampling and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Because the sample containers are usually glass, they must be covered with a protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be labelled and recorded, and cross-checked with field sheets and CoC forms.
- Appropriate CoC must be maintained and samples must be secured.

3.12.1 Water Profiling

Step	
☐	In the absence of equipment that can give real-time fluorometry readings (such as a YSI) or if the area is outside the depth capability of instrument (i.e. 250 m), deploy the water column profiler before using the water sampling equipment so that the depths of peaks in fluorometry readings can be determined first. If a dual profiler/sampler is available, then these steps can be done at the same time.
☐	Check that all sampling has been accomplished from the previous drop and the equipment has been decontaminated.
☐	Check that the area where the profiler is to be lowered has no surface slick (which is not expected at this stage of monitoring). If it does, follow the steps below to remove hydrocarbons before deployment.
☐	Remove any protective casings on the profiler sensors before deployment.
☐	Set the profiler to logging mode before lowering it into the water column.
☐	Deploy the profiler over the side of the vessel via a Hiab or similar. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Perform any relevant deployment checks on the profiler that are specific to that piece of equipment.
☐	Allow the profiler to sit at the surface water with sensors submerged so the sensors can equilibrate with environment.
☐	Lower the profiler into the water column at a rate of half a metre per second. Use the ship's echo sounder and markings on the lowering cable/rope to judge water depth and the position of the profiler.
☐	For surface spills involving light hydrocarbons: • Water column profile to 50 m (or depth indicated by other information) Surface spill involving heavy hydrocarbons: • Water column profile to full water depth

Step	
☐	When the water profiler reaches the desired bottom depth, retrieve the equipment and download the data. Keep the sensors moist and protected when the profiler is not in the water. Review data for peaks in fluorometry then collect water samples at those depths.

3.12.2 Water Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. If using sampling equipment that only closes remotely (rather than opens and closes remotely), follow these steps to prevent decontamination across depths (when collecting subsurface samples). Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area . Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Drain the sampling equipment so that no water remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only. Misfires could occur if any errors are made when cocking the bottles (when Van Dorn sample bottles are used).
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	Deploy the water sampling equipment over the side of the vessel via a Hiab or winch. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Lower the sampling equipment into the water column at a rate of half a metre per second. Use the ship's echo sounder and markings on the lowering cable/rope to judge water depth and the position of the water sampling system.
☐	Collect samples at the depths where peaks in fluorometry were observed, or, if this was inconclusive, at a minimum of two depths for waters <50 m deep (near surface and near bottom) or a minimum of three depths for water >50 m deep (near surface, mid-water, and near bottom). How samples are collected depends on the sampling equipment used.
☐	For surface spills involving light hydrocarbons: • minimum two water sample depths (surface 0–0.5 m) and subsurface (~5–10 m) For subsurface spills or a surface spill involving heavy hydrocarbons: • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive a surface and near-bottom sample) • in waters >50 m, a minimum 3 water sample depths (as determined by fluorometer, or if inconclusive a surface, mid-water, and near-bottom sample).
☐	Retrieve the equipment once the subsurface samples have been collected, and extract the water samples. Lower a single water sampling bottle to 0–0.5 m and activate it as the near surface water sample collection.
☐	Once the sample is retrieved, empty the water into sampling containers before filling the laboratory sample jars. Filling sample containers directly from sampling equipment can be difficult and possibly lead to contamination. Decontaminate these containers (as for all sampling equipment) and cover them, if required, to prevent contamination.
☐	Place samples into laboratory provided jars/bottles and seal. Fill sample jars to zero headspace to prevent evaporative loss of volatiles.
☐	Label jars/bottles immediately with: • sample number or code

Step	
	• analysis required • depth • time and date (24-hour clock and DD/MM/YYYY).
☐	Place samples in a small esky with frozen ice bricks. Transfer to refrigerator when possible for storage at 4 °C.
☐	Complete laboratory-specific CoC forms.
☐	Send samples to the laboratory within 72 to 96 hours if possible. Maximum holding time including extraction is 7 days.
☐	At each site, complete a field log including details on: • time arrived at site • environmental conditions at the site • presence of a hydrocarbon slick • sample details for individual samples (as above) • sample description notes (oil, debris, thick slick, film etc.) • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site.
☐	Take photographs throughout the sampling process of: • sampling area (including surface of water) • sampling site • sampling jar before the sample is collected • sampling process • sample jar with contents and being sealed • sealed and secured sampling jars in the case • completed paperwork • sealed and secured case on completion of the sampling. Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.

3.13 Forms and Tools

Refer to Appendix C.

4 SCI2 – Sediment Quality Impact Study

4.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI2 – Sediment Quality Impact Study (SCI2) is to describe the influence of hydrocarbon exposure (level, duration, and type) on sediments.

The objectives of SCI2 are to:

- quantify the temporal and spatial distribution of hydrocarbons in marine sediment
- assess hydrocarbon content of sediment samples against accepted environmental guidelines or benchmarks.

Monitoring requires consistent repeat surveys to determine trends over time. SCI2 is best informed with comprehensive baseline data. The data collected as part of SCI2 should be as comparable as possible (in sampling methods, analysis, and interpretation of results) to baseline data and operational monitoring data.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Data and Information Requirements

Table 4-1 lists the inputs relevant to planning for the implementation of SCI2, once the notification to commence is initiated.

Table 4-1: Data Requirements Summary for SCI2

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS (WA only), or from other agencies, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated data file (Excel file) including exceedances of benchmark levels.

SCI2 will likely inform other SCI studies, and as such outputs from it will be required by those studies.

4.4 Design

4.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS4 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons in sediments, as determined through OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 4-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS4* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)

1 *Reference sites required for each monitoring approach are detailed in Section 1.*

2 *It is recommended that sample replication is conducted for 10% of samples.*

4.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS4 are generated so that the depth and extent of the spill can be incorporated into the survey design. The location of these sites will also be coordinated with the requirements of SCI1 – Water Quality Impact Study.

Sampling sites will be based on locations where hydrocarbons may have sunk through the water column and have contact with sediments. These include areas:

- around the well head, in the event of a loss of well control, as most hydrocarbon-contaminated deposits will be distributed close to the release site
- underlying hydrocarbons that have sunk through water column
- with high levels of suspended sediments (generally nearshore areas)
- such as shorelines and tidal flats where hydrocarbons can potentially become concentrated
- where other SCIs have been triggered

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water and weather conditions. As an example, for a spill in 300 m water depth or greater, assuming 12 hours operations in good weather, it is expected an average of 6 to 8 sites can be sampled each day. This is based on currently available grab sample methods and a winch speed of half a metre per second. This time also includes the requirement for comprehensive field notes and photos for each sample.

4.4.3 Monitoring Parameters

Sediment samples will be collected from all sampling sites using a stainless steel grab, box corer, or remotely operated vehicle (ROV) with corers (or equivalent) for subsequent laboratory analysis of these parameters:

- particle size distribution (PSD)
- TRH
- PAH; only analysed if TRH is detected
- BTEX; only analysed if TRH is detected
- total organic carbon (TOC).

All samples will be compared to the USEPA Sediment Quality Benchmarks for Aquatic Life (Ref. 22) or other relevant benchmarks or guidelines, as detailed in OPS4. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

4.4.4 Monitoring Frequency and Duration

Following the initiation of SCI2, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by examining the data collected to date and the spatial, temporal, and seasonal variability of any associated biological indicators measured in other plans. Survey frequency may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI2 may reach termination criteria but still be required by other SCIs.

4.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 4-3. At each site, three sample jars and one sample bag (total volume/site 1400 mL minimum) will be required. Spare sample containers are required for redundancy.

Table 4-3: Test Parameters for SCI2

Test Parameter	ANZECC Guidelines (µg/g)	USEPA Aquatic Life Benchmark Value (µg/g)	Storage Container	Preservation	Holding Time
TRH (C_6–C_{40})	550[1]		250 mL wide-mouth glass with Teflon cap liner[2]	4 °C (fridge)	14 days (plus holding extracts for up to 40 days)
PSD		N/A	300–500 mL polyethylene bag	-20 °C (freezer)	6 months
TOC		N/A	150 mL wide-mouth glass jar[3]	-20 °C (freezer)	6 months

Test Parameter	ANZECC Guidelines (µg/g)	USEPA Aquatic Life Benchmark Value (µg/g)	Storage Container	Preservation	Holding Time
PAHs			250 mL wide-mouth glass with Teflon cap liner[3]	-20 °C (freezer)	56 days (plus holding extracts for up to 40 days)
Acenaphthene		1 020 000			
Acenaphthylene		800 000			
Anthracene		1 235 000			
Benz (a)anthracene		1 750 000			
Benzo(a)pyrene		2 010 000			
Benzo(b) fluoranthene		2 035 000			
Benzo(g,h,i) perylene		2 270 000			
Benzo(k) fluoranthene		2 040 000			
Chrysene		1 755 000			
Dibenz (a,h) anthracene		2 330 000			
Fluoranthene		1 470 000			
Fluorene		1 120 000			
Indeno (1,2,3-cd) pyrene		2 310 000			
Naphthalene		800 000			
Phenanthrene		1 240 000			
Pyrene		1 450 000			
BTEX			250 mL wide-mouth glass with Teflon cap liner (taken from TRH sample)[2]	4 °C (fridge)	14 days
Benzene		1 680 000			
Toluene		2 060 000			
Ethylbenzene		2 465 000			
Xylenes		2 490 000			

1 *National Assessment Guidelines for Dredging (Ref. 23) ISQG Trigger Value*

2 *Minimise headspace in jars. Avoid exposure to light.*

3 *Room for expansion (during freezing) must be left at the top of the jar. Avoid exposure to light.*

4.4.6 Sample Analysis

Sediment samples will be analysed at NATA-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is recorded. PSD will be analysed using laser diffraction (for <500 µm fraction) and dry sieving (≥500 µm fraction).

4.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. These data are usually received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

4.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples, but, instead, using a sample jar pre-filled with laboratory-certified clean sediment. A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during transport, storage, and analysis, laboratory-certified clean sediment will be provided by the laboratory in the relevant sample jars and these jars are to remain unopened. The sediment will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Sampler will be cleaned with Decon 90 and ultrapure water between sampling sites.
- Sample processing equipment (utensils/bowls) will be cleaned between replicates.
- Contaminant samples will not be taken from within 5 to 10 mm of the sides of the sampler walls.
- Samples where water has dripped into the sample from the winch wire will be discarded.
- Samples in which the grab has not closed correctly will be sampled again.
- Nitrile gloves must be worn at all times when handling sediment sampling equipment. Gloves must be changed between each sediment sampling location or when contaminated.

- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the sediment sampling equipment.
- No smoking is to occur while sampling is being undertaken.
- As far as possible, the insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, surfaces, or vessel).
- A review of the deck will be undertaken before vessel departure to identify any areas of potential contamination and to define a clean area where sample processing may be undertaken to reduce contamination risk.
- Take GPS waypoints of all sites sampled from the vessel.

4.7 Mobilisation Requirements

4.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

4.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
☐	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
☐	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
☐	Assemble scientific survey team
☐	Book flights, accommodation, and car hire
☐	Confirm equipment list and availability of items; purchase consumables (as required)

	Task
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from the vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

4.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

	Task
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

4.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 4-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Sediment Quality Field Lead	• Develop sampling plan	• Minimum degree in relevant subject • Sediment quality sampling experience
Sediment Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Sediment quality sampling field experience

4.11 Equipment

This list is not exhaustive, but includes basic items that may be used for sediment quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Stainless steel grab or box corer, or equivalent
☐	Glass mixing bowl
☐	Stainless steel spoons
☐	Boom
☐	Absorbent pads
☐	CoC documents
☐	Polyethylene/ziplock bags for PSD
☐	Polyethylene/ziplock bags to place glass jars into
☐	Insulated esky to place samples into
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook
☐	Digital camera with integrated GPS stamp, if practicable
☐	Camera set up for sampling equipment
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Field laptop
☐	Hard drives for data backup

4.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- Sediment samples will be collected using a corer/grab, either from a vessel or using an ROV, on an ongoing basis (if hydrocarbons are detected during the initial survey and attributable to the spill) until the termination criteria are reached.
- The grab or corer for sampling marine sediments should close when the equipment encounters the seabed to ensure that the bottom has been reached. This can be achieved using a grab or box corer, which is made of stainless steel.

- Sampling equipment must be decontaminated and rinsed before use and in between sites. Sampling jars that do not contain preservatives must also be rinsed before use.
- When the core or grab is retrieved, the sample should be photographed with a site label, then homogenised in a glass bowl using a stainless steel spoon.
- Samples must be placed into laboratory-provided sampling containers.
- Samples must be stored in the laboratory-provided sampling containers.
- Nitrile rubber gloves must be worn at all times when sampling, and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Samples must be put into refrigerated storage immediately and chilled to 4 °C before shipping to a NATA-accredited laboratory.
- Sample containers must be covered in protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Samples should be analysed by the analytical laboratory within 14 days of collection.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be recorded and photographed for forensic/legal purposes.
- Appropriate CoC forms must be maintained and samples must be secured.

4.12.1 Sediment Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. As most sediment sampling equipment passes through the water column in the open position and only closes when it contacts bottom sediments, there is potential for contamination from a surface slick. Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area. Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Check the equipment is empty so that no sediment remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only.
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	The sediment sampling equipment will likely be deployed over the side of the vessel via a Hiab or deck winch. The Sediment Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Sediment Quality Assistant.
☐	Lower the equipment into the water column at a rate of approximately half a metre per second. Use the ship’s echo sounder and markings on the rope or cable to judge water depth water and the position of the sediment sampling equipment.
☐	Take samples when the sampling equipment reaches the bottom. Preferably, sampling equipment will have an attached camera that can take plan view and downward-facing photos of the seabed.

Step	
☐	Retrieve the equipment and extract the sediment samples.
☐	Assess the sediment samples before removing them from the sediment sampler to check that sufficient volume was collected and there is no indication of potential contamination or loss of sediment that could affect the integrity of the sample. Take photos of the sample before removal, including a photo slate that shows: • date • sample reference (including information on location, site, and replicate number) • scale bar
☐	Collect subsamples from the surface 2–3 cm, put into the glass mixing bowl, then homogenise. Collect subsamples from the bowl for each analyte required. TOC and PAH samples both require room for expansion as these samples will be frozen. Samples for TRH/BTEX should not have any headspace.
☐	Label jars/bottles immediately with: • sample number or code • analysis required • depth • time and date (24-hour clock and DD/MM/YYYY)
☐	Place samples in a small esky with frozen ice packs. Transfer to refrigerator/freezer (depending on sample type) when possible.
☐	Complete laboratory-specific CoC forms.
☐	Send samples to the laboratory within 10 days if possible. The maximum holding time including extraction is 14 days for TRH and BTEX.
☐	Complete a field log at each site, including details on: • time arrived at site • environmental conditions at the site • presence/absence of a hydrocarbon slick • sample details for individual samples (as above) • sample description notes (oil, debris, thick slick, film etc.) • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site
☐	Take photographs throughout the sampling process of: • sampling area • sampling site • sampling jar before the sample is collected • sampling process • sample jar with contents and being sealed • sealed and secured sampling jars in the case • completed paperwork • sealed and secured case on completion of the sampling. Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.

4.13 Forms and Tools

Refer to Appendix C.

5 SCI3 – Coastal and Intertidal Habitat Impact Study

5.1 Aims and Objectives

The primary aim of SCI3 – Coastal and Intertidal Habitat Impact Study (SCI3) is to assess impacts to coastal and intertidal habitats and associated biological communities after a hydrocarbon spill. Sampling may need to be conducted on an ongoing basis throughout the spill, response activities, and for some time after termination of the response.

The intertidal zone is the focus of SCI3—it is the region that extends from the lowest astronomical tide (LAT) to the highest astronomical tide. Habitats seaward of LAT (e.g. the subtidal zone) are included in SCI6 – Benthic Habitat Impact Study.

The objective of SCI3 is to:

- determine the extent, severity, and persistence of impacts on intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities.

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Data and Information Requirements

Table 5-1 lists the inputs relevant to planning for the implementation of SCI3, once the notification to commence is initiated.

Table 5-1: Data Requirements Summary for SCI3

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models, where available, for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • Oil Spill Response Atlas (OSRA) provided by AMSA	Outputs from OPS5 activities including: • intertidal habitat distribution, extent, and impact (i.e. maps, photographs, Excel datasheets) • intertidal assessment methods Outputs from MES activities including: • spill type • spill volume and duration • details of dispersants used, volumes, locations, and methods of application • observed and/or recorded spatial extent and movement of the spill • metocean data (e.g. currents, wind, sea state) • consolidated water quality and chemical characterisation data from Operational Scientific Monitoring, including locations of exceedances of benchmark levels, where available.	Information available at the commencement of SCI3 on survey design, or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI6)

5.4 Design

5.4.1 Monitoring Design

Intertidal habitats within the study area support various biological communities, which vary in their sensitivity to hydrocarbon spills. Some ecosystems have been reported to recover quickly from spills, with little or no noticeable harm, while others experience long-term harmful effects. To help inform scientific monitoring, it is essential that the pre-impact condition of the intertidal habitats of interest are known or can be reliably inferred. This can be achieved by assessing against pre-impact baseline data (if available) or inferring from reference sites that are considered comparable to impact locations.

Monitoring will concentrate on activities that help in understanding the impacts on the most sensitive areas. A combination of monitoring types will be used:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during intertidal surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from OPS5 and MES scope may be suitable). Once images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large-scale changes in some intertidal habitats.
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on intertidal habitats and associated biological communities.
- Chemical studies: To identify contamination and attribute cause and effect relationships to the impacts of a hydrocarbon spill.

The monitoring approach needs to consider the data collected during MES and OPS activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, sediments, and shoreline, as determined through OPS3, OPS4, and OPS5. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 5-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 5-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with repositioned centre point, aligned with results from OPS monitoring or SCI1 or SCI2 and/or modelling), and/or Lines of Evidence Approach.	Minimum of **two** replicate sites at each distance from the centre point
Nearshore spill or spill reaches shoreline	BACI, IvC, Gradient Approach, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); or minimum **two** replicate sites at

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
		each distance from source (Gradient); and/or multiple replicates depending on Line of Evidence type
Spill interacts with area of biological importance (bay/shoal/island)	BACI, IvC, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); and/or multiple replicates depending on Line of Evidence type

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from a spill, then during and after the spill
- randomly or haphazardly select transect position for grabs, quadrats etc. within each site.

5.4.2 Monitoring Sites

Sampling sites will be defined once data and information from the sources outlined in Section 1.4 are reviewed. This review will help identify sensitive habitats, species, and protected areas.

Identify monitoring sites using these guidelines:

- likelihood of hydrocarbon impact on benthic habitats
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- the degree of hydrocarbon exposure or potential exposure of the benthic habitats
- accessibility of habitat types.

When selecting monitoring sites, follow these guidelines:

- Select several impact and reference locations over a large spatial area.
- Select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the environment that may be affected (EMBA), or those within areas of protection or conservation priority.
- When selecting reference sites, key physical factors (e.g. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between sites.
- Reference sites may also include areas impacted by the spill and left to recover naturally.
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations.

- Dispersion of a large spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

5.4.3 Monitoring Parameters

5.4.3.1 Physical Monitoring Parameters

Monitoring physical parameters complements biological monitoring where direct changes to the intertidal habitats are measured. Monitoring will be conducted at all biological monitoring sites, where practicable.

The physical character of the intertidal sites will be described by recording the parameters in Table 5-3.

Table 5-3: Physical Parameters and Methods

Parameter	Method
Surface and subsurface oil observations, mass of oil on intertidal	See AMSA [Ref. 17], Guidelines S.5, S.6, and S.9
Substrate type	See AMSA [Ref. 17], Guideline S.2
Form: geomorphological type, dimensions, profile, or gradient	See AMSA [Ref. 17], Guideline S.3
Energy: winds, waves	See AMSA [Ref. 17], Guideline S.1
Water quality	Refer to data collected from SCI1

5.4.3.2 Biological Monitoring Parameters

Cause-effect relationships based on existing literature will guide the selection of monitoring indicators that are likely to show a response in the target receptor for the intertidal habitat(s) surveyed. This risk-based approach initially focuses on response indicators that show early warning signs of effect (e.g. molluscs) in intertidal habitats. The proposed parameters, biological indicators, and monitoring methods are listed in Table 5-4.

Table 5-4: Proposed Biological Parameters and Survey Methods within Coastal and Intertidal Habitats

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
Rocky shoreline	Algae	Macroalgae	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1]	• Density/distribution of sensitive taxa[1] • Above-ground biomass[1]	• Hydrocarbon cover • Leaf/blade/thallus condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Molluscs[2], barnacles, chitons, crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/distribution of sensitive taxa • Size structure1	• Hydrocarbon cover • Tainting[2]
Sandy beach	Infauna	Amphipods, polychaetes	Stratified/haphazard sampling using quadrats/transects	• Density of organisms[3] • Diversity[3] • Distribution[3] • Dominant taxa[3]	N/A	• Tainting[2]
Low (intertidal) tidal flats	Algae and plants	Macroalgae (e.g. *Sargassum*), seagrass	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1] • Canopy height[1]	• Density/distribution of sensitive taxa[1] • Above-/below-ground biomass[1]	• Hydrocarbon cover • Thallus/leaf/blade condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Hard corals, soft corals, filter feeders, molluscs[2], crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Percentage cover/ density of organisms • Diversity • Dominant taxa	• Density/distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Health indicators (bleaching, disease) • Tainting[2]
	Algae and plants	Samphire shrubs[4]	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution[1]	N/A

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
High (intertidal) tidal flats		Samphire shrubs[4], microalgae[4]	Stratified/haphazard sampling using quadrats/transects	• Plant density[1] • Distribution[1]	• Species density/ distribution[1] • Increase in microalgal density[1]	• Plant height[1] • Hydrocarbon cover • Seedling height and density • Tainting (microalgae)[2]
	Epifauna	Molluscs[4], burrowing crabs[4]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]
Mangrove and depositional intertidals	Plants	Mangroves	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution1	N/A
			Stratified/haphazard sampling using quadrats/transects	• Density of trees[1] • Distribution[1]	• Species density/ distribution[1]	• Foliage density[1] • Health (withered yellowing leaves, dull colouring) • Canopy height • Girth • Dead vegetation • Pneumatophore density • Seedling height and density
	Epifauna	Molluscs[3], burrowing crabs[3]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]

1 *Some of these parameters can be expected to show large seasonal and interannual variability and this must be taken into account when designing the surveys (i.e. number of replicates required, frequency of surveys).*

2 *Can show strong variation in response to physical parameters such as height of tide, wind direction, position of the sun. Sampling times should be collected from similar heights on shore and similar tidal patterns.*

3 *Highly variable and adequate replication is required for sampling replicates and frequency. On sandy intertidal habitats, shows strong correlations with PSDs and depth. Some species show strong behavioural cycles such as response to temperatures and inactivity during moulting (e.g. crabs in mangroves).*

4 *Can show strong variation in response to physical parameters such as rainfall patterns and salinity.*

5.4.3.3 Chemical Monitoring Parameters

Chemical monitoring of water and sediment samples should be conducted at all biological monitoring sites, where practicable. Parameters to be tested and methods for water and sediments are described in detail in SCI1 and SCI2 respectively.

Tissue samples of benthic organisms may be examined for chemicals at both impact and control sites to determine the bioavailability and bioaccumulation of hydrocarbon contaminants. The requirement for tissue sampling will be determined based on the scale and magnitude of the impact. SCI7a – Fisheries and Aquaculture Impact Study details the parameters, methods, and sampling protocols to collect samples from molluscs and similar organisms. Selection of taxa depends on their relative abundance, and consequent ability to obtain suitable sample sizes over a range of sites and treatments (impacted, non-impacted). Potential indicator taxa to be tested for bioaccumulation of hydrocarbons include:

- bivalve molluscs (Ref. 24)
- gastropod molluscs (Ref. 25)
- macroalgae
- infauna, corals and filter feeders may provide suitable alternatives (Ref. 26).

5.4.4 Monitoring Frequency and Duration

Following the initiation of SCI3, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

5.4.5 Sample Integrity

5.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

5.4.5.2 Remote Sensing Methods

Remote sensing can be used initially to determine potentially impacted habitats, habitats at risk, and reference areas (the outputs from OPS3, OPS4, OPS5, and MES scopes may also be suitable). Remote sensing may, if practicable, also be used to assess biological parameters for some habitat types within the study area to measure the condition of those habitats during scientific monitoring. For example, remote sensing is the quickest way to estimate the distribution and extent, and in some cases the condition, of upper intertidal habitats such as mangroves and samphire shrubs, and can also detect hydrocarbon spills.

A guideline for undertaking aerial surveillance of intertidal areas is provided in AMSA (Ref. 17), Guideline S.4. The remote sensing technique used (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) will depend on the intended parameter to be collected (e.g. presence/absence, percentage cover), and evaluating the pixel size required (i.e. coarse, medium, fine) as well as cost. A guideline for implementing remote sensing monitoring equipment is provided in by the Remote Sensing Research Centre (Ref. 27).

However, to correctly calibrate remote sensing imagery, ground-truthing (i.e. validating the density of trees and distribution and extent of the habitat) of imagery and measurements will be required (as discussed in the subsections below). Remote sensing has been shown to be a successful tool for estimating canopy density and extent in mangrove and high tidal flat habitats (Ref. 28), and these parameters can be used to infer the condition of these habitats during scientific monitoring.

In Situ Monitoring Methods

Intertidal systems are highly complex and demonstrate natural spatial and temporal variation in physical and biological structure. The monitoring program must target the main ecological communities, biological indicators, and key species of intertidal habitats that are sensitive indicators, and which can act as proxies for assessing wider community health. Potential biological indicators, parameters, and methods are shown in Table 5-4.

Mangrove, Saltmarsh, and Epiflora

Ground surveys provide quantitative data on the health, density, and condition of mangrove and saltmarsh habitats, as well as data for calibrating remote sensing data, validating the density and distribution of trees, and determining the extent of the habitat. Systematic sampling of quadrats along transects for mangrove and saltmarsh environments will, as far as practicable, include measures of the parameters in Table 5-3.

Ground surveys will use 0.25 m^2 quadrats for measuring seedling density and height, and, depending on the density of trees, a minimum of 1 m^2 (often 5 m^2) quadrats for tree measurements. The quadrant sizes should be adjusted according to the density of the taxa being surveyed. Quadrats will, as far as practicable, be photo documented to allow for skilled interpretation at a later stage, and to allow precise, digitised estimates of the relevant parameter.

Transects/quadrats may also be used to determine the percentage cover, diversity, and distribution of macroalgae on low tidal flats and microalgae on high tidal flats. Any assessment of the potential impact of hydrocarbons on these organisms may be influenced by large natural variability in both populations and communities.

Monitoring of macroalgae and microalgae will be of limited value unless the intention is to demonstrate and confirm that hydrocarbons have been taken up into these organisms.

Epifauna

An initial guideline for monitoring the potential impact on invertebrate intertidal fauna is provided in AMSA (Ref. 17), Guideline S.10. The recommended methods for monitoring community structure and population density on rocky intertidal (and mangrove and mudflat) habitats for epifaunal macroinvertebrates are those described in MacFarlane and Burchett (Ref. 29). Surveys would typically lay multiple quadrats (0.25 m^2 quadrats are commonly used) along a transect line.

Transect locations may be stratified in different heights in the intertidal zone (i.e. high, mid, and low intertidal).

Information recorded by field scientists for each quadrat will vary with location and assessment goals; however, it may include:

- main species (macroinvertebrates and algae) present
- range of species richness (i.e. numbers of species)
- indicator species
- ranges of mean abundances in each subzone.

Quadrats should be photo documented to allow for further skilled interpretation at a later stage, and to allow precise, digitised estimates of percentage cover, density diversity, and abundance.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). A guideline for obtaining intertidal sediment samples is provided in AMSA (Ref. 17) Guideline S.8.A. The entire sample is sieved for benthic infaunal analyses, or, if chemical subsamples are required, care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, and then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and a representative sample of the species present.

As infauna community structure is often strongly correlated with PSD, sediment samples should also be collected for PSD analysis.

If a decision is made to investigate infauna as part of SCI3, it will likely be based on assessments made during OPS5.

Dead Fauna

Any marine invertebrates, including bivalves, crabs, sea urchins, and starfish found washed up dead or moribund and discovered opportunistically during surveys should be recorded and, in some cases, collected. Dead fauna provide essential information for assessing impacts and wider ecological interest. Handling of large dead fauna and birds should be done in accordance with SCI4 – Seabirds and Shorebirds Impact Study. Numbers of individuals and species identification should be recorded, with photographs and at least some specimens taken for later analysis. Individual samples must be labelled with information that includes the location and date found.

5.4.5.3 Chemical Monitoring Methods

Chemical monitoring of water and sediment samples will be conducted at all biological monitoring sites, where practicable.

Water and Sediment Sampling

Water and sediment sampling are described in detail in SCI1 and SCI2 respectively. The general steps outlined in SCI1 and SCI2 will be followed for determining the overall sampling design and appropriate levels of replication.

Biota Tissue Sampling

Tissue samples of epibenthic organisms for chemical analysis and examination may be obtained through field sampling. Following collection, tissues samples should be extracted from shells, and holdfasts removed from algae. Material should be separated by taxa and approximately 50 g wet weight of flesh for each sample, transferred into sterile packs, then frozen until delivery to the analytical laboratory. SCI7a details the parameters, methods, and sampling protocols to collect biota specimens for analysis.

These protocols outline the sampling methodology used for SCI3:

- Sampling Surface Oil Slicks and Films (AMSA [Ref. 17] M.6)
- Sampling of Subsurface Water (AMSA [Ref. 17] M.7)
- Guideline for Handling Samples (AMSA [Ref. 17] G.1)
- sampling of invertebrate intertidal communities, based on MacFarlane and Burchett (Ref. 29)
- sampling of macro infauna intertidal communities, based on Junoy *et al*. (Ref. 30)
- Guidelines for Sediment Sampling (AMSA [Ref. 17] S.8)
- biomarker assessment of macroinvertebrate tissue, based on Brooks *et al*. (Ref. 31) for mussels
- Mangrove Tree Health Scoring System, as adapted from Eldridge *et al*. (Ref. 32).

See Section 5.13 for the SOPs associated with each of these sampling methods.

5.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Including results from field sampling and observations.
- Photo documentation: Photographic and video evidence, ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that is easily accessible for future reference.

Many of the monitored parameters collected using quadrats will be measured and quantified from the still photos taken in the field. Percentage cover of common and conspicuous organisms (e.g. macroalgae, microalgae) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. gastropods, bivalves) the density, diversity, and abundance of organisms will be recorded per quadrat or unit area.

5.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

5.6 QA/QC Procedures

QA/QC procedures will be used to objectively remove any photographic images that are not suitable for analysis (e.g. images that are blurred, smudged, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the World Register of Marine Species (WoRMS) Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove ‘ecological noise’ from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

5.7 Mobilisation Requirements

5.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)

Task	
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

5.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required, to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements, and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

5.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working(for an equipment list, see Section 5.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

5.10 Resources

Accurate identification of marine intertidal biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct technical QA/QC of image analysis. The personnel required to undertake SCI3, their roles, and relevant qualifications are listed in Table 5-5.

Table 5-5: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Field Lead/ Party Chief	• Manage survey plan • Capture survey positional data • Coordinate with aerial and ground survey teams • Manage fatigue and health and safety • Prepare daily field survey reports • Plan survey schedule	• Minimum degree in a relevant subject • Significant field experience
Marine Scientists / Field Technician (as required)	Scientific program delivery: • set up transects and quadrats • classify habitat • QA/QC still photos • manage data • collect sediment samples • sieve and preserve benthic infauna samples • conduct physical site observations • record survey and sampling data • backup digital data (including images) • maintain equipment and resolve technical issues	• Minimum degree in a relevant subject • Specialist coastal ecological knowledge of the region • As above if vessels are used

5.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment required for SCI3 is listed below.

Items	
☐	Specialist equipment: • Multiparameter probe/conductivity temperature depth (CTD) probe • Thermometer • Benthic grab and sieve • Remote sensing platform
☐	Is redundancy required?
☐	Measuring equipment: • Transect tape measure • Tape measure for establishment of 5 × 5 m^2 quadrats • 1 m^2 quadrat • 0.5 m^2 quadrat

Items	
	• 0.25 m^2 quadrat • Metal ruler • Dressmakers tape • Tree-high pole
☐	Sediment sample collection: • Trowel • Plastic sediment corers • Shovel
☐	Beach profiling tools: • Dumpy level • Staff
☐	Paperwork: • Clipboards (large enough for A4 datasheets) • Datasheets (printed on waterproof paper) • Several pencils • Tide tables • Species identification sheet
☐	Cameras, including batteries and data cables
☐	Radios, 3G data, satellite phone/data for communication
☐	First aid equipment and PPE (e.g. reef boots, lycra leggings)
☐	Field laptops with relevant software (e.g. CPCe, photo editing, Collaborative and Annotation Tools for Analysis of Marine Imagery and Video [CATAMI; Ref. 60])
☐	Backup field data storage

5.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected.

5.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives.
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives.
☐	Prepare and assemble all field equipment, including redundancies.
☐	Arrange access to vessel or other suitable monitoring platform.

5.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects.
☐	Randomly select the locations of transects at each site.

Step	
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect.
☐	Use a minimum of three replicate transects at each site.
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment).
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites.
☐	Take photos with a still camera, or as still images from video transect footage.
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable, use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage).
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale.
☐	Where possible, locate transects in similar depths within sites.
☐	After retrieval, QA/QC check and backup data on site.
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

5.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site.
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2.
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier.
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory.

5.13 Forms and Tools

Refer to Appendix C.

6 SCI4 – Seabirds and Shorebirds Impact Study

6.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI4 – Seabirds and Shorebirds Impact Study (SCI4) is to document and quantify shorebird and seabird presence and any resulting impacts and potential recovery from hydrocarbon exposure.

The objectives of SCI4 are to:

- identify and quantify, if time allows, the post-spill/pre-impact presence and status (e.g. foraging and/or nesting activity) of shorebirds and seabirds in the study area
- observe, and if possible quantify, actual exposure of shorebirds and seabirds to oil (i.e. post-impact) and to the response
- identify and quantify the post-impact status of shorebirds and seabirds (e.g. foraging and/or nesting activity) in the study area
- quantify recovery of shorebirds and seabirds from any harmful effects of hydrocarbons.

The scope of seabird and shorebird monitoring depends on the receptors identified within the EMBA of the hydrocarbon spill.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Data and Information Requirements

Table 6-1 lists the inputs relevant to planning for the implementation of SCI4, once the notification to commence is initiated.

Table 6-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
Any existing baseline data including population sizes and any known life-history parameters. Baseline data may be available from: • OSRA provided by AMSA • I-GEMS (WA only) • Species Profile and Threats (SPRAT) database (Ref. 34) • Bird Life Australia (birdlife.org and birdsinbackyards.net) • Birds Korea (birdskorea.org). Review methods undertaken during baseline studies to ensure that data collected during SCI3 can be directly compared to the existing baseline data.	Outputs from MES, OPS3, OPS 4, OPS5, OPS6, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS6) • knowledge of any proposed designs for other SCI activities • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches.

6.4 Design

Flexibility is required when implementing the scientific monitoring program to allow for changes to the trajectory of the actual hydrocarbon spill, weather conditions, seasonal presence of shorebirds/seabirds, and/or the life stages present. To prioritise monitoring, this information will be necessary to establish which species may occur in the area, and to select appropriate survey methods and effort to be used:

- review maps that characterise activities of seabirds and shorebirds in the study area
- assess the regional habitat frequency and function:
  - are the habitats rare or common?
  - are the habitats likely to be critical to the species' persistence?
  - how likely is the species to use the site? (breeding, overwintering etc.). Adjust the survey design to determine these aspects, if necessary.
- identify ecologically significant birds known to occur in the study area and determine the likelihood of occurrence, habitat requirements, and timing.

Existing information on the study area and surrounding region and the best-available information on species composition and population sizes developed from OPS6, together with available ongoing seabird and shorebird studies, should be used to develop the sampling design of the seabird and shorebird monitoring program

6.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS6 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS6. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 6-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 6-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Offshore hydrocarbon plume (pelagic surveys)	Gradient Approach	Will be determined when the program is finalised
Hydrocarbon spill reaches shoreline with known roosting habitat	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised
Hydrocarbon spill interacts with areas of biological importance, foraging areas	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised

1 Reference sites required for each monitoring approach are detailed in Section 1.

The scientific monitoring program may include shoreline and pelagic assessments. The program must allow for more detailed bird counts and inclusion of other parameters (e.g. nests or roosting sites) as compared to the program conducted under OPS6. The scientific monitoring program also requires repeating targeted searches of selected colonies and/or foraging grounds at frequent intervals. The procedure for moving from single measures of the diversity and abundance of populations to a monitoring program is described below:

- Select colonies, foraging grounds, and species for routine monitoring: Colonies and/or foraging grounds must support a variety of species and be reasonably accessible, allowing both aerial survey/photography and ground counts, and must include colonies and/or foraging grounds in vulnerable areas as well as reference colonies and/or foraging grounds not considered to be at risk from the hydrocarbon spill; species selected should be representative of the taxonomic and ecological variety of the region.
- Within selected colonies and/or foraging grounds, identify particular resources or habitat strata and representative study plots where birds will be counted in detail to assess changes in status. Permanently mark these plots in the field and on good-quality photographs, for future reference.

6.4.1.1 Shorebirds

Shorebird assessments will focus on monitoring species at important foraging sites. Specific shorebird monitoring techniques recommended by the former Commonwealth Department of Environment Water, Heritage, and the Arts [Ref. 35]) are outlined in Table 6-3.

Table 6-3: Recommended Survey Methods for Shorebirds

Environment	Recommended Techniques
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.1.2 Seabirds

Seabird assessments will focus on monitoring species at important breeding colonies. Table 6-4 outlines the proposed techniques for monitoring the diversity and abundance of seabird populations.

Table 6-4: Recommended Survey Methods for Seabirds

Environment	Recommended Techniques
At sea	• Shipboard transect surveys, observing in all directions from the ship • Aerial transect surveys for detecting in expansive areas • Observation from onshore vantage points using a telescope, particularly during strong onshore winds
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.2 Monitoring Sites

The scale of monitoring depends upon the size, location, and time of year of a spill. Sampling, and therefore monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify monitoring locations, including impact sites (all colonies/nesting sites that may have been exposed to hydrocarbons) and reference sites.

The selection of monitoring sites will be based on these criteria:

- the type of hydrocarbon spilt, weathering characteristics, and extent of the spill
- for shorebirds, the number of important foraging areas affected by the spill
- for seabirds, the number of colonies affected by the spill.

Colonies and nesting sites for ground-based surveys should be accessible by a tender from a vessel or from land. Sites that are inaccessible by land or boat may not be monitored.

6.4.3 Monitoring Parameters

Shorebird and seabird scientific monitoring programs will focus on a subset of shorebird and seabird species—indicator species—considered to be ecologically significant to the study area. These indicator species have a high number of interactions with the region (nesting and/or foraging) or have life-history characteristics that make them particularly susceptible at a population level to impacts from a hydrocarbon release (Ref. 36). Routine data on all other shorebird and seabird species that are encountered should also be gathered.

Table 6-5 summarises the monitoring methods and associated parameters that will be used to assess the impact and recovery of seabird and shorebird populations in the event of a hydrocarbon spill.

Table 6-5: Monitoring Metrics for Seabird and Shorebird Populations

Environmental Focus	Methodology	Condition Metric
Seabird and shorebird abundance	• Aerial shoreline surveys • Vessel shoreline surveys • Ground shoreline surveys • Aerial pelagic surveys • Vessel pelagic surveys	• Species diversity • Abundance of indicator species based on numbers of adults • Abundance of non-breeding birds • Abundance of breeding pairs • Species distribution • Total counts of occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • Qualitative abundance estimates (breeding presence) • Injury/mortality

6.4.4 Monitoring Frequency and Duration

Following the initiation of SCI4, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached

For robust estimates of shorebird populations, counts should be conducted at least once (preferably twice) during summer and winter and possibly repeated based on the initial results, so that natural variation can be accounted for and used to predict potential future trends. However, shorebird populations are known to vary between years and even within seasons when environmental conditions change. Estimates of seabird populations are best measured at a time of the year when their presence is most stable; e.g. breeding season.

For robust estimates of the breeding seabird population it is recommended to conduct the assessment towards the end of the incubation period. Any ongoing monitoring should to be undertaken at the same time of year (within the bounds of finding the most appropriate tidal series). Appropriate tide heights will be identified by CAPL when the study commences (e.g. the second high tide series in November may be considered appropriate based on other shorebird monitoring conducted in the north-west of Australia). Spring tides are favoured for shorebird surveys—birds are concentrated appropriately during high water, making the identification of important roost sites possible, and making the birds relatively easy to count.

6.4.5 Sample Integrity

Transect estimations for each observer will be calibrated before aerial and vessel surveys (see SOPs in Section 6.13).

6.4.6 Sample Analysis

These analyses will be used as part of this assessment:

- Observe and quantify actual hydrocarbon exposure of birds: Detail and compare records of oiled and dead birds during the spill and for a required duration after the spill.
- Identify and quantify the post-impact presence and activity/status of birds (e.g. foraging and/or nesting activity in the study area): Measure changes of selected bird populations at impact sites before and after impacts, compared to population changes recorded at reference sites.
- Quantify recovery: Monitor populations at impact and reference sites over time until they display similar dynamics.

6.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings

- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

6.6 QA/QC Procedures

These field data procedures and protocols will be implemented:

- All personnel will have training, where relevant, on species identification and procedures for shorebird and seabird surveys.
- All images will be checked to confirm that they are not blurry, etc.
- Each day, the Field Lead will review video and datasheet recordings and the database/spreadsheet to confirm accuracy and consistency in recording of data.

6.7 Mobilisation Requirements

6.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

6.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire

	Task
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble the scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

6.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

	Task
☐	Confirm specialist equipment requirements and availability (grab, corer or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

6.10 Resources

The personnel required to undertake SCI4, their roles, and relevant qualifications are listed in Table 6-6.

Table 6-6: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Seabird/ Shorebird Field Lead	• Conduct shoreline and pelagic observations • Identify species • Prepare daily field reports	• Shorebird and seabird identification skills relevant to the species in the study area • Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Field Assistant	• Record survey observations and GPS positions during observations on datasheets	• Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Oiled Wildlife Responders	• Handle oiled wildlife	• Oiled wildlife response • Fauna handling • Fauna euthanasia

6.11 Equipment

The basic set of equipment required for SCI4 is listed below.

Item	
☐	Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration
☐	Field guides to help identify shorebirds and seabirds
☐	Note pad and pen (or alternative recording means e.g. laptop)
☐	GPS and spare batteries
☐	Survey plan
☐	Field datasheets
☐	Required permits, where applicable
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size (smaller or larger binoculars are inappropriate for bird watching)
☐	Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification
☐	Log book/observation sheets
☐	Camera, storage media, and batteries (with spares)
☐	Laptops, battery chargers
☐	Hard drives
☐	Phones, satellite or radio communications
☐	Measurement tools
☐	Gloves
☐	Refrigerator or eskies with ice
☐	Sample bags
☐	Aircraft for reconnaissance
☐	Vessel/vehicle (depending on location)

6.12 Standard Operating Procedures (SOPs)

6.12.1 Shoreline Surveys

Shoreline assessments are effective for detecting the presence and abundance of many breeding shorebird and seabird species. Shoreline assessments will be conducted using one or more of these methods:

- aerial surveys, including drone surveys (can rapidly cover large areas of land and/or water and can provide information on nesting sites for follow-up ground surveys)
- vessel surveys
- ground surveys (used to count birds, pairs, or nests).

6.12.2 Pelagic Surveys

Both vessel and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel surveys allow more time to identify the taxa and record other details such as age, sex, and behaviour, thus improving the chances of recording rare, inconspicuous, and diving taxa.

The SOPs for these survey techniques are detailed below.

Vessel Survey SOP	
Pre-survey	
☐	Calibrate distance estimation for each observer
☐	Establish transects or shoreline plots to be surveyed
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification
During Survey	
☐	Vessel speed: 10 knots (range 5–15 knots)
☐	Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger
☐	Two observers record from each side of the vessel
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Count actual numbers (direct counting) or estimate if numbers are large. If estimating: • estimate total number of birds first; then • estimate the proportion of species within the total number of birds estimate
☐	Take photographs to help identify and count species
☐	General observations: • describe the habitat in detail (including condition of the habitat at the time of the survey) • predator presence / evidence of predation.
☐	Record other variables including, as far as practicable: • location • vessel speed and direction • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.
☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas
☐	Record the presence of other vessels in the survey area, as they may affect the behaviour of the birds
☐	Count individuals following the vessel only once

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
Pre-survey	
☐	Calibrate transect estimation for each observer
☐	Establish transects or shoreline plots to be surveyed
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During Survey	
☐	Aircraft speed [1]: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Select aircraft speed and altitude to maximise ease of bird detection and identification and minimise the risk of collision with ground structures or airborne birds (Ref. 37) (~600 to 1000 transects can be flown in a six-hour period)
☐	Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger
☐	Two observers record from each side of the aircraft
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Count actual numbers (direct counting) or estimate if numbers are large. If estimating: • estimate total number of birds first; then • estimate the proportion of species within the total number of birds estimate
☐	Take photographs to help identify and count species
☐	General observations: • describe the habitat in detail (including condition of the habitat at the time of the survey) • predator presence / evidence of predation.

☐	Record other variables including, as far as practicable:
	• location
	• aircraft speed and direction
	• weather conditions, including:
	  – temperature
	  – precipitation
	  – wind strength and direction
	  – visibility.

☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas

[1] Can use a helicopter, fixed-wing aircraft, or drone (with replacement of equivalent methods)

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
☐	Record the presence of vessels or other aircraft in the survey area, as they may affect the behaviour of the birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

Ground Survey SOP	
Pre-survey	
☐	Determine colonies and/or transects/shoreline plots to be surveyed
☐	Sampling units should be positioned far enough apart that individual birds are unlikely to be detected from more than one sampling location, ensuring the samples are independent
☐	The number of sampling units within the study area (or strata) should be proportional to its size, a principle referred to as 'area-proportionate sampling'
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish points or census method for colonies and/or strip width for transects
During Survey	
☐	Breeding sites: • describe the colony in as much detail as possible to allow precise relocation in future surveys • develop a map that describes the relevant features and limits of the environment • take photographic records that include location, direction of photograph, date, time, camera, and shooting distance.
☐	Obtain GPS positioning for: • extent of the colony • survey points within the colony • start and end points for transects.
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour (including nesting activity) • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Initially assess live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel, collecting information, as far as practicable, on: • date and location of finding • identification to species level • details of rings or other markers (e.g. satellite transmitters) • oiling status of the bird (% oiled) • external ageing and sexing • external biometrics (to determine age and breeding population of origin) including: – bill length – bill shape – body mass – wing length – tarsus length • internal examination to determine sex and age

Ground Survey SOP	
☐	Store dead seabirds and shorebirds in appropriate facilities (on ice in eskies and then preferably freezing facilities).
☐	Take photographs to help identify and count species
☐	Record other variables including, as far as practicable: • location • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.
☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas
☐	Census techniques** for breeding sites: • count breeding pairs • count occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • count non-breeding birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

6.13 Forms and Tools

Refer to Appendix C.

7 SCI5a – Marine Megafauna Impact Study: Marine Reptiles

7.1 Aims and Objectives

The aims of this Scientific Monitoring Program SCI5a – Marine Megafauna Impact Study: Marine Reptiles (SCI5a) are to identify and quantify the status and recovery of marine reptiles, including marine turtles and sea snakes, related to a hydrocarbon spill

The objectives of SCI5a are to:

- determine abundance (including life stage) of marine reptiles present in the EMBA
- where possible, identify mortality of marine turtles and sea snakes directly related to the oil spill or other secondary spill-related impacts (including vessel strike and/or use of dispersants)
- assess the impact of the oil spill on nesting turtles, nests, and hatchlings
- understand changes in nesting beach usage by marine turtles following the hydrocarbon spill.

The monitoring program will focus primarily on marine turtles. The highly dispersed distribution and ecology of sea snakes restricts the opportunity to monitor this group, although sea snakes will still be studied in a limited capacity.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Data and Information Requirements

Table 7-1 lists the inputs relevant to planning for the implementation of SCI5a, once the notification to commence is initiated.

Table 7-1: Data Requirements Summary for SCI5a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for marine turtle nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and marine turtle nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches

7.4 Design

7.4.1 Monitoring Design

Scientific monitoring for marine reptiles will be achieved by observing populations in potentially affected areas, and tissue sampling and analysis to examine direct contamination of turtles and sea snakes. The focus is on marine turtles because of the challenges of estimating sea snake population status. Monitoring of marine turtles will include, where applicable:

- assessing population size of the affected and unaffected marine turtle species (including both nesting and in-water populations)
- assessing exposure of marine turtles to hydrocarbon (e.g. oiled wildlife)
- assessing nesting site condition e.g. hydrocarbon contamination levels.

Note: There are limitations to this study. Scientific studies on marine reptiles are only likely to produce impact assessment outcomes if there is a known resident population, or reasonable confidence in the population numbers and use of an area. Often, insufficient data exists to compare the behaviour and condition of animals after a spill.

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 7-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 7-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	**Monitoring Design[1]**	**Replicate Sites Required[2]**
Offshore hydrocarbon plume (in-water surveys only)	Gradient Approach	Will be determined as part of Program finalisation
Hydrocarbon spill reaches shoreline with known nesting beaches	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation
Hydrocarbon spill interacts with areas of biological importance, and/or internesting areas	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation

1 Reference sites required for the monitoring approaches are detailed in Section 1.

2 Design implemented depends on available baseline data.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from the spill, then during and after the spill.

7.4.2 Monitoring Sites

The scale of monitoring depends on the size, location, and time of year of a spill. Sampling, and therefore the location of monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from

MES, OPS3, OPS4, OPS5, and OPS7 will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify impact beaches (known turtle nesting beaches where shoreline contact has been identified) and impact in-water survey locations, as well reference beaches and in-water reference locations.

7.4.2.1 Population Abundance/Status of Marine Turtles

7.4.2.2 Marine Turtle Nesting Populations

Beaches with nesting activity in the EMBA will be divided into primary beaches (those with high nesting density) and secondary beaches (restricted sandy nesting habitat [e.g. small physical size] or low to moderate nesting activity).

7.4.3 Monitoring Parameters

7.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of marine reptiles in the EMBA will address the selection and spatial/temporal variation of measured parameters (Table 7-3).

Table 7-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameter
Population abundance/status of marine reptiles	Annual marine turtle nesting abundance	Census and snapshot track counts (aerial or field surveys)	• number (#) of tracks • species identification
	Marine turtle nesting distribution on beaches	Census and snapshot track counts (aerial or field surveys)	• # and spatial distribution of tracks • species identification
	In-water abundance (sea snakes and marine turtles) and distribution	Aerial or vessel surveys	• # of individuals • species identification
Marine reptile exposure/mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TRH levels • PAH levels • condition of individual turtles e.g. oiling, sores • # of oiled individuals (dead and alive) • # of dead marine reptiles
	Marine turtle reproductive success	Excavation of hatched nests to characterise clutch sizes, hatching success, emergence success, and record any deformities	• clutch size • hatching success • emergence success • records of hatchling conditions

Environmental Focus	Condition Metric	Methods	Parameter
Beach condition	Hydrocarbons in sediments	Results from SCI2	• TRH levels • PAH levels • USEPA priority pollutants • saturated hydrocarbons (C10 to C36) • BTEX • organochlorides • trace metals (mercury and arsenic)

Before finalising the survey plan, an assessment will be done to determine the likelihood of marine reptile presence/absence, species, and life cycle stage (e.g. nesting, mating) at the time of the hydrocarbon spill, based on the predicted EMBA and time of year.

7.4.3.2 Indicator Species

Indicator species may be selected for monitoring; selection will consider:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons.

Additionally, prioritisation of indicator marine turtle species for monitoring should follow this order, as far as practicable:

1. breeding/nesting females
2. mating males
3. incubating nests
4. hatchlings
5. foraging residents.

7.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5a, surveys will be undertaken at least once in the first year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

7.4.4.1 Population Abundance/Status of Marine Reptiles

In respect to marine turtle nesting populations, monitoring will be timed to occur during the first peak nesting period (if known and feasible for mobilisation) after the hydrocarbon release. If the peak nesting period for a particular beach is not known, monitoring will be undertaken during the nesting periods for the relevant species, based on literature for the area. However, the frequency of the monitoring plan may be determined by the extent of the spill and the spatial, temporal, and seasonal variability of the biological indicators. Ideally, the survey will occur early in the morning when the light is low and before the first high tide.

If the hydrocarbon release occurs during the nesting season, the priority will be to mobilise teams to capture pre-hydrocarbon contact data for key marine turtle nesting beaches. For impacted areas, intra-season variation will be assessed via repeated sampling within a season. Conversely, inter-season variation identifies the duration of impact over time at the impact site(s) when compared to the selected regional pre-spill baseline and/or reference site(s). Primary beaches will be assessed over five consecutive days and surveys will be conducted weekly during the spill event, then every two weeks during clean-up. Secondary beaches will be assessed twice a week during the spill event then weekly during clean-up.

7.4.4.2 Marine Reptile Exposure, Health, and Mortality

Reproductive success surveys will occur concurrently with the surveys for population abundance and status (see Section 7.5.4.1). Tissue samples will be collected opportunistically.

7.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine turtle expert.

7.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements for tissue sampling must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered dimethyl sulfoxide (DMSO) solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 7-4 summarises the storage and transport needs for tissue samples.

Table 7-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Scute (1 to 2 cm^3)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

7.4.6 Sample Analysis

Once data for biological and habitat parameters are collected, they can be conveyed to decision makers using control charts, if sufficient information from historic populations is known. These decision-aiding tools allow managers to visualise whether a management action (e.g. spill response) is having a predicted effect on the recovery of a parameter, and whether natural variation is driving the changes observed. Control charts may help managers diagnose when a parameter of interest (e.g. turtle track counts) shows deviation beyond those naturally expected by plotting through time some measure of a stochastic process with reference to its expected (baseline) value, where data are available.

7.4.6.1 Population Abundance

In-water Populations

These resources will be used for in-water population estimates:

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Florida's Wildlife Contingency Plan for Oil Spill Response – June 2012 Sea Turtle Guidelines for Oil Spill Response (Ref. 39)
- The Centre for Research into Ecological and Environmental Modelling at University of St Andrews, Scotland, has developed a statistical tool for analysing distance data. The program—DISTANCE 6.0—can be downloaded free of charge (http://www.ruwpa.st-and.ac.uk/distance/). An indication of the statistical power to detect change in monitoring criteria will be assessed following analysis of the baseline/reference data by the subject matter expert (SME) statistician/modeller

Nesting Populations

Track counts will be used as the abundance metric for the nesting female population.

7.4.6.2 Marine Reptile Exposure, Health, Mortality

Reproductive Success

Hatching and emergence success will be calculated for each nest. Formulas used to determine clutch size, hatching, and emergence successes (Ref. 40) are:

1. Clutch size = #S+ #UD + #UH + #UHT + #LE + #P
2. Hatching success = #S × 100/clutch size
3. Emergence success = #S-(#L+#D) × 100/clutch size

= numbers of:

S = shells

L = live hatchlings in nest

D = dead hatchlings in nest

UD = undeveloped eggs

UH = unhatched eggs

UHT = unhatched eggs with full-term embryos

E = emerged hatchlings

P = depredated eggs

Y = yolkless eggs

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. These standardised protocols for carcass handling and necropsy procedures will be adopted:

- A veterinarian's guide for sea turtle post mortem examination and histological investigation (Ref. 41)
- Sea turtle necropsy annual for biologists in remote refuges. (Ref. 42)

Tissue Sample Analysis

Samples collected from all stranded and live animals during the oil spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with the SME. Tissue sample analyses will, as far as practicable, include:

- PAH and the USEPA list of 16 priority pollutants, via normal phase silica chromatography and gas chromatography mass spectrometry (GCMS)
- saturated hydrocarbons in the C10 to C36 range via by flame ionisation gas chromatography (GC)
- volatile hydrocarbons via purge and trap into a GCMS (BTEX)
- organochlorides (dichlorodiphenyldichloroethylene ; dichlorodiphenyltrichloroethane)
- trace metals (mercury and arsenic) if assay indicates concentrations above detection limits
- DNA
- stable isotopes.

Turtle carcasses may also be sampled for humeri (flipper bones) and scleral ossicles (a ring of bones embedded in the sclera and surrounding the irises of the eye) to help determine the age of the animal.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the oil will be screened to confirm the oil source.

Chemical analysis of turtle tissue will consider methods outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

7.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

7.6 QA/QC Procedures

7.6.1 Data

These field data procedures and protocols will be implemented:

- The Marine Turtle Field Lead will review the hardcopies and the database/spreadsheet daily, to ensure accuracy.

7.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine turtle surveys.
- All images will be checked to confirm that they are not blurry etc.

7.7 Mobilisation Requirements

7.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

7.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

7.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 7.12).

Task	
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

7.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 7-5.

Table 7-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Turtle Expert	• Lead turtle beach surveys including track counts and nest excavations • QA/QC database each day	• Experience in marine turtle surveys from aerial surveys (desirable), track counts, and necropsy (desirable)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake ground/aerial/vessel surveys • Input data into database each day	• Experience in marine turtle surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine turtle necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in marine turtle population estimates • Marine turtle necropsy procedures • Sampling/monitoring design suitable for control charting

7.11 Equipment

The equipment required for the beach survey component of SCI5a is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing craft or marine vessels
☐	Site access to remote beaches (vessel or chopper)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining turtles
☐	Turtle stretcher big enough to take an adult turtle
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps

Item	
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)
☐	Sampling bottles and preservative (70–100% ethanol) • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

7.12 Standard Operating Procedures (SOPs)

7.12.1 Population Abundance/Status of Marine Turtles

Assessments of marine turtle populations and population status will be carried out via field studies, based on SOPs for surveying marine turtles from aerial, vessel, and track census surveys.

7.12.1.1 In-water populations

The standard survey platforms used for assessing marine reptiles at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

7.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

7.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine reptiles (marine turtles and sea snakes) are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 7-6 will apply.

Table 7-6: Survey Techniques: Guidelines

Timing	Survey Techniques	
	Vessel	Aerial[1]
Pre-survey	N/A	Preference: aircraft-mounted cameras and techniques that can photograph transects flown
	Calibrate distance estimation for each observer	
	Establish transects to be surveyed	

Timing	Survey Techniques	
	Vessel	**Aerial[1]**
	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). **NOTE**: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During survey	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Selected to maximise ease of marine turtle detection and identification, and minimise the risk of collision with ground structures or airborne birds (Ref. 37)
	Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger	
	Marine turtle (or sea snake) observations: • Record observations of each individual turtle or group of turtles in real time to a dedicated handheld data logger • Count all observed turtles and record their identity (preferably species), and determine their age class (if possible)	
	Take photographs and/or video to help identify and count species	
	Record other variables including, as far as practicable: • location • vessel/aircraft speed and direction • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.	
	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas	
	Record any marine reptiles close to the surface slicks and document any unusual behaviour or ill health.	N/A

7.12.2 Nesting Populations

Dead and injured stranded turtles will be collected (where practicable) during the ground-based snapshot and census track surveys. Track surveys may be replaced with aerial photographic surveys following data analysis and consultation with SMEs. If aerial surveys of beaches are used, these must be conducted in early morning when the sun is low and tracks can be seen.

7.12.2.1 Snapshot Track Counts – Secondary Beaches

These counts are designed to rapidly assess beaches and include a single standalone beach inspection, which provides a limited indication of the number of turtles that have visited the beach. However, no temporal inference can be made as the number of tracks present depends on several factors, including weather conditions, tide state, and substrate type.

Step	
☐	Conduct snapshot track census in the early morning after a midnight high tide and before the nest high tide washes the overnight tracks away
☐	Walk the length of the beach and record all downward tracks, or use high-resolution drone imagery
☐	Assess track patterns to identify species, where possible
☐	Follow downward tracks back to the last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record the number of clutches hatched (based on hatchling tracks)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish

7.12.2.2 Census Track Surveys – Primary Beaches

Census track surveys collect data on nesting marine turtle abundance, spatial and temporal usage, and distribution between nesting beaches. Census track surveys record the number of new overnight nesting tracks on a beach across consecutive days. Primary indicator beaches will undergo regular ground-based census track monitoring, which may be supported by aerial photographic transect surveys.

Step	
Day 1	
☐	Day 1 – see SOP for Snapshot Track counts (Section 7.13.2.1
☐	Mark all tracks to ensure they are not counted the following day
Day 2	
☐	Walk the length of the beach and record all downward tracks, if no lines are marked
☐	Follow downward tracks back to last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record number of clutches hatched overnight (based on hatchling tracks) – see Reproductive Success SOP (Section 7.13.3.1)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times

Step	
	• GPS position, latitude/longitude at start and finish

7.12.3 Marine Reptile Exposure, Health, and Mortality

7.12.3.1 Reproductive Success

Step	
☐	Walk the entire beach and identify emerged nests, through hatchling tracks (the optimal time to follow hatchling tracks is early morning when there is low light)
☐	Use GPS to record nest locations
☐	Excavate nests using hands and/or digging implements
☐	Count and record nest contents including number of: • shells • live hatchlings • dead hatchlings • undeveloped eggs • unhatched eggs • emerged hatchlings
☐	Collect unhatched eggs (up to 10) and freeze for chemical analysis

7.12.3.2 Chemical Contamination

Step	
☐	Only trained personnel are to handle live or dead stranded turtles and sea snakes.
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake necropsy, as required
☐	Sample carcasses of oil-affected turtles/sea snakes
☐	Samples may include: • necropsy and biopsy samples (e.g. serum samples, gall bladder bile, liver, gonads) • 10 g of skin or muscle for DNA and stable isotope analysis • 100 g of muscle tissue per sample for chemical (hydrocarbon, trace metal, VOC etc.) and stable isotope analysis • gut (stomach/intestinal contents) for hydrocarbon analysis • fibropapillomatosis tumours and spirorchoidiasis (spirorchid trematodes), if present
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage.
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross-check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

7.12.4 Beach Condition

See sediment SOPs in SCI2 (Section 4.13)

7.13 Forms and Tools

Refer to Appendix C.

8 SCI5b – Marine Megafauna Impact Study: Pinnipeds

8.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI5b – Marine Megafauna Impact Study: Pinnipeds (SCI5b) is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected pinniped populations (Australian Sea Lion, *Neophoca cinerea*, New Zealand Fur Seal, *Arctocephalus forsteri* and the Australian Fur Seal, *A. pusillus*) where they exist within the hydrocarbon release EMBA.

The objectives of SCI5b are to:

- where possible, identify mortality of pinnipeds directly related to the hydrocarbon spill or other spill-related impacts (including boat strike and/or use of dispersants)
- assess the impact of the hydrocarbon spill on pinniped species populations as recorded for breeding colonies and haul-out sites of hydrocarbon exposure/contact
- evaluate the recovery of pinniped breeding colonies.

The monitoring focus is onshore populations (e.g. breeding colonies and haul-out sites), which is based on the priority of the life cycle stage (e.g. breeding) and that population estimates are generally based on direct counts onshore.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Data and Information Requirements

Table 8-1 lists the inputs relevant to planning for the implementation of SCI5b, once the notification to commence is initiated.

Table 8-1: Data Requirements Summary for SCI5b

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for pinniped nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and pinniped nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5b can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on beaches / other terrestrial habitats

8.4 Design

Scientific monitoring for pinnipeds will be achieved by using tissue sampling and analysis to examine direct contamination of pinnipeds, as well as assessing the population status of potentially affected pinniped species. Monitoring of pinnipeds will include, where applicable:

- assessing the population size of the affected pinnipeds
- assessing the exposure of pinnipeds to hydrocarbon.

The most accepted census technique for pinnipeds is to directly count newborn pups at breeding colonies, as this is the only age class guaranteed to be on land and available at one occasion. Additionally, pups generally remain ashore when disturbed during pupping season. Trends in pup numbers can be used as an indicator of the change in population over time. A census will also be undertaken to assess impacts at haul-out sites, with observations undertaken remotely from the haul-out site (e.g. aerial, vessel, lookout location) to avoid disturbing sea lions or seals, which are highly mobile and often leave the colony when disturbed.

8.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 8-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 8-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required
Hydrocarbon spill reaches shoreline areas known to be pinniped breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined before the survey; at least **three** replicate sites within impact and control areas.
Hydrocarbon spill interacts with nearshore areas close to breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	

1 Reference sites required for the monitoring approaches are detailed in Section 1

8.4.2 Monitoring Sites

Sampling will address spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations , and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact sites (pinniped terrestrial habitat that may have been exposed to hydrocarbons) and reference sites.

8.4.3 Monitoring Parameters

8.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of pinnipeds in the EMBA will address the spatial and temporal variation of measured parameters (Table 8-3).

Table 8-3: Selection of Parameters for Assessment

Environmental Focus	Key Parameter	Methods	Metric
Population abundance of pinnipeds	Abundance at breeding colonies (pup production)	Ground surveys for pup counts at breeding colonies	• # of pups (dead, alive, brown, moulted)
	Abundance at haul-out sites	Aerial or boat census	• # of pinnipeds
Marine reptile exposure/ mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TPH levels • PAH levels • condition of individual pinnipeds (e.g. oiling, sores) • # of oiled individuals

Before finalising the survey plan, an assessment will be done to determine the likelihood of pinniped presence/absence, species and life cycle stage (e.g. breeding) at the time of the hydrocarbon release, based on the predicted EMBA and time of year.

8.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5b, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Surveys should be undertaken during the breeding season and at each breeding colony location and haul-out site. Annual variations occur in pup production (e.g. annual variation can be as high as 25% in a stable population of the New Zealand Fur Seal, *Arctocephalus forsteri*) and therefore, ongoing surveys should occur annually. Survey data will be reviewed annually, and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Tissue samples will be collected opportunistically during the census of breeding colonies.

8.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine pinniped expert.

8.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 8-4 summarises the storage and transport needs for these samples.

Table 8-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

8.4.6 Sample Analysis

8.4.6.1 Population Abundance

Breeding Colonies of New Zealand and Australian Fur Seals

Total pup production for each breeding colony will be the maximum sum of live and dead pups counted. Total population size will be estimated by multiplying the total pup production by a factor of

- 4.79 to 4.9 based on two age-structure population models for New Zealand Fur Seals (Ref. 46; Ref. 47).
- 4.5 based on survivorship model for Australia Fur Seals (Ref. 48).

Breeding Colonies of Australian Sea Lion

Small Colonies (<40 pups)

Pup numbers will be estimated for each survey from the number of marked pups and accumulated dead pups plus the number of live unmarked pups. The maximum of the estimates from each survey will be taken as the pup production estimate for the season.

Large Colonies (<40 pups)

Pup numbers will be calculated using the Cormack-Jolly-Seber (CJS) capture-mark-recapture (CMR) model implemented in a software package (e.g. MARK) to model year-specific survival, recapture probability of pups, population size, and new individuals entering a population.

Total population size will be estimated by multiplying the total pup production by a factor of 4.08, as derived by Goldsworthy and Page (Ref. 47).

Haul-out sites

Abundance will be the total number of seals or sea lions counted at each location.

8.4.6.2 Pinniped Exposure, Health, Mortality

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. The standardised protocol for carcass handling and necropsy procedures to be adopted is:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue sample analyses will, as far as practicable, include:

- swabs from visibly oiled pinnipeds for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source.

All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses.

8.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

8.6 QA/QC Procedures

8.6.1 Data

These field data procedures and protocols will be implemented:

- The Pinniped Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

8.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for pinniped surveys.
- All images will be checked to confirm that they are not blurry etc.

8.7 Mobilisation Requirements

8.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

8.8 Logistics

These activities must be undertaken before mobilisation to the field.

	Task
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC form, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

8.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

	Task
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

8.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 8-5.

Table 8-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Pinniped Field Lead	• Lead pup production counts • Lead and undertake counts of pinnipeds at haul-out sites • QA/QC database each day	• Experience in pinniped surveys • Experience in aerial surveys (if this method is used)
Field Assistants	• Undertake pup production counts • Assist in counts at haul-out sites	• Experience in pinniped surveys

Role	Responsibility	Qualifications
	• Input data into database each day	
Veterinary and Pathology Expert	• Conduct necropsy and take tissue samples	• Relevant degree • Able to advise on cause of death • Experience in pinniped necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in pinniped population estimates • Pinniped necropsy procedures

Access to breeding colonies or haul-out sites may require vessels and/or vehicles and therefore, additional team members (e.g. vessel master) and qualifications may be required (e.g. offshore medical, 4WD/off-road training).

8.11 Equipment

The equipment required for the beach survey component of SCI5b is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing aircraft or marine vessels
☐	Site access to remote beaches (vessel or helicopter)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining pinnipeds
☐	Stretcher big enough to take an adult pinniped
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)

Item	
☐	Sampling bottles and preservative (70–100% ethanol): • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

8.12 Standard Operating Procedures (SOPs)

8.12.1 Population Abundance of Pinnipeds

Different methods will be implemented depending on whether it is a breeding colony or haul-out site, or whether it is a breeding site for the Australian Sea Lion or the New Zealand/Australia Fur Seal. During the surveys, any seals or sea lions with visible oiling will be recorded.

8.12.1.1 Breeding Colonies of New Zealand and Australian Fur Seals – 'Direct Count'

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Count and record all pups
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups brown, moulted, unclassed
☐	Once the count of live pups is complete, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.2 Breeding Colonies of Australian Sea Lion

Because of the long breeding season of Australian Sea Lions (up to 7 months), by the end of the pupping season, some pups may have dispersed or moulted (and therefore, may go unrecognised). Therefore, one of these methods will be used:

- Cumulative Mark and Count method to estimate pup numbers for small colonies (<40 pups); or
- CJS CMR model to estimate pup numbers for large colonies (>40 pups) (Ref. 50; Ref. 51; Ref. 52)

Breeding Colony

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Catch and mark all pups (marks can include clipping a patch of hair on the back, bleach on the shoulder, or tags on the fore-flipper)
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups as marked or unmarked
☐	Record the number of pups marked (that were previously unmarked)
☐	Once the count of live pups is undertaken, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

Haul-out sites – 'direct count'

Step	
☐	Two observers will observe the haul-out site from aerial surveys, a vessel, or land-based (e.g. cliff lookout)
☐	Each observer will undertake an independent count; count all seals and/or sea lions and identify them to species level (if possible)
☐	If aerial surveys are undertaken simultaneously with the real-time counts, take oblique photographs to corroborate the counts
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather

Step	
	• start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.3 Pinniped Exposure, Health, and Mortality

Step	
☐	Only trained personnel can handle live or dead stranded pinnipeds
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake a necropsy, if required (see Section 8.5.6)
☐	Sample carcasses of oil-affected pinnipeds
☐	Samples may include: • swabs from externally visible oiled pinnipeds • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

8.13 Forms and Tools

Refer to Appendix C.

9 SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna

9.1 Aims and Objectives

The aim of Scientific Monitoring Program SCI5c – Other Marine Megafauna (SCI5c) is to is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected marine mammals (cetaceans and dugongs) and large cartilaginous fish (such as Whale Sharks, Great White Sharks, Manta Rays, and sawfish).

The objectives of SCI5b are:

- where possible, identify mortality of marine megafauna directly related to a hydrocarbon spill or other spill-related impacts (such as vessel strike, use of dispersants)
- assess the impact of a hydrocarbon spill on marine megafauna. If applicable, evaluate recovery of impacted species.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Data and Information Requirements

Table 9-1 lists the inputs relevant to planning for the implementation of SCI5c, once the notification to commence is initiated.

Table 9-1: Data Requirements Summary for SCI5c

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases2F2F2F2) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5c can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS5, OPS7, and SCI1 activities, including: • identify and map sensitive resources and key receptors within the EMBA • identify and map sensitive resources and key receptors within the EMBA (OPS 5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

9.4 Design

Scientific monitoring for marine megafauna, including marine mammals (cetaceans and dugongs) and cartilaginous fish, will be achieved by determining the abundance of marine megafauna in the EMBA and using tissue sampling and analysis to examine direct contamination of marine megafauna.

[2] Access to data relevant to third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

Monitoring will include, where applicable:

- assessing the presence/absence or abundance of marine megafauna
- assessing the exposure of marine megafauna to hydrocarbons.

There are several limitations in this study, including:

- Current information on the status of marine mammal populations (e.g. stock structure; abundance; movement patterns; age structure; reproductive rates; survival rates and health) is required and can be lacking in most regions. The monitoring of cetacean health is currently considered unfeasible and although visual signs such as changes in behaviour or skin lesions can be used as indicators of health, clearly identifiable links to a particular hydrocarbon incident are unlikely to be established. It is likely statistical tests will not be feasible and interpretation will be largely qualitative.
- A quantitative assessment of cartilaginous fish species is unlikely because of the small numbers encountered. Assessing changes to the presence of adult sawfish at sea is not plausible due to the low numbers and their benthic habitat association, making their detection difficult. However, the presence/absence of populations ascertained by monitoring numbers entering the creeks (using acoustic methods) may be an appropriate proxy to assess change.
- Cartilaginous fish species strandings are unlikely—they do not have a swim bladder so are more likely to sink to the seabed.

A degree of flexibility is required in implementing the scientific monitoring program—the limitations listed above, the focus of assessment in terms of species, and locations cannot be determined until the actual spill event occurs. The methods listed in the subsections below outline several potential approaches for collecting the necessary information, with the actual methods to be selected at the time of the spill.

9.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 9-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 9-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon spill interacts with areas of biological importance (feeding areas or migration routes)	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Minimum of three sites within each of impact and control areas (for BACI and IvC)

1 Reference sites required for each monitoring approach are detailed in Section 1

9.4.2 Monitoring Sites

9.4.2.1 Species Presence

Sampling will address the spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact and reference sites.

If marine megafauna are to be assessed, two reference sites/regions (three if possible) should be selected to compare against the EMBA. The reference sites/regions must be matched with impact areas in relation to spatial dimension, habitat, and distance from mainland and/or island coastline habitats, and must be determined during the pre-survey planning period.

The scale of likely impact will determine the spatial and temporal scale of monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be appropriate to the EMBA of a hydrocarbon spill incident. The priority of resources and receptors and the sites themselves, are likely to be different under different spill or weather conditions, the seasonal presence of key species, or the life stage of the species present.

9.4.3 Monitoring Parameters

Sampling to assess the status of marine megafauna populations in the EMBA will address the spatial and temporal variation of measured parameters (Table 9-3).

Table 9-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameters
Species presence	Species present	Aerial/vessel survey	• record presence of species • species identification (where possible)
	Estimate of Abundance	Aerial/vessel survey/ passive acoustic monitoring (PAM)	• # of individuals • species identification
Mortality, health, and fitness	Chemical contamination	Laboratory analysis	• hydrocarbons • biomarkers • trace metals • DNA • stable isotopes
	Oil distribution on individuals	Aerial/vessel survey	• percentage of oiled individuals • distribution of oil on individuals

9.4.3.1 Indicator Species

Depending on location of the spill and its predicted extent, potential indicator species for assessing risks to marine mammals and cartilaginous fish during the operational response have been identified. The selection of indicator species for a particular event will be based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. EPBC Act listed species).

9.4.4 Monitoring Frequency and Duration

Monitoring will be conducted at least once in the first year, although is likely to be at a greater frequency (e.g. every three months) in the first year to identify the short-term direct impacts of the hydrocarbons, unless the termination criteria are triggered within this time. Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

9.4.4.1 Aerial Surveys

Aerial surveys work well for large marine megafauna (principally whales, Whale Sharks, and Dugongs) and where waters have good light penetration and visibility. The standard protocols for recording effort and sighting data via aerial surveys recommends line-transect distance sampling methods. The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer. Visual and photographic/video data and information on sea state and flight path (as outlined in Table 9-3) should be collected. To limit bias, double-platform line-transect and cue counting will be implemented, where possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include: location (GPS); species; group size; group composition (adults and calves); behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.2 Vessel Surveys

Vessel surveys are suitable in shallow coastal waters where waters may be turbid and therefore, visibility for aerial surveys may be limited. Vessel surveys will be undertaken, if considered practicable, to gather observational data on any marine megafauna close to where the spill occurred or inshore waters (and appropriate reference sites). The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer.

Observers will, as far as practicable, be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure the radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals. Double-platform data collection will be implemented, when possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include:

location; species; group size; group composition (adults and calves); angle to sighting (declination), behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.3 Passive Acoustic Monitoring (PAM)

PAM uses acoustic monitoring technologies and recognition software to detect and record marine mammal vocalisations, with data coupled with visual monitoring. This tool may be used to assess relative abundance estimates of large whales in the EMBA and suitable reference sites. Vocalisation signatures for whale species exist and data are freely available via the Integrated Marine Observing System website (Ref. 53) through the acoustic observatories. Each observatory comprises four autonomous sea noise loggers deployed on the sea floor to form a triangular array of about 5 km sides, with the fourth logger installed in the centre. The Centre for Marine Science and Technology at Curtin University and the Murdoch University Cetacean Research Unit have developed, or are developing, passive acoustic methodology for monitoring marine mammals.

9.4.5 Marine Megafauna Mortality, Health, and Fitness

Data will be collected via visual observations (see Sections 9.5.4.1 and 9.5.4.2) and through chemical contamination.

Marine mammal strandings create an important opportunity for gathering information on an animal's biology, pathology, toxicology, and population genetics, as well as data on natural and human-induced mortality of cetacean populations of the concerned species. If fauna stranding is recorded, a minimum of ten carcasses will be sampled for tissue analysis (providing the necropsy criteria are met). If fewer than ten carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

Trained professionals will be involved in handling strandings. If carcasses are observed, physical details (species, length, sex, condition, etc.) will be documented and photographs taken. Basic biological information will need to be collected, and where appropriate, tissue samples for laboratory analysis. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of the mortality can be attributed to the hydrocarbon spill event.

The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis (analysis is unlikely for severely decomposed carcasses). Tissue samples are required for hydrocarbon analysis and for the interpretation to be meaningful these will need to be assessed against background reference points, where possible. Immediate necropsy, or appropriate freezer storage of carcasses, is required to correlate the physiological and pathological state to any concentration of petroleum products found in tissue samples.

9.4.6 Sample Integrity

Any uncertainties concerning species identification will be mitigated in the field by communicating with the Field Lead.

9.4.6.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler. Samples should be kept cool (<5 °C) if kept in bags but not frozen, and they should not be held for an extended period. Table 9-4 summarises the storage and transport needs for these samples.

Table 9-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

9.4.7 Sample Analysis

In addition to contrasting between impact and reference sites, the power of a sampling design to detect real changes in system state is determined by the level of replication. In this instance, replication is unlikely to achieve sufficient power; hence statistical tests will not be conducted to compare spatial and temporal variability. However, the Marine Mammal Health and Strandings Response Program (Ref. 54), which uses the Unusual Mortality Events (UME) method to assess strandings significance, may be used.

9.4.8 Species Presence

These resources will be used for distance sampling design and analyses (Line-Transect Surveys):

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Design of distance sampling surveys and Geographic Information Systems (Ref. 55).

An indication of the statistical power to detect change in strandings should be provided. Data will need to be stratified and categorised accordingly. The Marine Mammal Health and Strandings Response Program (Ref. 54) uses the UME method to assess strandings significance.

9.4.9 Marine Megafauna Exposure, Health, Mortality

9.4.9.1 Necropsy

Necropsies (and subsequent pathological or toxicological tests) help diagnose the likely cause of mortality of dead individuals collected. This standardised protocol for carcass handling and necropsy procedures will be adopted:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

9.4.9.2 Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue samples analyses will, as far as practicable, include:

- swabs from visibly oiled marine megafauna for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source. All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses
- teeth for determining the animal's age.

9.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

9.6 QA/QC Procedures

9.6.1 Data Collection

These field data procedures and protocols will be implemented:

- The Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

9.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine megafauna surveys.
- All images will be checked to confirm that they are not blurry etc.
- All samples that will be transported for laboratory analysis will be accompanied by a CoC form that provides details of the samples being sent and that will be used to verify that all samples collected were received at their intended location. The CoC form documents all aspects of sample storage and transport from collection to the final storage location or laboratory.

9.7 Mobilisation Requirements

9.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

9.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

9.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

9.10 Resources

The personnel required to undertake SCI5c, their roles, and relevant qualifications are listed in Table 9-5.

Table 9-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Mammal Observer/Field Lead	• Lead aerial/vessel surveys • QA/QC database each day	• Marine Mammal Observer certification • Experience in marine mammal aerial surveys (desirable), vessel surveys (desirable), and necropsy (essential)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake aerial/vessel surveys • Input data into database each day	• Experience in aerial and/or vessel surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine mammal necropsy (desirable)

9.11 Equipment

The basic set of equipment required for SCI5c is listed below.

Item	
☐	Survey platform: e.g. rotary or fixed-wing craft (recommended AMSA Dornier 318 or CASA 212–400 fixed-wing aircraft), i.e. high-wing aircraft with downward visual capability or marine vessels, or long-distance capable drone
☐	Handheld video camera with date stamp and GPS
☐	Digital camera (with GPS) and telephoto lens
☐	GPS
☐	Clinometers
☐	Binoculars, 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Audio recorder
☐	Tissue sample collection kit

9.12 Standard Operating Procedures (SOPs)

9.12.1 Population Abundance/Status of Marine Megafauna

Marine mammal populations and population status will be assessed using field studies that are based on SOPs for surveying marine megafauna from the air and from vessels.

9.12.1.1 In-water Populations

The standard survey platforms used for assessing marine megafauna at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

9.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

9.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine megafauna are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 9-6 will apply.

Table 9-6: Standard Survey Methods

<table>
<tr><th>Timing</th><th>Vessel Survey Methods</th><th>Aerial Survey Methods</th></tr>
<tr><td rowspan="3">Pre-survey</td><td colspan="2">Calibrate distance estimation for each observer</td></tr>
<tr><td colspan="2">Establish transects to be surveyed</td></tr>
<tr><td>Establish strip width for transects e.g. 400 m each side of the vessel and 100 m ahead
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td><td>Establish strip width for transects to each side of the aircraft:
• 400 m for whales and dugong, and/or
• 750 m for Whale Sharks</td></tr>
<tr><td rowspan="6">During survey</td><td>Vessel speed: 10 knots (range 5–15 knots)</td><td>Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot
Altitude: approximately 500 ft
Beaufort state: <3</td></tr>
<tr><td colspan="2">Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger</td></tr>
<tr><td colspan="2">Marine mammal observations:
• Record observations of each individual or group in real time to a dedicated handheld data logger
• Count all observed individuals and record their identity (preferably to species level), and determine their age class (if possible)</td></tr>
<tr><td colspan="2">Take photographs and/or video to help identify and count species</td></tr>
<tr><td colspan="2">Record other variables including, as far as practicable:
• location
• vessel/aircraft speed and direction
• weather conditions, including:
– temperature
– precipitation
– wind strength and direction
– visibility (including glare)
• whether transect is in hydrocarbon-affected water.</td></tr>
<tr><td colspan="2">Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
</table>

9.12.2 Marine Megafauna Exposure, Health, and Mortality

Step	
☐	Only trained personnel are to handle live or dead stranded marine megafauna
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake necropsy, as required (see Section 8.5.6)
☐	Take samples of carcasses of oil-affected marine megafauna

Step	
☐	Samples may include: • swabs from externally visible oiled marine megafauna • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

9.13 Forms and Tools

Refer to Appendix C.

10 SCI6 – Benthic Habitat Impact Study

10.1 Aims and Objectives

The primary aim of SCI6 – Benthic Habitat Impact Study (SCI6) is to determine the extent, severity, and persistence (including recovery) of impacts on subtidal benthic habitats and biological communities following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the EMBA, as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 focuses on the subtidal zone—habitats seaward of LAT, separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- collect information to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time after termination of the response

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Data and Information Requirements

Table 10-1 lists the inputs relevant to planning for the implementation of SCI6, once the notification to commence is initiated.

Table 10-1: Data Requirements Summary for SCI6

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.) and information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 activities, including: • consolidated data file including exceedances of benchmark levels (this information should be provided in electronic format, as it becomes available).	Information available at commencement of SCI6 on survey design or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI3)

10.4 Design

10.4.1 Monitoring Design

Benthic habitats may support various biological communities during all, or part of, the year. To help inform scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities that help understand impacts on the most sensitive areas and will involve a combination of these monitoring strategies:

- Physical: To provide observations and measurements that describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be a proxy for biological monitoring of large-scale changes on shallow benthic habitats (e.g. seagrass, macroalgae).
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by assessing commonly monitored ecological, population, and community parameters. As far as practicable, monitoring will also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae, and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 10-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 Reference sites required for each monitoring approach are detailed in Section 1

10.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide, refer to Table 10-2) are reviewed. This will help identify sensitive habitats, associated parameters, and methods.

Monitoring locations will be defined taking into account these considerations:

- likelihood of hydrocarbon impact on benthic habitats
- select several impact and reference locations over a large spatial area
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- degree of hydrocarbon exposure or potential exposure of the benthic habitats
- when selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

10.4.3 Monitoring Parameters

10.4.3.1 Physical Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods), as detailed in Table 10-3.

Table 10-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

10.4.3.2 Biological Monitoring Parameters

Table 10-4 lists the proposed range of biological parameters and associated survey methods that may be monitored.

Table 10-4: Proposed Biological Parameters (including remote sensing) within Intertidal Habitat

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
Coral Reef	Fine-scale benthic surveys	Coral reef	Stratified haphazard transects (e.g. within zones of: lagoon, reef flat, crest, and slope as applicable) using towed camera, drop camera, ROV camera, or diver-swum camera surveys. Divers for collection and deployment of coral reproduction parameters	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Percentage cover of other benthic organisms	• Coral recruitment (recruits) • Juvenile coral counts • Recent (whole colony) coral mortality	• Signs of bleaching, partial mortality, number of breaks • Colony and polyp level fecundity
		Coral reef	Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Macroalgae and seagrass	Broad-scale benthic surveys	Macroalgae Seagrasses	Stratified haphazard transects using towed camera or ROV and benthic grab for seagrass	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Other benthic organisms	• Abundance (seagrass/algae) • Shoot density (seagrass) • Holdfast density (macroalgae) • Biota tissue sampling (where possible and appropriate) (macroalgae)	• Blade condition (signs of blackening and defoliation) • Growth rates
			Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Subtidal pavement, rocky reef, or hard substrate	Broad-scale benthic surveys	• Macroalgae • Filter feeders (sponges) • Corals • Hydroids	Stratified haphazard transects using towed camera	• Percentage cover/ density • Diversity • Distribution • Dominant taxa	• Biota tissue sampling	N/A

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
		• Soft corals				
Soft-bottom	Broad-scale benthic surveys	Infauna	Sediment sampling using sediment grab	• Density • Diversity • Distribution • Dominant taxa	• e.g. ratio of polychaetes/ amphipods	N/A

10.4.3.3 Chemical Monitoring Parameters

The chemical monitoring parameters to be tested and the methods for water and sediments are described in detail in SCI1 and SCI2.

10.4.4 Monitoring Frequency and Duration

Following the initiation of SCI6, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

10.4.5 Sample Integrity

10.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

10.4.5.2 Remote Sensing Methods

Remote sensing may initially be used to determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). If practicable, remote sensing will be used to assess biological parameters within the study area to measure the condition of these habitats during scientific monitoring.

The remote sensing technique (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) used will depend on the intended parameter to be collected (i.e. presence/absence, percentage cover), which requires evaluation of the pixel size required (i.e. coarse, medium, fine) and cost. A guideline for implementing appropriate remote sensing monitoring equipment is provided by the Remote Sensing Research Centre (Ref. 27).

To correctly calibrate remote sensing imagery, field surveys will be required to ground-truth or validate field measurements from the target area to be monitored. Remote sensing techniques are not always practicable and will probably not be suitable to characterise benthic habitat within turbid nearshore waters or substrate beyond the coastal zone (>20 m depth).

10.4.5.3 Biological Monitoring Methods

Subtidal systems are highly complex and natural spatial and temporal variation in physical and biological structure is almost always high. Biological monitoring must target the main ecological components of benthic communities that reflect the particular sensitivities of the subtidal location and that can be used as an indicator for wider community health. Potential indicator flora and fauna for each broad habitat type are summarised in Table 10-4.

Marine Flora and Epifauna Surveys

Benthic surveys are intended to enable broad-scale but detailed observations of the physical and biological structures of benthic habitats. The survey methodology for benthic habitats involves recording imagery from transects for real-time and later analysis (e.g. stills and video footage from handheld camera, towed video, drop-down camera, or ROV).

The imagery will be assessed for:

- real-time habitat classification—used to verify and map the variety and extent of the benthic habitats at risk. Observations of benthic habitat features will be recorded at fixed time intervals, or when a feature of interest or a change in habitat type is observed. These methods ensure data are collected instantaneously and can be immediately used for generating maps, allowing information to be passed to other teams within useful time frames
- quantitative analysis of high-quality still images taken during benthic transect surveys—used to measure community and health parameters for indicator taxa (e.g. Ref. 56; Ref. 57; Ref. 58 ; Ref. 59). The georeferenced still photo images will be subsampled at a standardised spatial separation then grouped for detailed point-intercept analysis. Choice of indicator taxa will be based on advice from SMEs, but will likely include corals, non-coral benthic macroinvertebrates, seagrass, and macroalgae.

Habitat data will be classified according to a hierarchal system of biophysical characteristics designed to consistently define benthic habitats (e.g. CATAMI classification scheme [Ref. 60]). The most common or dominant taxa within each assemblage should be classified to the greatest practicable taxonomic resolution. This classification depends on the clarity of the video footage, which will vary with weather conditions and water clarity. Database software should be used with pre-programmed habitat types or biota of interest, with the associated data on position and depth recorded. In the absence of this software, the GPS position and depth should be recorded at regular intervals.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). Sediment sampling collects infauna found directly below the surface in soft-substrates. Sediment samples are typically collected using a grab, although can also use trawls, dredges, box corers, suction samplers, and handheld corers (see AMSA [Ref. 17], Guideline M.9). Usually the entire sample is sieved for benthic infaunal analyses or if chemical subsamples are required; care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and provide a representative sample of the species present.

Guidance on Methods and Assessment of Potential Population Parameters

Seagrass Above- and Below-ground Biomass

Sediment grab samples will be collected within seagrass sites for above-/below-ground biomass. Sediment samples for seagrass biomass will be wet sieved with a 125 µm sieve on site and all seagrass material removed, dried on tissue paper, and weighed and frozen, before sediment and seagrass is sent to the laboratory for analysis. Seagrass material will be weighed in the laboratory.

10.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that makes it easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software CPCe (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes), the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy appearance, partially or fully bleached; Ref. 62).

Where possible, image analysis and machine learning methods will be used (e.g. Ref. 63) after verifying they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and/or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be determined at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size, and depth.

10.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

10.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove 'ecological noise' from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the monitoring program.

10.7 Mobilisation Requirements

10.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures

Task	
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

10.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

10.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
☐	Confirm specialist equipment requirements and availability: • ROV/autonomous underwater vehicle (AUV)/drop camera/towed camera • subsea positioning (if required) i.e. ultra-short baseline (USBL) • dive spread (if required) • benthic grab • remote sensing platform
☐	Check if instrument calibration is required And that calibration certificates are on file
☐	Check if equipment redundancy is required
☐	Check if a DGPS is required
☐	Confirm installation of real-time classification software (if available)
☐	Book freight to mobilisation port

10.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities, and relevant qualifications are listed in Table 10-5.

Table 10-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• Australian Diving Accreditation Scheme (ADAS) Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

10.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment requirements for SCI6 are listed below.

Items	
□	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
□	Is redundancy required?
□	DGPS
□	Echo sounder on each vessel

Items	
☐	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
☐	Backup data storage for field data
☐	Tissue preservation material and sample jars
☐	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
☐	Specialist PPE (i.e. PFD, respiratory protective equipment [RPE])
☐	Book freight to mobilisation port

10.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques is:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.

10.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives
☐	Prepare and assemble all field equipment, including redundancies
☐	Arrange access to vessel or other suitable monitoring platform

10.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects
☐	Randomly select the locations of transects at each site
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect
☐	Use a minimum of three replicate transects at each site
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment)
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites
☐	Take photos with a still camera, or as still images from video transect footage
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable,

Step	
	use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage)
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale
☐	Where possible, locate transects in similar depths within sites
☐	After retrieval, QA/QC check and backup data on site
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats

10.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory

10.13 Forms and Tools

Refer to Appendix C.

11 SCI7a – Fisheries and Aquaculture Impact Study

11.1 Aims and Objectives

The primary aim of SCI7a – Fisheries and Aquaculture Impact Study (SCI7a) is to determine the extent of impact from hydrocarbons on fish and aquaculture resources in regards to hydrocarbons detected in fish tissue if a hydrocarbon spill impacts an area considered ecologically important for fish and aquaculture resources.

The objectives of SCI7a are to:

- identify, report, and monitor lethal impacts on fish as related to the hydrocarbon spill and/or to the hydrocarbon spill response
- determine the spatial and temporal extent of sublethal impacts on indicator species, which may impact commercial and recreational fish species, including:
  - health effects attributable to the spill and/or response activities
  - tainting of the flesh and/or bioaccumulation of toxins in fish

The actual scope of fish and aquaculture resources monitoring depends on the receptors identified within the EMBA by a hydrocarbon spill. SCI7a outlines how the effects of hydrocarbon spills on bony and cartilaginous fish and aquaculture species, such as bivalves will be assessed, excluding those fish assessed under other studies, i.e. SCI5c, which covers Whale Sharks and large sharks.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Data and Information Requirements

Table 11-1 lists the inputs relevant to planning for the implementation of SCI7a, once the notification to commence is initiated.

Table 11-1: Data Requirements Summary for SCI7a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases3F3F3F3) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI7a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS8, SCI1, and SCI2 activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters Outputs from OPS8 activities, including: • consolidated data file

11.4 Design

11.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES, OPS3, and OPS8 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES, OPS3, and OPS8 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 11-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 11-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume that dissipates from source	Gradient Approach and Lines of Evidence Approach	At least two sites at each distance from source
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, wherever practicable, data representing the current state of the receptors of interest will be collected before the spill reaches them.

11.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS8 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

[3] Access to data from relevant third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

11.4.3 Monitoring Parameters

Indicator Species

Given the number of fish species with the potential to be in an area at any one time, indicator species need to be selected for detailed tissue and health analysis. Indicator (target) fish and aquaculture species will be selected from the identified receptors at risk within the EMBA to represent impact to fish health and will include demersal and/or pelagic commercial and recreational species based on the species available in sufficient abundance within the EMBA. The selection of a fish species as an indicator species will be based on knowledge of which species represent the most sensitive component with reference to:

- abundance within the impacted area
- distribution within the impacted area
- availability of prior baseline information
- vulnerability to the impacts of a hydrocarbon spill.

The selected indicator species must be sufficiently widespread to allow sampling both inside and outside affected areas; where low numbers of preferred indicator species are collected, alternative species may need to be considered during the survey. Representative indicator fish species and aquaculture species will be collected using methods appropriate to the sampling habitat, characteristics of the target species, and the life-history stage. The samples collected in impacted areas will be compared to samples collected at suitable reference sites. If fish kill occurs, whole fish will be obtained and preserved for necropsy to attempt to determine the cause of death.

Table 11-3 summarises the monitoring parameters.

Table 11-3: Selection of Parameters for Assessment

Type	Parameter
Physiological indicators and biochemical markers	• Condition factor • Liver-somatic index • Gonadosomatic index and histological examination of gonads • Oxidative DNA damage • Liver detoxification enzymes • Biliary PAH metabolites • Sorbitol dehydrogenase (SDH) activity
Muscle tissue, biopsy, and gut content samples	• PAH and the standard USEPA list of 16 priority pollutants • Saturated hydrocarbons in the C10 to C36 range • Volatile hydrocarbons.
Blood serum	• SDH activity • Oxidative DNA damage (8-oxo-dG content)
Bile	• Biliary metabolites
Gonads	• Histology assessment
Fish mortality	• Dead fish count

11.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7a will be determined by the level of impacts from the hydrocarbon spill and achievement of the termination triggers.

11.4.5 Sample Integrity

Methods for specimen handling were derived from Gagnon and Rawson (Ref. 44; Ref. 45) and Burns *et al*. (Ref. 43). In summary, the general requirements for samples are:

- Fish flesh for chemical analysis will be wrapped in HPLC-grade solvent-rinsed aluminium foil and frozen at 20 °C.
- Fish flesh for taint testing will be wrapped in food-approved ziplock bags and frozen at 20 °C.
- Biopsies of solid tissues and bile must be placed in a sterile cryovial and immediately frozen in liquid nitrogen at 190 °C.
- Biopsies of blood need to be centrifuged, serum isolated, and placed in a cryogenic vial at 190 °C.

Care should be taken not to contaminate samples; work spaces should be thoroughly cleaned and decontaminated between samples.

White flesh samples collected for taint testing and for chemical analysis must be treated as two different samples. Chemical analysis requires 25 g of flesh whereas taint testing requires 400 g.

Jars and plastic bags must be labelled with all relevant information including: species, location, identification number, and date. The sample number is related to a record containing species name, size, type of tissue, handling details, capture location, capture depth, and all observations of health, presence of visible hydrocarbons, etc.

11.4.6 Sample Analysis

Chemical analysis of fish tissues for hydrocarbon will follow the procedures outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). Equivalent procedures may also be considered provided they are capable of yielding information of equivalent or superior quality. Onshore chemical analysis will, where relevant, be completed at an ecotoxicology laboratory.

Statistical analysis of fish tissue data will be undertaken and may include regression analysis relating hydrocarbon concentrations in the water column (or other relevant exposure index) to concentrations in fish tissues and various indexes and biochemical markers of fish health. Other analytical methods including mixed-effect linear models or analysis of similarities could also be used to examine before-after and impact-reference effects (and the interaction), in accordance with the sampling design implemented.

11.5 Data Management

Monitoring activities may be undertaken over several years and are likely to result in data that may be obtained/generated from several sources in various formats. All records will be kept in a field log. This log will be copied to an electronic spreadsheet/database at the end of each day.

Data (including GPS locations and photos) will be backed up to a separate location, e.g. external hard drive. This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. This data will be received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to Chevron as required.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

11.6 QA/QC Procedures

For each fish collected, a datasheet will be completed, which will contain this information as a minimum:

- date
- site number
- species
- sample identification
- location of capture (coordinates)
- health of specimen (including abnormalities/signs of stress) as per Section 1.5.2
- basic morphological measurements (including length, weight, gonad weight, liver weight, sex, and reproductive stage) as per Section 1.5.2
- sample types taken
- photos of specimen taken (with sample identification visible in photograph)
- preservation method
- relevant CoC reference
- notes.

11.7 Mobilisation Requirements

11.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required

Task	
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

11.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

11.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

11.10 Resources

The personnel required to undertake SCI7a, their roles, and relevant qualifications are listed in Table 11-4.

Table 11-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish pathologist, or suitably experienced marine scientist	• Develop sampling plan • Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Fish collection experience • TBOSIET • Offshore medical
Ecotoxicologists for collection and handling of biopsies	• Undertake on-board fish biopsies • May also assist in collecting samples if suitably qualified • Handle, store, and label samples according to guidelines	• Field biopsy experience • TBOSIET • Offshore medical

11.11 Equipment

Chemical analysis of tissue samples will require an extensive list of equipment for extracting the tissue and examining fish health; a complete list should be developed in consultation with the ecotoxicologist responsible for biopsy collection and handling.

Appropriate sampling equipment for collecting live specimens will also be required, and will depend on the specific receptors being examined, and the location of sampling. This will be established during the operational phase of the spill response.

Redundancy for key pieces of equipment should also be considered.

11.12 Standard Operating Procedures (SOPs)

11.12.1.1 Fisheries and Aquaculture Species Exposure and Health

Field studies to collect fish and other species will be undertaken at various reference and potentially impacted sites. As far as practicable, specimens collected for sampling must be sacrificed immediately for biopsy collection. These samples will be used to determine the extent of contamination in tissues (tainting), as well as assess associated physiological stress.

Table 11-5: Steps for Sampling Fish Health, Tainting, and Fish Mortality

Step	
Fish Health and Tainting Samples	
☐	Investigate potential indicator species once the location and extent of the spill is known
☐	Collect fish. Potential collection methods may include: netting, trawling, baited fish traps, spear fishing, and line fishing, depending on species selected and spill location
☐	Collect a target sample size of 20 individuals per species per site

Step	
☐	At each site, complete the field log , including details on: • weather conditions • time arrived at site • environmental conditions at the site • presence of a hydrocarbon slick • sample details for individual samples/health assessments/fish mortality • sample description notes • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site
☐	Take photographs throughout the sampling process and add the reference number to the field log
☐	Identify samples, look for any visible signs of abnormality or physical stress, photograph the sample, and record the geographic coordinates of the place of capture
☐	Take measurements of basic morphological data, including: length, weight, gonad weight, liver weight, sex, and reproductive stage
☐	If biopsies are not to be done straight after specimen capture, then keep specimens alive in oxygenated aquariums until ready for biopsy
☐	Obtain tissue and gut contents samples: • a target of 400 g of white flesh per sample (fish) for hydrocarbon analysis (tainting) or equivalent for other species (e.g. bivalves) • a target of 25 g of white flesh per sample (fish) for chemical analysis or equivalent for other species (e.g. bivalves) Analyse tissues and gut contents for: • PAH and the standard USEPA list of 16 priority pollutants via normal phase silica chromatography and GCMS • saturated hydrocarbons in the C10 to C36 range via by flame ionisation GC • volatile hydrocarbons via purge and trap into a GCMS
☐	Blood serum, gall bladder, bile, liver, and gonad samples will be processed and analysed at a suitable laboratory for the parameters listed in Section 12.5.1
☐	Handle and preserve samples appropriately; mark all samples with appropriate sampling information as listed in Section 12.5.1.
Collecting Dead Fish	
☐	If fish kill is observed, collect and preserve (freeze) whole, dead fish for necropsy. If many dead fish are evident, estimate the total number and retain a reduced number (~20 fish per species) of representative specimens for necropsy. Comply with the standard procedure for reporting fish kills to the relevant state fisheries authorities.

11.13 Forms and Tools

Refer to Appendix C.

12 SCI7b – Fish Impact Study

12.1 Aims and Objectives

The primary aim of SCI7b – Fish Impact Study (SCI7b) is to determine the extent of impact on populations and abundance of fish and fisheries resources if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.

The actual scope of the fish and fisheries resources monitoring depends on the receptors identified within the EMBA by the hydrocarbon spill. SCI7b outlines how the indirect effects on bony and cartilaginous fish populations and abundance will be assessed, excluding those fish assessed under other studies, e.g. SCI6, which covers Whale Sharks and large sharks.

The objective of SCI7b is to determine whether the spill has directly or indirectly impacted the abundance and composition of fish assemblages.

12.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

12.3 Data and Information Requirements

Table 12-1 lists the inputs relevant to planning for the implementation of SCI7b, once the notification to commence is initiated.

Table 12-1: Data Requirements Summary for SCI7b

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • For many fish species, a range of baseline datasets exists for both pelagic (e.g. State Fisheries) and demersal species (e.g. State Governmental Environmental Agencies) • Review methods undertaken during baseline studies, if available, to ensure that data collected during SCI7b can be directly compared to the existing baseline data.	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and SCI1: • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

12.4 Design

12.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES and OPS3 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 12-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 12-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume dissipating from source	Gradient Approach	Will be determined as part of program finalisation
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, data representing the current state of the receptors of interest will be collected before the spill reaches them, where practicable.

Additional parameters, such as measured hydrocarbon concentrations at sample sites (obtained through other OPS and SCI activities) can help establish a cause and effect relationship. This highlights that an essential link exists between the sampling design developed for SCI7b, and that used during other OPS and SCI activities. As such, the sampling designs developed here for each objective should be considered when designing other relevant monitoring activities.

12.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from the MES and OPS3 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

If a spill event occurs and baseline data are not available and cannot be collected immediately before impact, greater sampling effort must be undertaken to ensure that the sampling design incorporates at least three reference sites and three potentially impacted sites (Ref. 44) to maximise the possibility for attributing cause and/or detecting change. Reference sites are those that are minimally disturbed regarding their physical, chemical, and biological characteristics (Ref. 68). Reference sites should be selected in the same bioregion as the impacted sites to have comparable physical, chemical, and biological characteristics.

12.4.3 Monitoring Parameters

Assessments of fish populations will use methods that relate to the particular species identified to be at risk.

Data will be obtained for replicate sites within the EMBA and at reference sites, and relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures. The main parameters recorded will be:

- species identification
- fish counts.

12.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7b will be determined by the level of impacts from the Level 3 hydrocarbon spill and achievement of the termination triggers.

12.4.5 Sample Integrity

Observations using baited remote underwater video stations (BRUVS) will, if practicable, be conducted during SCI7a. If possible, the vessel will move away from the catch area to a suitable site to conduct BRUVS while biopsies are conducted.

BRUVS footage will be downloaded and backed up (two copies) before leaving each site.

12.4.6 Sample Analysis

Statistical analysis will be undertaken using approaches suitable to the overall sampling design established, will involve evaluating differences between impact sites and suitable reference sites, and will consider any existing baseline data (where available). Wherever possible, direct quantitative information of exposure (e.g. ancillary data on the hydrocarbon concentrations of water and sediment samples) will be used to strengthen analysis conclusions. In addition, information from other SCI activities (e.g. SCI4) will be used as additional covariates in analyses to examine potential indirect effects so as to avoid confounding effects and improve statistical power. Ancillary information—such as habitat complexity and type—should also be collected (where feasible) to serve as additional predictors in statistical models to evaluate potential confounding factors and reduce error variance, thereby improving statistical power (Ref.69).

12.4.6.1 BRUVS Analysis

High-definition stereo BRUVS footage will be converted from .m2ts to .mpeg format using Elecard Converter Studio AVC HD V 3.0. EventMeasure and PhotoMeasure software (Ref. 70) will be used to view and analyse footage for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.4.6.2 ROV Video and Towed/Diver Video Analysis

Analysis of video transects will be conducted in two stages. First, taxon counts will be determined by viewing the video at normal speed and recording identifiable fish as they pass through the ‘gate’ formed by the two laser dots. Second, frame grabs will be extracted from the video at five-second intervals. The video footage and still images will be analysed for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.5 Data Management

Field data must be stored securely and maintained. To achieve this, the field team will follow these procedures:

- enter metadata for each video file recorded into prepared electronic spreadsheets
- download data at the completion of each site.

Data will be backed up to a separate location (e.g. external hard drive). This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

12.6 QA/QC Procedures

For each site sampled, a summary of high-level information will be captured in the datasheet, and will contain this information as a minimum:

- date
- site number
- GPS location
- general family/species
- numbers
- notes.

12.7 Mobilisation Requirements

12.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

12.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports

Task	
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

12.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

12.10 Resources

The personnel required to undertake SCI7b, their roles, and relevant qualifications are listed in Table 12-3.

Table 12-3: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish biologist	• Develop sampling plan • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • BRUVS and/or ROV experience • TBOSIET • Offshore medical
BRUVS/ROV Operator	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe	• Qualified BRUVS/ROV operator • TBOSIET • Offshore medical

12.11 Equipment

Depending on the exact scope of the study and the receptors being examined, other necessary equipment may include equipment to record footage to be used to determine population and community status (e.g. ROV-based still or video camera for image capture for demersal fish surveys, or BRUVS equipment).

Redundancy for key pieces of equipment should also be considered.

12.12 Standard Operating Procedures (SOPs)

Assessments of fish populations will be carried out via field studies, based on methods that relate to the particular receptors identified at risk. Because fish populations can show considerable natural fluctuations and are subject to additional anthropogenic pressures from other sources (e.g. recreational and commercial fisheries), it can be difficult to isolate impacts from a single pressure. Thus obtaining useful baseline data is particularly important, especially in the case of a large spill when reference sites may be difficult to obtain. For all fish population surveys, data will be obtained for replicate sites within and outside the EMBA, and comparison of relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures.

For pelagic fish species, trolling and/or BRUVS (Ref. 71) surveys will assess fish population status. If important commercial fisheries species are potentially impacted, methods that align with usual population assessment surveys will be adopted (e.g. Ref. 72). For demersal fishes, methods should align with standard government procedures (e.g. Ref. 73) and commercial methods, where relevant, and may involve video transects (Ref. 74) captured using suitable methods, e.g. ROVs or BRUVS surveys (Ref. 71).

Table 12-4: Steps for Sampling Fish Health~~, Tainting,~~ and Fish Mortality

Step	
☐	Use appropriate survey equipment/methods (e.g. BRUVS, ROV, towed video or diver-swum video transects), depending on species selected and spill location
☐	Deploy up to eight replicate BRUVS units/transects at each site
☐	Deploy BRUVS/other equipment from vessels using Hiabs or equivalent
☐	Separate sampling stations by at least 250 m between BRUVS to avoid overlapping bait plumes and reduce the likelihood of fish moving between deployments within the sampling period
☐	Deploy for at least 60 minutes to maximise measures of diversity and relative abundance of fish
☐	A detail description of BRUVS technological requirements, methods, and recommended procedures is found in Heyward *et al*. (Ref. 75) (Section 4.2.1 for camera set up and field sampling procedures, and Section 4.2.2 for fish community analysis and video processing, pp. 128–1332)

12.13 Forms and Tools

Refer to Appendix C.

13 SCI8 – Heritage (including Shipwrecks)

13.1 Aims and Objectives

The primary aim of SCI8 – Heritage (including Shipwrecks) is to determine the extent, severity, and persistence of impacts on heritage features—including shipwrecks—following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the environment that may be affected (EMBA), as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 is focused on the subtidal zone, which is defined as habitats seaward of LAT and are separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- Determine the extent, severity and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- Collect information for the purposes of determining; short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following the termination of the response

13.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

13.3 Data and Information Requirements

Table 13-1 lists the inputs relevant to planning for the implementation of SCI8, once the notification to commence is initiated.

Table 13-1: Data Requirements Summary for SCI8

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 including: • consolidated data file including exceedances of benchmark levels • this information should be provided in electronic format, as it becomes available.	Information available at commencement of SCI6 on survey design or results from implemented Scientific Monitoring (primarily *SCI1, SCI2*, and *SCI3 – Coastal and Habitat Impact Study*).

13.4 Design

13.4.1 Monitoring Design

Benthic habitats may support a variety of biological communities during all, or part of, the year. To assist in informing scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities to assist in understanding impacts on the most sensitive areas and will involve a combination of:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk and reference areas (outputs from MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large scale changes on shallow benthic habitats e.g. seagrass and macroalgae.
- Biological: To determine the extent, severity and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by an assessing commonly monitored ecological, population and community based parameters. Monitoring will, as far as practicable, also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 13-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 *Reference sites required for each monitoring approach are detailed in Section 1*

13.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide refer to Table 3) have been reviewed. This will aid with the identification of sensitive habitats, associated parameters and methods.

Monitoring locations will be defined using the following considerations:

- Likelihood of hydrocarbon impact on benthic habitats
- Select several impact and reference locations over a large spatial area
- Similarity and representation of habitats, physical features and sediment type between impact versus reference locations
- Impact sites will be selected and prioritised within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- The degree of hydrocarbon exposure or potential exposure of the benthic habitats
- When selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- Accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

13.4.3 Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods) detailed in Table 13-3.

Table 13-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

Quantifying biological response to oil is dealt with under other SCI monitoring components; however, if biological growth may affect heritage features (i.e. increased bacteria causing corrosion or breakdown of material), additional biological monitoring parameters on heritage features, including shipwrecks, may be done. This may include quantifying bacteria and algae growing on structures.

13.4.4 Monitoring Frequency and Duration

Following the initiation of SCI8, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

13.4.5 Sample Integrity

Table 13-3 details the physical monitoring parameters and sampling methods to be used.

13.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment or tissue samples that require preservation, transport, storage and analysis. The procedures for sampling, storage and analysis are provided in SCI1, SCI2 and SCI7.
- Field data: This includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparisons with data collected in later years. It is essential that data be organised in a way, which makes them easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes) the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy in appearance, partially bleached or fully bleached; Ref. 62).

Image analysis and machine learning methods will be used, where possible (e.g. Ref. 63), following verification they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be performed at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size and depth.

13.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

13.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using the following methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)

- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove ‘ecological noise’ from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

13.7 Mobilisation Requirements

13.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements i.e. data format, metadata, storage protocols, delivery schedule and communication method
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

13.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation

Task	
□	Assemble scientific survey team
□	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

13.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
□	Confirm specialist equipment requirements and availability • ROV/AUV/drop camera/towed camera • subsea positioning (if required) i.e. USBL • dive spread (if required) • benthic grab • remote sensing platform
□	Check if instrument calibration is required, and calibration certificates are on file
□	Check if equipment redundancy is required
□	Check if a DGPS is required
□	Confirm installation of real-time classification software (if available)
□	Book freight to mobilisation port

13.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities and relevant qualifications are listed in Table 13-4.

Table 13-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical

Role	Responsibility	Qualifications
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• ADAS Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

13.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment for SCI8 are listed below.

Items	
□	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
□	Is redundancy required?
□	DGPS
□	Echo sounder on each vessel
□	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
□	Backup data storage for field data
□	Tissue preservation material and sample jars
□	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
□	Specialist PPE (i.e. PFD,RPE)
□	Book freight to mobilisation port

13.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- haphazard transects – in situ.

Step	
☐	Percentage cover of each habitat type will be assessed at each site using photo quadrats, taken along transects.
☐	The locations of transects at each site will be selected at random
☐	The start location (latitude and longitude) of each transect will be recorded and georeferenced, and bearing and distance of each transect similarly recorded.
☐	A minimum of three replicate transects will be undertaken at each site.
☐	Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment (e.g. quadrats) and will be randomly located along each transect
☐	The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives, but a minimum of five photo quadrats per transect should be planned. Note that the length of transects and number of quadrats should be standardised across sites.
☐	Photographs will be taken with a still camera, or taken as still images from video transect footage.
☐	The methodology of photograph capture will be kept consistent among a survey and where possible, across all survey sites, noting that technology improvements may be incorporated into surveys. If practicable, high-quality still plan (downward facing) images (taken from a still camera or still images from video transect footage), should be captured with sufficient lighting.
	If practicable, the quadrat boundary should be marked within each image as either a solid boundary (i.e. frame placed on the transect) or by underwater lasers marking out a scale.
☐	Where possible, transects will be located in similar depths within sites.
☐	Upon retrieval, data will be QAQC checked and backed up on site
☐	Data will be analysed using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

13.13 Forms and Tools

Refer to Appendix C.

14 Acronyms and Abbreviations

Table 14-1 defines the acronyms and abbreviations used in this document.

Table 14-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
#	Number
°C	Degrees Celsius
µg/g	Micrograms per gram
µg/L	Micrograms per litre
µm	Micrometer
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ADAS	Australian Diving Accreditation Scheme
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUV	Autonomous Underwater Vehicle
BACI	Before-After-Control-Impact
BRUVS	Baited Remote Underwater Video Station
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Carbon chain length
CATAMI	Collaborative and Annotation Tools for Analysis of Marine Imagery and Video; a classification scheme for scoring marine biota and substrata in underwater imagery
CJS	Cormack-Jolly-Seber
cm	Centimetre
cm^3	Cubic centimetre
CMR	Capture, mark, recapture
CoC	Chain of Custody
CPCe	Coral Point Count with Excel extension
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	Conductivity Temperature Depth
dB(A)	Decibel, unit of sound loudness
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions (formally Parks and Wildlife)
DMSO	Dimethyl sulfoxide

Acronym / Abbreviation	Definition
DNA	Deoxyribonucleic Acid. A self-replicating material present in nearly all living organisms as the main constituent of chromosomes. It carries genetic information.
DoF	Western Australia Department of Fisheries
DOSS	Dioctyl sulfosuccinate
DoT	Western Australian Department of Transport
DotEE	Formally the Commonwealth Department of the Environment and Energy (now DAWE)
DPnB	Dipropylene Glycol n-Butyl Ether
EGMBE	Ethylene Glycol Monobutyl Ether
EMBA	Environment that May Be Affected
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HAZID	Hazard Identification
HES	Health, Environment, and Safety
I-GEMS	Industry-Government Environmental Meta-database
IMG	Incident Management Guide
Impact Site	Site impacted by oil
Infauna	The assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans)
IvC	Impact versus Control
IvR	Impact versus Reference
JHA	Job Hazard Analysis
km	Kilometre
km^2	Square kilometres
kn	Knot
LAT	Lowest Astronomical Tide
LNG	Liquefied Natural Gas
m	Metre
MBACI	Multiple Before-After-Control-Impact
MES	Monitoring, Evaluation and Surveillance
mL	Millilitre

Acronym / Abbreviation	Definition
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
mS/cm	Milli Siemen per centimetre; measure of conductivity
MSDS	Material Safety Data Sheet
N/A	Not Applicable
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NTU	Nephelometric Turbidity Unit
NWS	North West Shelf
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PERMANOVA	Permutational Multivariate Analysis of Variance
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
PSD	Particle Size Distribution
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.
RFU	Raw Fluorometry Units
ROV	Remotely Operated Vehicle
RPE	Respiratory Protective Equipment
SCI	Scientific Monitoring Program
SD	Standard Deviation
SDH	Sorbitol dehydrogenase
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPRAT	Species Profile and Threats (database)

Acronym / Abbreviation	Definition
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia
TBOSIET	Tropical Basic Offshore Safety Induction and Emergency Training
TOC	Total Organic Carbon
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
UME	Unusual Mortality Event
USBL	Ultra-short Baseline
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere
WA	Western Australia
WoRMS	World Register of Marine Species

15 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 15-1: References

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Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
Barrow Island	Thevenard Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Barrow Island	Onslow	63	51	7.9	5.7	3.7	2.5	22 mins	-
Barrow Island	Dampier	80	77	10.0	7.3	4.7	3.2	33 mins	-
Barrow Island	Exmouth	110	105	13.8	10.0	6.5	4.4	45 mins	-
Barrow Island	Platform	57	57	7.1	5.2	3.4	2.3	24 mins	
Thevenard Island	Barrow Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Thevenard Island	Onslow	12	12	1.5	1.1	0.7	0.5	5 mins	-
Thevenard Island	Dampier	116	107	14.5	10.5	6.8	4.6	46 mins	
Thevenard Island	Exmouth	54	65	6.8	4.9	3.2	2.2	28 mins	
Dampier	Exmouth	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Dampier	Barrow Island	80	77	10.0	7.3	4.7	3.2	33 mins	
Dampier	Thevenard Island	116	107	14.5	10.5	6.8	4.6	46 mins	
Dampier	Onslow	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Dampier	Platform	87	87	10.9	7.9	5.1	3.5	37 mins	
Exmouth	Barrow Island	110	105	13.8	10.0	6.5	4.4	45 mins	-
Exmouth	Thevenard Island	54	65	6.8	4.9	3.2	2.2	28 mins	-
Exmouth	Onslow	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Exmouth	Dampier	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Onslow	Barrow Island	63	51	7.9	5.7	3.7	2.5	22 mins	-
Onslow	Thevenard Island	12	12	1.5	1.1	0.7	0.5	5 mins	-
Onslow	Dampier	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Onslow	Exmouth	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Onslow	Platform	108	108	13.8	9.8	6.4	4.3	46 mins	

1. *Allow ~3 hours to travel from east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time-based on-site information and knowledge and http://ports.com/sea-route/*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Guideline for Data Management

Oil Spill Monitoring Handbook

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

	Page 1 of 2	**Q.1**

Oil Spill Monitoring Handbook

Q.1	Methodology Continued			
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

	Page 2 of 2	**Q.1**

Appendix C Forms

Form number	Description
1.	CoC forms
2.	Freight consignment form
3.	Marine Vessel Survey Log Form
4. 4.	Environmental Permit Application Forms

Form 1 – Chain of Custody

Chevron

Chain of Custody Form
Environmental Sample Submission Sheet

1.0 General Information			
Samples sent to: (contract laboratory)			
Attention:			
Chevron Charge Caption:		or Service Order No.:	

2.0 Sample Information			
Samples From:		Sampled by:	
Sample Type:		Date Sampled:	

	Description of sample	Analysis required
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

☐ **Additional samples overleaf** ☐ **Preserved at 4°C**

3.0 Tracking			
☐ **Copy 1** To Contract Lab with Sample - Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative. - Lab to mail this **original** copy to EH&S representative with completed results.			
☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.			
☐ **MEJ number must be included prior to analysis of samples.**			
Acknowledge receipt signature:		**Date:**	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre, Building 500 Resources and Chemistry Precinct,
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

Off Conlon Street, BENTLEY WA 6102

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:	**NOTES**	ANALYSIS REQUIRED	**ChemCentre Job No:**
CLIENT (Billing): ADDRESS: CLIENT P/O No: .... SAMPLED BY: .... RESULTS TO:			**Please indicate if QC results are required:** ☐ **Method QC** ☐ **Batch QC** ☐ **Special LOD (use comments section)** *Method QC data refers to results from a lab blank and a lab verification standard. *Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.

LAB ID	**SAMPLE ID / DESCRIPTION**	**Sample Type**	**Depth**	**DATE COLLECTED**	**TIME COLLECTED**							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ **Normal Turnaround**	☐ **Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

CVX Advanced Shipping Notification (ASN)

Order Ref No:	
Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)

	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
SI No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Marine Vessel Survey Log Form

Blue Planet Marine

Chevron

Gorgon LNG Project
Marine Fauna Observations

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page _____ *of* _____

Form 4 – Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations,* hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (……)..

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)
.... (signature)	.... (print name)	.... (date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix
Seal
Here

Director : .... (signature) .... (print name) .... (date)

Director/Secretary: .... (signature) .... (print name) .... (date)

Declaration where sole director/secretary (if applicable):

I .... declare that I am the sole director and sole company secretary of
(print name)

.... (print company name) .... (signature) .... (date)

Attorney

Attorney under Power: .... (signature) .... (print name) .... (date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee
The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant** - state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought** - give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents** -

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.

Appendix D Description of the Environment CAPL Planning Area

Chevron

human energy®

description of the environment CAPL planning area

Document ID:	ABU-COP-02890
Revision ID:	4.1
Revision Date:	17 August 2023
Information Sensitivity:	Company Confidential

description of the environment

CAPL planning area

Document information

Document Number	ABU-COP-02890	**Revision**	4.1
Document Owner	Shane Waldeck	**Department Owner**	HSE Regulatory Affairs Team Lead

Revision history

Rev No.	Description	Date	Prepared By	Approved By
1.0	Issued for use	01 May 2020	A Fertch	D Salins
2.0	Updated with Offshore Areas incorporated into Planning Area	11 Sep 2020	A Fertch	D Salins
3.0	Annual review	23 Jul 2021	M Carey	D Smith
4.0	Annual review, and revision of Planning Area to incorporate IOT	01 Mar 2023	R Hill / E Rosengart	D Salins
4.1	Annual review	17 Aug 2023	R Hill	D Salins

Approvals

	Name	Signature	Date
Author:	Rebecca Hill HSE Advisor		
Checked:	Duanne Salins HSE Regulatory Approvals Advisor		
Approved:	Shane Waldeck HSE Regulatory Affairs Team Lead		

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figures

1 introduction

1.1 Purpose

This document describes the environment within Chevron Australia Pty Ltd's (CAPL's) Planning Area (PA) (Figure 1-1), which is the 'offshore area' in which CAPL's activities may interact with the environment. Offshore areas are defined under section 8 of the *Offshore Petroleum and Greenhouse Gas Storage Act (2006)* (Cth). This document applies to all CAPL operations and may be used to support Environment Plans (EPs) (specifically including the Operational and Scientific Monitoring Plans [OSMPs]), submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Each EP will define an environment that may be affected (EMBA) and Planning Area for Scientific Monitoring (previously referred to as Environmental Exposure Area [EEA]) for its specific petroleum activity. The EMBA and Planning Area for Scientific Monitoring for each activity will most likely be based on conservative stochastic spill modelling for a worst case credible scenario. If an EMBA or Planning Area for Scientific Monitoring from an individual EP extends into an offshore area that is beyond the existing PA, this document will be revised, and the PA extended to incorporate the additional 'offshore area'.

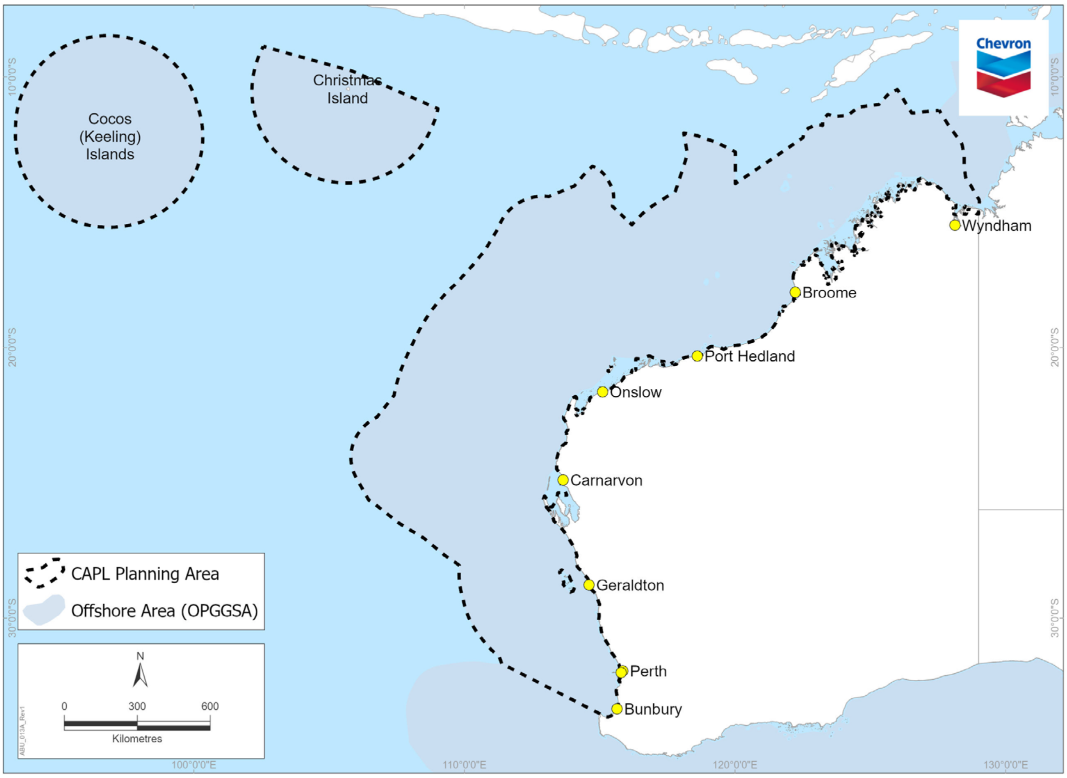


Figure 1-1: CAPL's planning area

1.2 Regulatory context

The Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth) (OPGGS(E)R) detail the information that must be included in an EP. Specifically:

Regulation 13(2) states that the environment plan must:

(a) describe the existing environment that may be affected by the activity; and

(b) include details of the particular relevant values and sensitivities (if any) of that environment.

Regulation 4 defines the environment as:

(a) ecosystems and their constituent parts, including people and communities; and

(b) natural and physical resources; and

(c) the qualities and characteristics of locations, places and areas; and

(d) the heritage value of places;

and includes

(e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).

Regulation 13(3) further provides that, without limiting paragraph (2)(b) of regulation 13(2), particular relevant values and sensitivities may include any of the following:

(a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;

(b) the national heritage values of a National Heritage place within the meaning of that Act;

(c) the ecological character of a declared Ramsar wetland within the meaning of that Act;

(d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act;

(e) the presence of a listed migratory species within the meaning of that Act;

(f) any values and sensitivities that exist in, or in relation to, part or all of:

(i) a Commonwealth marine area within the meaning of that Act; or

(ii) Commonwealth land within the meaning of that Act.

Specific to the description of the environment, NOPSEMA’s Environment Plan Content Requirement guidance (Ref. 1) states:

> The level of detail within the plan should be appropriately scaled to the nature of the impacts and risks to the particular values and sensitivities. For example, the environment that may be affected by planned operations will need to be described in a greater level of detail than areas exposed to low levels of hydrocarbon in the unlikely event of a worst-case hydrocarbon release.

Consequently, CAPL has taken the approach that this document provides information suitable for summarising the particular values and sensitivities in order to inform the Planning Area for Scientific Monitoring under an OSMP for CAPL operations.

If additional information is available for specific locations (typically an Operational Area for a specific activity) and if this information can be used to further influence or inform the impact and risk assessment, this additional information will be included in the ‘Description of the Environment’ section of the individual EP.

1.3 Review and revision

The information provided in this document is derived from various referenced desktop sources. As a minimum, this document will be reviewed annually to include any relevant changes to source documents, which may include State (Western Australian [WA]) or Commonwealth Management Plans, Recovery Plans, *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) status, or new published research.

2 matters of national environmental significance

Matters of national environmental significance (MNES) are protected under the EPBC Act. The presence of MNES within the PA has been determined from the Australian Government's online Protected Matters Search Tool (PMST) (Ref. 109). The presence of relevant marine and/or coastal MNES within the PA are summarised in Table 2-1. The full PMST report[1] is included as appendix a.

It should be noted that the EPBC Act PMST is a general database that conservatively identifies areas in which protected species have the potential to occur.

Table 2-1: Presence of MNES within the PA

MNES	PA
World Heritage properties^	✓
National Heritage places^	✓
Wetlands of international importance (Ramsar wetlands)^	✓
Nationally listed threatened species and communities^	✓ species ✓ communities
Nationally listed migratory species^	✓
Commonwealth marine area^	✓
Great Barrier Reef Marine Park	✗
Nuclear actions (including uranium mining)	—
Water resources (in relation to coal seam gas or large coal mining development)	—

^ *These MNES are also identified as particular values and sensitivities under the OPGGS(E)R.*

^ *Where ✓ = present, ✗ = not present, and — = not relevant to the petroleum activity.*

2.1 World Heritage properties

Properties nominated for World Heritage listing are inscribed on the list only after they have been carefully assessed as representing the best examples of the world's cultural and natural heritage. At the time of writing this document, Australia has 20 properties on the World Heritage List (Ref. 2).

The list of Australia's World Heritage areas (Ref. 2), searches of the online PMST (appendix a), and a review of the World Heritage Areas Spatial Database (Ref. 3) show that two World Heritage properties are within the PA[2]. Table 2-2 summarises the values of these World Heritage properties.

Table 2-2: World Heritage properties

World Heritage property	Brief overview of values^
Shark Bay	On the Indian Ocean coast at the most westerly point of Australia, Shark Bay's waters, islands, and peninsulas covering a large area of ~2.2 million hectares (of which about 70% are marine waters) have a number of exceptional natural features, including one of the largest and most diverse seagrass beds in the world. However, it is for its stromatolites (colonies of microbial mats that form hard, dome-shaped deposits, which are said to be the oldest life forms on

[1] The PMST is a general database that includes all MNES, including species or features (such as terrestrial-based species or features) that are not expected to credibly occur within the PA.

[2] Only World Heritage properties with a coastal and/or marine interface have been identified and described.

World Heritage property	Brief overview of values^
	earth), that the property is most renowned. The property is also famous for its rich marine life including a large population of dugongs and provides a refuge for a number of other globally threatened species.
The Ningaloo Coast	The Ningaloo Coast is located on WA's remote coast along the East Indian Ocean. The property holds a high level of terrestrial species endemism and high marine species diversity and abundance. An estimated 300 to 500 Whale Sharks aggregate annually coinciding with mass coral spawning events and seasonal localised increases in productivity. The marine portion of the nomination contains a high diversity of habitats that includes lagoon, reef, open ocean, the continental slope, and the continental shelf. Intertidal systems such as rocky shores, sandy beaches, estuaries, and mangroves are also found within the property. The most dominant marine habitat is the Ningaloo reef, which sustains both tropical and temperate marine fauna and flora, including marine reptiles and mammals. The main terrestrial feature of the Ningaloo Coast is the extensive karst system and network of underground caves and water courses of the Cape Range. The karst system includes hundreds of separate features such as caves, dolines, and subterranean water bodies and supports a rich diversity of highly specialised subterranean species. Above ground, the Cape Range Peninsula belongs to an arid ecoregion recognised for its high levels of species richness and endemism, particularly for birds and reptiles.

^ *Source: Ref. 2.*

2.2 National Heritage places

The National Heritage List is Australia's list of natural, historic, and Indigenous places of outstanding significance to the nation. The National Heritage List spatial database (Ref. 4) describes the place name, class (Indigenous, natural, historic), and status.

A search of the National Heritage List spatial database (Ref. 4) and searches of the online PMST (appendix a) identified that National Heritage places occur in the PA[3] (Table 2-3). The information presented in Table 2-3 outlines the nominator's Summary Statement of Significance sourced from the Australian Heritage Database (Ref. 5).

Table 2-3: National Heritage places

National Heritage place	Class	Summary of significance^
Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos	Historic	Wrecked on 4 June 1629, the *Batavia* is the oldest of the known Verenigde Oost-Indische Compagnie wrecks on the WA coast. Because of its relatively undisturbed nature, the archaeological investigation of the wreck itself has revealed a range of objects of considerable historical value. The recovered sections of the hull of the *Batavia* have been reconstructed in the Western Australian Maritime Museum and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at *Batavia* (now Jakarta) in the early 17th century.
Dampier Archipelago (including	Indigenous	The Dampier Archipelago located about 1,550 km north of Perth. On the magnificent Dampier Archipelago in WA, where the striking red earth of the Burrup Peninsula meets the blue Indian Ocean,

[3] Only National Heritage places with a coastal and/or marine interface have been identified and described.

National Heritage place	Class	Summary of significance^
Burrup Peninsula)		rock engravings thought to number in the millions and other significant sites are helping us learn more about our Indigenous heritage. Made up of islands, reefs, shoals, channels and straits, and covering a land area of around 400 km^2, the Burrup Peninsula is 27 km long and 4 km wide. Many important native plants, animals and habitats are found in the area. The Archipelago was formed 6-8,000 years ago when rising sea levels flooded what were once coastal plains. The underlying rocks are amongst the oldest on earth, formed in the Archaean period more than 2,400 million years ago. The Dampier Archipelago was included in the National Heritage List on 3 July 2007.
Dirk Hartog Landing Site 1616 – Cape Inscription Area	Historic	Cape Inscription is the site of the oldest known landings of Europeans on the WA coastline, and is associated with a series of landings and surveys by notable explorers over a 250-year period. The first known European landing on the west coast of Australia was by Dirk Hartog of the Dutch East India Company's ship the Eendracht at Cape Inscription on 25 October 1616. Hartog left a pewter plate, inscribed with a record of his visit and nailed to a post left standing upright in a rock cleft on top of the cliff. This plate is the oldest extant record of a European landing in Australia. Hartog's discovery had a major impact on world cartography. After leaving the island, he sailed northwards charting the coastline of WA to 22° south. As a result, a known part of the coastline of WA appeared on world maps for the first time, replacing the mythical southern continent of 'Terra Australis Incognita'.
HMAS Sydney II and *HSK Kormoran* Shipwreck Sites	Historic	The naval battle fought between the Australian warship *HMAS Sydney II* and the German commerce raider *HSK Kormoran* off the WA coast during World War II (November 1941) was a defining event in Australia's cultural history. *HMAS Sydney II* was Australia's most famous warship of the time and this battle has forever linked the stories of these warships to each other. The tragic loss of *HMAS Sydney II* and its entire crew of 645 following the battle with *HSK Kormoran* remains Australia's worst naval disaster.
Shark Bay, Western Australia	Natural	Shark Bay is on the most western point of the Australian coast. The region is one of the few properties inscribed on the World Heritage List (see Table 2-2) for all four outstanding natural universal values: • as an outstanding example representing the major stages in the Earth's evolutionary history • as an outstanding example representing significant ongoing ecological and biological processes • as an example of superlative natural phenomena • containing important and significant habitats for in situ conservation of biological diversity. 25% of vascular plants (283 species) are at the limits of their range in Shark Bay. Many vegetation formations and plant species are found only in the interzone area. The area south of Freycinet Estuary contains the unique type of vegetation known as tree heath. There are also at least 51 species endemic to the region and others that are considered new to science. The Shark Bay region is an area of major zoological importance, primarily due to habitats on peninsulas and islands being isolated from the disturbance that has occurred elsewhere. Of the 26 species of endangered Australian mammals, five are found on Bernier and Dorre Islands. These are the Boodie or Burrowing

National Heritage place	Class	Summary of significance^
		Bettong, Rufous Hare Wallaby, Banded Hare Wallaby, the Shark Bay Mouse, and the Western Barred Bandicoot. The Shark Bay region has a rich avifauna with over 230 species, or 35%, of Australia's bird species having been recorded. A number of birds attain their northern limit here, such as the Regent Parrot, Western Yellow Robin, Blue-breasted Fairy-wren, and Striated Pardalote. The region is also noted for the diversity of its amphibians and reptiles, supporting nearly 100 species. Again, many species are at the northern or southern limit of their range. The area is also significant for the variety of burrowing species, such as the Sandhill Frog, which, apparently, needs no surface water. Shark Bay contains three endemic sand-swimming skinks, and 10 of the 30 dragon lizard species found in Australia. The 12 species of seagrass in Shark Bay make it one of the most diverse seagrass assemblages in the world. Seagrass covers >4,000 km^2 of the bay, with the 1,030 km^2 Wooramel Seagrass Bank being the largest structure of its type in the world. Seagrass has contributed significantly to the evolution of Shark Bay as it has modified the physical, chemical, and biological environment as well as the geology and has led to the development of major marine features, such as Faure Sill. The barrier banks associated with the growth of seagrass over the last 5,000 years has, with low rainfall, high evaporation, and low tidal flushing, produced the hypersaline Hamelin Pool and L'Haridon Bight. This hypersaline condition is conducive to the growth of cyanobacteria, which trap and bind sediment to produce various mats and structures including stromatolites. Stromatolites represent the oldest form of life on Earth. They are representative of life forms from ~3,500 million years ago. Hamelin Pool contains the most diverse and abundant examples of stromatolite forms in the world. Shark Bay is renowned for its marine fauna. For example, the Shark Bay population of about 10,000 Dugong is one of the largest in the world, and dolphins abound, particularly at Monkey Mia. Humpback Whales use Shark Bay as a staging post in their migration along the WA coast. This species was reduced by past exploitation from an estimated population of 20,000 on the west coast to 500–800 whales in 1962; the population is now estimated at 2,000–3,000. Green and Loggerhead Turtles are found in Shark Bay near their southern limits; they nest on Dirk Hartog Island and Peron Peninsula beaches. Dirk Hartog Island is the most important nesting site for Loggerhead Turtles in WA. Shark Bay is also an important nursery ground for larval stages of crustaceans, fishes, and medusae (jellyfish).
The Ningaloo Coast	Natural	The integration of the Ningaloo Reef and Exmouth Peninsula karst system as a cohesive limestone structure is at the heart of the natural heritage significance of the Ningaloo Coast. The modern Ningaloo Reef, Exmouth Peninsula karst, and the wave-cut terraces, limestone plains, Pleistocene reef sediments of Exmouth Peninsula, and associated marine, terrestrial, and subterranean ecosystems, including the Muiron Islands, demonstrate a geological, hydrological, and ecological unity, which harmonises the region's present ecosystem functions with its evolutionary history as a time-series of coral reefs and an evolving karst system. The history of coral reefs during the last 26 million years is chronicled in the limestone parapets and wave-cut terraces of Cape

National Heritage place	Class	Summary of significance^
		Range, which record previous high water levels. Demonstrating late Quaternary deformation at a passive continental margin, the uplifted Neogene wave-cut terraces and fossil reefs that fringe Exmouth Peninsula, and the submerged fossil reef terraces that form the substrate of the modern reef, in immediate juxtaposition with the undeformed modern Ningaloo Reef, contribute to an understanding of the mechanisms that led to the modern character of the west coast of Australia. Archaeological deposits in the rock shelters on Cape Range show Aboriginal people had a comprehensive and sophisticated knowledge of edible and non-edible marine resources between 35,000 and 17,000 years ago. The rock shelters of Exmouth Peninsula are outstanding because they provide the best evidence in Australia for the use of marine resources during the Pleistocene, including their uses as food and for personal adornment. The evidence for standardisation in size and manufacture of the shell beads found at Mandu Creek rock shelter, coupled with the fact they provide the earliest unequivocal evidence for the creation of personal ornaments in Australia, demonstrates a high degree of creative and technical achievement.
The West Kimberley	Natural	The National Heritage listing of the West Kimberley recognises the natural, historic, and Indigenous stories of the region that are of outstanding heritage value to the nation. These and other fascinating stories about the west Kimberley are woven together in the following description of the region and its history, including a remarkable account of Aboriginal occupation and custodianship over the course of more than 40,000 years. The Kimberley occupies more than 420,000 km^2 on the north-western margin of the Australian continent. Its rocky coastline edges the Indian Ocean, and off the coast lie thousands of islands, many fringed with coral. The Mitchell Plateau (Ngauwudu) rises to nearly 800 m above sea level at its centre, in places dropping into steep escarpments, and losing altitude as it approaches the sea. Further south, Yampi Peninsula lies in a transitional area between the high rainfall of tropical north Kimberley and the drier conditions characteristic of central WA. These different environments meet in a complex landscape of plains, dissected sandstone plateaus, and rugged mountains. The central Kimberley, which includes the periphery of north Kimberley plateau country and the King Leopold Ranges, is very rugged; the physical structures here were formed by significant geological events, which folded rocks intensely, many thousands of millions of years ago. That such evidence of a distant past can today be seen so clearly in the landscape is due to the region's remarkable geological stability. This stability has also allowed the much more recent appearance of extensive limestone ranges, built from the remains of an extraordinary reef complex which, more than 300 million years ago, rivalled the Great Barrier Reef in size. The ranges have since eroded to form complex networks of caves and tunnels. Dinosaur footprints and tracks are another remarkable remnant of past life in the Kimberley; they are exposed in many places in the Broome sandstone, along the western length of Dampier Peninsula. This coastline is subject to one of the highest tidal ranges in the world, and many of the fossil footprints can only be seen for short periods during very low tides. Inland of Dampier Peninsula, south of the broad floodplains of the Fitzroy River, the distinctive red of the pindan country opens onto a vast expanse of desert.

National Heritage place	Class	Summary of significance^
		Throughout the Kimberley, where water meets land—in estuaries, mangroves and mudflats, in moist vine thickets, along the banks of rivers and creeks, around waterholes or soaks—there is an abundance of plants and animals, some of which live only in the Kimberley, while others may have travelled from the far side of the world to nest or breed here.

^ Source: Ref. 5.

2.3 Wetlands of international importance (listed under the Ramsar Convention)

At the time of writing this document, Australia has 67 Ramsar wetlands that cover >8.3 million ha. Ramsar wetlands are those that are representative, rare, or unique wetlands, or that are important for conserving biological diversity. These are included on the List of Wetlands of International Importance held under the Ramsar Convention (Ref. 7).

A search of the Ramsar Wetlands of Australia spatial dataset (Ref. 8) and searches of the online PMST (appendix a) identifies the presence of Ramsar wetlands within the PA[4] (Table 2-4). The Ramsar Convention defines ecological character as the combination of the ecosystem components, processes, benefits, and services that characterise the wetland at a given point in time (Ramsar Convention 2005a, Resolution IX.1 Annex A). A summary of the ecological character of the wetlands is described in Table 2-4.

Table 2-4: Ramsar wetlands

Summary of the ecological character of Ramsar wetlands
Ashmore Reef Commonwealth Marine Reserve
Ashmore Reef Commonwealth Marine Reserve is located in the Indian Ocean on the edge of Australia's North West Shelf, ~610 km north of Broome and ~840 km west of Darwin. The Reserve is in Australia's External Territory of Ashmore and Cartier Islands. It is the largest of only three emergent oceanic reefs present within the north-eastern Indian Ocean. The Reserve is comprised of numerous marine habitats and supports a regionally important and diverse range of species. The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher (Ref. 9). Ecosystem components and processes • Climate: Arid tropical monsoonal climate. Located outside the main belt of tropical cyclones in the Timor Sea. • Geomorphic setting: Located in an area of high oil and gas reserves, with active hydrocarbon seeps. Geomorphic groups within the site include reef slope, reef crest, reef flat, back reef sands, lagoons and islands. • Tides and currents: Strong seasonal influences of the Indonesian Throughflow and Holloway currents. Internal waves are a feature of the region and Ashmore Reef may act to break these resulting in increased nutrients from the bottom waters. High energy environment with spring tides over 4.5 m and large flushing on tidal cycles. • Water quality: Seasonal variations in temperature and salinity in ocean and lagoon water. Water clarity, turbidity and other water quality parameters remain a knowledge gap. • Vegetation: Five species of seagrass recorded with *Thalassia hemprichii* dominant, comprising over 85% of total cover. Total cover of 470 ha, over 3,000 ha of macroalgae, mostly on reed slope and crest areas. Algae dominated by turf and coralline algae with fleshy macroalgae comprising typically less than 10% of total algae cover.

[4] Only Ramsar Wetlands classified as marine/coastal wetlands have been identified and described.

Summary of the ecological character of Ramsar wetlands
• Marine invertebrates: Ashmore Reef has a diversity of marine invertebrates including hard and soft corals, molluscs, echinoderms and crustaceans. 275 species of hard coral, covering an area of around 700 ha. 39 taxa of soft coral, covering an area of around 300 ha. Total coral cover was low around the time of listing following the 1998 bleaching event but recovered in recent years to baseline levels. Over 600 species of mollusc, including two endemic species. Over 180 species of echinoderm, including 18 species of sea cucumber. Sea cucumber density is highly variable, but on average exceeds 30 per hectare. 99 species of decapod crustacean. • Fish: Over 750 species of fish, including five species of fish and three species of shark listed as threatened. Predominantly shallow water, benthic taxa that are common throughout the Indo-Pacific. Density of small reef fishes is around 20,000 to 40,000 per hectare. Low density of sharks (less than one per hectare). • Seasnakes: Prior to listing there was a high diversity and population, peaking in 1998 with an estimated total population of 40,000 snakes in the site. However, by time of listing in 2002 the site was on a trajectory of decline and diversity and abundance was low. • Turtles: Three species of marine turtle: Green (*Chelonia mydas*), Hawksbill (*Eretmochelyis imbricata*) and Loggerhead (*Caretta caretta*) all of which are listed threatened species. Green Turtles are the most abundant, with a total estimated population of around 10,000. Nesting by two species; Green Turtles and Hawksbill Turtles. • Seabirds and shorebirds: Ashmore Reef supports an abundance and diversity of wetland birds. 72 species of wetland dependent bird recorded within the Ramsar site. 47 species listed under international migratory agreements. Average of around 48,000 seabirds and shorebirds annually. Six species are regularly recorded in numbers greater >1% of the population. Nesting of 20 species, 14 of which regularly breed in the site. • Dugong: Small but significant population, that may breed within the site. Data deficient. Ecosystem services • Provisioning services–Freshwater: Indonesian fishers use the freshwater lens at West Island. • Cultural services–Recreation and tourism: Although remote and access is controlled, the site is important for passive recreation such as diving and bird watching. • Cultural services–Cultural heritage and identity: Ashmore Reef has been regularly visited and fished by Indonesians since the early 18th century. West Island contains some archaeological artefacts and graves. • Cultural services–Scientific and educational: The reef has high value for scientific research because it currently received relatively low use and is ecologically unique within the bioregion. • Supporting services–Near-natural wetland types: Ashmore Reef supports a number of largely unmodified wetland types. • Supporting services–Biodiversity: Ashmore Reef is a hotspot of biodiversity within the Timor Province bioregion. Highest biodiversity of reef building corals (275 species from 56 genera). Highest diversity of soft corals (39 taxa). More than 600 species of mollusc. Over 180 species of echinoderm, including 13 species of sea cucumber. Nearly 100 species of decapod crustacean. Over 750 species of finfish. High diversity of seasnakes. • Supporting services–Physical habitat: The site supports large breeding colonies of seabirds. • Supporting services–Priority wetland species: The Ramsar site supports 47 species of shorebirds listed under international migratory bird treaties. • Supporting services–Threatened species: Ashmore Reef supports 62 species listed as threatened at the national and/or international level.
Eighty-mile Beach
The Eighty-mile Beach Ramsar site comprises two separate areas: ~220 km of beach and associated intertidal mudflats from Cape Missiessy to Cape Keraudren, and the Mandora Salt Marsh ~40 km to the east. The beach is characterised by extensive (1–4 km wide) intertidal mudflats comprised of fine silt and clay, bounded to the east by a narrow strip of coarse quartz sand and then coastal dunes. The beach is a relatively linear stretch with a few tidal creeks with small extents of the grey mangrove (*Avicennia marina*). Mandora Salt Marsh comprises of a series of floodplain depressions within a linear dune system. The site contains two large seasonal depressional wetlands (Lake Walyarta and East Lake) and a series of small permanent mound springs.

Summary of the ecological character of Ramsar wetlands

The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher (Ref. 10).

Ecosystem components and processes

- Climate: Semi-arid monsoonal with a prolonged dry period. >80% of rainfall in the wet season (December to March). High inter-annual variability. High occurrence of tropical cyclones.
- The Beach:
  - Geomorphology: Extensive intertidal mudflats comprised of fine-grained sediments. Site is backed by steep dunes comprised of calcareous sand.
  - Hydrology: Macro-tidal regime. No significant surface water inflows. Groundwater interactions unknown (knowledge gap).
  - Primary production and nutrient cycling: Data deficient, but organic material deposited from ocean currents driving the system through bacterial or microphytobenthos driven primary production.
  - Invertebrates: Large numbers and diversity of invertebrates within the intertidal mudflat areas.
  - Fish: Data deficient, but anecdotal evidence of marine fish (including sharks and rays) using inundated mudflats.
  - Waterbirds: Significant site for stop-over and feeding by migratory shorebirds. Regularly supports >200,000 shorebirds during summer and >20,000 during winter. High diversity with 97 species of waterbird recorded from the beach. Regularly supports >1% of the flyway population of 20 species.
  - Marine turtles: Significant breeding site for the Flatback Turtle.
- Mandora Salt Marsh:
  - Geomorphology: Wetland formation dominated by alluvial processes. Wetlands were once a part of an ancient estuary. Freshwater springs have been dated at 7,000 years old.
  - Hydrology: Lake Walyarta, East Lake and the surrounding intermittently inundated paperbark thickets are inundated by rainfall and local runoff. Extensive inundation occurs following large cyclonic events. Salt Creek and the mound springs are groundwater fed systems through the Broome Sandstone aquifer.
  - Water quality: Most wetlands are alkaline reflecting the influence of soils and groundwater. Salinity is variable, mound springs are fresh, Salt Creek hyper-saline and Lake Walyarta variable with inundation. Nutrient concentrations in groundwater and groundwater fed systems are high.
  - Primary production and nutrient cycling: Data deficient. However, evidence of boom-and-bust cycle at Lake Walyarta with seasonal inundation.
  - Vegetation: Inland mangroves (*Avicennia marina*) lining Salt Creek are one of only two occurrences of inland mangroves in Australia. Paperbark thickets dominated by the saltwater paperbark (*Melaleuca alsophila*) extend across the site on clay soils which retain moisture longer than the surrounding landscape. Samphire (*Tecticornia* spp.) occurs around the margins of the large lakes. Freshwater aquatic vegetation occurs at Lake Walyarta when inundated and at the mound spring sites year round.
  - Invertebrates: Data limited, but potentially unique species
  - Waterbirds: Significant site for waterbirds and waterbird breeding, particularly during extensive inundation events. 66 waterbirds recorded. Supports >1% of the population of at least two species. Breeding recorded for at least 24 species.

Ecosystem benefits and services

- Provisioning service–Freshwater: The freshwater springs at Mandora Salt Marsh provide drinking water for livestock.
- Provisioning service–Genetic resources: Plausible, but as yet no documented uses.
- Regulating service– Climate regulation: Plausible, but data deficient.
- Regulating service–Biological control of pests: Evidence that many of the shorebirds feed on the adjacent pastoral land and that the incidence of 2.88 million oriental pratincole coincided with locusts in almost plague proportions, upon which the birds fed.

Summary of the ecological character of Ramsar wetlands

- Cultural Services–Recreation and tourism: The beach portion of the site is important for recreational fishing, tourism, bird watching and shell collecting.
- Cultural Services–Spiritual and inspirational: Spiritually significant for the Karajarri and Nyangumarta and contain a number of specific culturally significant sites. Site has inspirational, aesthetic and existence values at regional, state and national levels.
- Cultural Services–Scientific and educational: Mandora Salt Marsh and Eighty-mile Beach have been the site of a number of significant scientific investigations. In addition, Eighty-mile Beach is a significant site for migratory shorebird monitoring and is currently part of the Shorebirds 2020 program.
- Supporting services: As evidenced by the listing of the Eighty-mile Beach Ramsar site as a wetland of international importance. The system provides a wide range of biodiversity related ecological services critical for the ecological character of the site including:
  - contains exceptionally large examples of wetland types and includes rare wetland types of special scientific interest
  - supports significant numbers of migratory shorebirds
  - supports waterbird breeding
  - supports marine turtles.

Hosnies Spring (Christmas Island)

Hosnies Spring Ramsar site is located on the eastern side of Christmas Island in the Indian Ocean approximately 2,800 km west of Darwin, Australia and 900 km northeast of the Cocos Islands. The site is located within the Christmas Island National Park in the east of Christmas Island. At the time of listing (1990) Hosnies Spring comprised <1 ha of freshwater spring. In 2010 the boundary of Hosnies Spring was expanded from 0.33 ha to 202 ha. This extension increased the boundary of the Ramsar site to match that of the national park boundary on the eastern side of Christmas Island.

The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher (Ref. 92).

Ecosystem components and processes

- Climate: Warm tropical climatic zone; high rainfall (2,000 mm per year); warm to hot year round
- Geomorphology: Site is located within shore terrace on gravel overlying phosphoric soils; Spring is situated at the base of the inland cliffs where spring water flows over a limestone flowstone.
- Hydrological regime: Groundwater dominant, Source for Hosnies Spring in a perched, unconfined aquifer that, discharges where impermeable volcanic rocks are close to the surface, Flow rate is not known, but expected to be low.
- Water quality: Limited information; Typical of limestone karst systems with alkaline conditions and relatively high concentrations of calcium; Trace elements and metals are all low; Nitrogen is predominantly in the form of nitrate; High concentrations of sulphate result in a sulphurous odour.
- Mangroves: Stand of mangroves from the genus *Bruguiera* covers the majority of the wetland, comprises a range of age classes with evidence of active regeneration, a number of very large trees (large than typical for the species), with the largest tree measuring 82 cm diameter at breast height and exceeding 40 m, between 300 and 600 trees in total (more than 2.5 cm diameter at breast height) and a density of between 10 and 20 trees per 100 m^2.
- Land crabs: Supports large populations of at least three species: Red Crab (*Gecarcoidea natalis*), Robber Crab (*Birgus latro*), Blue Crab (*Discoplax hirtipes*).

Ecosystem services

- Recreation and tourism: While the site is open to the public, tourism is not promoted at the site. Rather, the site is managed to provide a limited number of visitors an opportunity to visit a unique wetland that is largely undisturbed by humans.
- Scientific and educational: The unique nature of the site and the pristine condition, provide excellent opportunities for research.
- Supports near-natural wetlands types: The spring at the Ramsar site is in near-natural condition and significant within the bioregion.

Summary of the ecological character of Ramsar wetlands
• Biodiversity: Supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species. • Food webs: Interactions between land crabs and mangroves form an important food web at the site. • Distinct wetland species: Blue crabs are reliant on the few permanent freshwater sites on Christmas Island (including Hosnies Spring) for reproduction, and for survival in the dry season • Ecological connectivity: Red crabs migrate from the plateau to the ocean to breed each year.
Ord River Floodplain
The Ord River Floodplain Ramsar site is located in the northeast of WA, ~8 km east of the town of Wyndham within the Victoria-Bonaparte bioregion. The site covers over 140,000 hectares and lies within the Shire of Wyndham–East Kimberley. The Ord River Floodplain site contains a wide range of wetland types and includes inland and marine components. The Ramsar site comprises: Parry Lagoons, Ord Estuary, and False Mouths of the Ord. The following summary of ecosystem components, processes and services has been extracted from Hale (Ref. 11). Ecosystem components and processes • Climate: semi-arid monsoonal; 80% of rainfall in the wet season (December to February); on average evaporation exceeds rainfall in 11 of 12 months • Geomorphology: estuarine reaches of river; tidal flat creek system (False Mouths of Ord); seasonally inundated floodplain with permanent waterholes (Parry Lagoons). • Hydrology: macro-tidal influence; modified flows from dams upstream; low flow during dry season; higher flows in wet season; overbank flows from the Ord River to Parry Lagoons now low frequency; Parry Creek major source of water for Parry Lagoons (and floodplains) • Water Quality: estuary is highly turbid; potentially high nutrient levels from upstream agriculture; estuary is a net exporter of nutrients; salinity in estuary varies seasonally (30–35 ppt in dry season; < 4 ppt in wet); Parry Lagoons predominantly fresh; levels of agrichemicals above ANZECC guidelines detected • Phytoplankton: estuary dominated by diatoms; plankton is predominantly epibenthic • Vegetation: extensive mangroves in intertidal areas – 15 species; saltmarsh at higher elevations; Parry Lagoons characterised by extensive sedge / grass lands (intermittent inundation); aquatic vegetation in permanent waterholes; wooded swamp surrounding • Invertebrates: commercially significant taxa include mud crabs and white banana prawns; data deficient for other communities and populations • Fish: > 50 species (estuarine, marine and freshwater); migratory route for ~17 species; supports threatened taxa listed under the EPBC Act (Freshwater Sawfish, Green Sawfish and Northern River Shark) • Birds: Regularly supports >20,000 waterbirds; breeding recorded for 16 species; regularly supports >1 % of the population of Plumed Whistling Duck and Little Curlew; supports the EPBC listed species the Australian Painted Snipe • Crocodiles: supports Saltwater and Freshwater Crocodiles Ecosystem services • Provisioning service–Wetland products: commercial fisheries for a number of species of fish, as well as prawns and crabs; genetic resources - plausible, but as yet no documented uses • Regulating services–Erosion control: mangroves • Regulating services–Climate regulation: plausible, but data deficient • Regulating services–Biological control of pests: support of predators of agricultural pests • Cultural services–Recreation and tourism: site is important for recreational fishing; tourism; bird watching and crocodile watching • Cultural services–Spiritual and inspirational: spiritually significant for the Miriuwung, Gajerrong and contain a number of specific culturally significant sites; site has inspirational, aesthetic and existence values at regional, state and national levels; the site contains a number of non-indigenous historical sites

Summary of the ecological character of Ramsar wetlands
• Cultural services–Scientific and educational: focus of scientific research (e.g. CSIRO investigation) • Supporting services: as evidenced by the listing of the Ord River Floodplain site as a wetland of international importance; the system provides a wide range of biodiversity related ecological services critical for the ecological character of the site including: – supporting diverse habitat types – supporting critical life stages – supporting threatened species – supporting waterbird populations – supporting fish populations.
Peel-Yalgorup System
The Peel-Yalgorup wetland system, in south-western Australia, is located ~80 km south of Perth within the Swan Coastal Plain bioregion. The 26,000 ha site includes shallow estuarine waters, saline, brackish and freshwater wetlands of the Peel Inlet, Harvey Estuary, several lake systems including Lake McLarty and Lake Mealup and the Yalgorup National Park. The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher (Ref. 12). Ecosystem components and processes • Peel-Harvey Estuary – Geomorphology: Shallow bar-built estuary. Narrow connection to the Indian Ocean (Mandurah Channel). Organic sediments (black ooze). – Hydrology: Highly seasonal freshwater inflows from direct precipitation and rivers. Limited tidal exchange with the Indian Ocean. Limited groundwater inflows. – Water Quality: High concentrations of nutrients (eutrophic) from catchment. Seasonal variability in salinity. Stratification and deoxygenation of bottom waters. – Acid Sulfide Soils: Monosulphidic black ooze. Exposed via dredging. – Phytoplankton: Winter diatom blooms. Spring Nodularia blooms in the Harvey Estuary. – Benthic Plants: Excessive growth of green macroalgae (Cladophora and/or Chaetomorpha) in the Peel Inlet. Smothering of seagrass. – Littoral Vegetation: Samphire communities around the shorelines. Paperbark communities in the Harvey River delta. – Invertebrates: Commercially significant taxa include blue swimmer crabs and western king prawns. Diverse communities in the estuary and the intertidal zones – Fish: Estuarine and marine species. Migratory route for some species. – Birds: High diversity and abundance of waterbirds. Regularly supports >20,000 waterbirds (maximum recorded 150,000 individuals). Breeding recorded for 12 species. Regularly supports >1% of the population of 11 species. • Yalgorup Lakes – Geomorphology: Shallow depressional wetlands. No defined surface water inflow or outflow channels. – Hydrology: Highly seasonal freshwater in-flows predominantly from groundwater. No surface water outflows. – Water quality: Brackish to hypersaline conditions. Seasonal salinity cycles. Low nutrient concentrations. Some lakes exhibit stratification. Highly alkaline (calcium and bicarbonate). – Benthic microbial community: Thrombolites in Lake Clifton. Cyanobacterial algal mats across the sediment surface in some lakes. – Flora: Small buffer zones. Some areas of paperbark communities. – Fauna: Significant site for waterbirds. Large numbers of Shelduck and Black Swans annually. 1% of population of Banded Stilt, Red-necked Stint, Hooded Plover, Shelduck and Musk Duck. Breeding of eight species. • Lakes McLarty and Mealup

Summary of the ecological character of Ramsar wetlands
– Geomorphology: Shallow depressional wetlands. No defined surface water inflow or outflow channels. – Hydrology: Highly seasonal freshwater inflows predominantly from groundwater. No natural surface water outflows (although there are drains present). – Water quality: Fresh to brackish conditions. Alkaline. – Flora: Typha across parts of each lake. Sedges on the margins. Paperbark community at higher elevations. – Fauna: Important habitat for freshwater invertebrates. Provides habitat for a large diversity and number of waterbirds. Breeding recorded for 12 species of waterbird. Ecosystem services • Provisioning services–Wetland products: Commercial fisheries for a number of species of fish, as well as prawns and crabs. • Regulating services–Pollution control and detoxification: Peel Inlet and Harvey Estuary act as sinks for nutrients from the catchment and a mechanism for discharges to the sea. • Regulating services–Climate regulation: Data deficient – plausible but not documented. Regulating service–Flood control: Site acts as a receiver for drainage water from the surrounding floodplain. • Cultural services–Recreation and tourism: The Peel Inlet and Harvey Estuary are important recreational fisheries. Passive recreational activities such as bird watching occur both in the estuarine and wetland areas within the site. The Peel Inlet and Harvey Estuary are important for water based recreational activities and water sports such as boating. • Cultural services–Spiritual and inspirational: Wetlands and estuarine areas are spiritually significant for the Nyoongar and contain a number of specific culturally significant sites. The site has inspirational, aesthetic and existence values at regional, state and national levels. • Cultural services–Scientific and educational: The Peel Inlet and Harvey Estuary are the sites for long-term monitoring dating back several decades. Lake Clifton represents one of very few places at which thrombolites can be studied. • Supporting services–Biodiversity: As evidence by the listing of the Peel-Yalgorup site as a wetland of international importance. The system provides a wide range of biodiversity values including: – supporting a wide range of ecological communities – supporting a number of regionally, nationally and internationally threatened species – supporting a high diversity of species (flora and fauna) – supporting a bio-regionally unique community (thrombolites). • Supporting services–Nutrient cycling: The Peel-Yalgorup system plays a large role in the recycling and discharge of nutrients from the surrounding catchment. Carbon sequestration – data deficient but plausible.
Pulu Keeling National park
The Pulu Keeling National Park (PKNP) Ramsar site is located in the Indian Ocean approximately 2,900 km northwest of Perth, Australia and 900 km southwest of Christmas Island. The Cocos (Keeling) Islands are an Australian territory comprising 27 coral islands with a total land area of approximately 14 km^2. There are 26 islands in the southern atoll of which two, Home Island and West Island, are inhabited. North Keeling Island (the PKNP Ramsar site) is located 24 km to the north of the Cocos (Keeling) Islands. The following summary of ecosystem components, processes and services has been extracted from Hale (Ref. 93). Ecosystem components and processes • Climate: Warm tropical climate. high rainfall (2000 mm per year). warm to hot year round • Geomorphology: Island comprises calcareous sand and rubble of coral origin. reef crest surrounding island. central lagoon of sand and muds with intertidal sandy area. Sandy beach on northern shores. • Hydrology: No surface freshwater. Semi -diurnal tide of 1 to 1.5 m. Hydrological connection between lagoon and Indian Ocean. • Water quality: Data deficient – no information could be sourced.

Summary of the ecological character of Ramsar wetlands
• Vegetation: Tall (30 m) *pisonia* forest covers much of the island. Saltmarsh herblands and Octopus shrublands near the lagoon shores • Seagrass: Data deficient – seagrass (Turtle grass) in the lagoon. • Marine invertebrates: Diverse community of Indo-Pacific species. A number of species recorded in the site do not occur in the southern atoll including the Coconut or Robber Crab (*Birgus latro*). A small number of Red Crab (*Gecarcoidea natalis*) are also present. • Fish: Community predominantly of Indo-Pacific origin. Endemism is low, but a number of species are at the western extent of their range at Cocos Island and there is evidence of hybridisation. • Turtles: Important foraging for the Hawksbill Turtle and breeding for the Green Turtle (both listed as vulnerable under the EPBC Act). The Green Turtle population is believed to be resident in the Cocos (Keeling) Islands. • Waterbirds: 23 species of waterbird; 15 species recorded breeding. Significant numbers of Red-footed Booby (30,000 pairs annually) Large numbers of Lesser and Greater Frigatebirds and Common Noddy. Cocos Buff-banded Rail is endemic and the Ramsar site has the only known population. Ecosystem services • Cultural services–Recreation and tourism: Although the site is remote and access is controlled, the site is important for passive recreation such as diving and bird watching. • Cultural services–Cultural heritage: Shipwreck of the Embden. Historical significance for the Cocos Malay people. • Cultural services–Scientific and educational: PKNP Ramsar site has been (and continues to be) used for long-term scientific studies. Examples include Red-Footed Booby surveys; breeding and migration of turtles and reef health. • Supporting services–Supports near natural wetland types: PKNP is regarded as one of the most pristine coral atolls in the Indian Ocean and supports a number of largely unmodified wetland types • Supporting services–Threatened species: The PKNP Ramsar site supports the following threatened species: the endangered Cocos Buff-banded Rail, the vulnerable Green Turtle and Hawksbill Turtle. • Supporting services–Biodiversity: PKNP Ramsar site supports a number of species that are no longer present in the southern atoll, making it significant in the Cocos Island IMCRA Province. In addition, the site supports a diversity of fish and marine invertebrates, many at the extent of their ranges. • Supporting services– Provides physical habitat for breeding waterbirds: The site supports large colonial waterbird breeding of Red-Footed Booby, Lesser Frigate bird and Common Noddy.
Roebuck Bay
The Roebuck Bay Ramsar site comprises 34,119 ha, mostly occupied by intertidal mudflats. Waters more than 6 m deep at low tide are excluded from the site, which stretches from Campsite (a location on the northern shore of Roebuck Bay) east of the town of Broome, to south of Sandy Point. The soft bottom intertidal mudflats of the northern and eastern shores of Roebuck Bay, and high tide roosts at Bush and Sandy Points are the most biologically significant parts of the site, which was listed for several reasons including, most notably, outstanding shorebird values. The following summary of ecosystem components, processes and services has been extracted from Bennelongia (Ref. 13). Ecosystem components and processes • Climate: The climate of the Broome region is semi-arid, monsoonal with a distinct wet (October to February) and dry season (March to September). Cyclonic flooding during the summer wet season results in periodic inundation of Roebuck Plains and drainage of freshwater off the Plains and through the mangroves. • Ocean currents: The Indonesian Flowthrough flows westwards from the Pacific to the Indian Ocean. This in turn provides a mass of warm water to the Leeuwin current off Western Australia as it sweeps south along the west coast and east along the south coast.

Summary of the ecological character of Ramsar wetlands
• Tidal variation: Tides in the vicinity of Broome have a very large range (9.5 m), thus exchange through the Bay is high, tidal velocities are relatively high and large mudflats have developed. • Geomorphology: A megascale irregular curved embayment that contains a wide expanse of intertidal mud and sand flats indented by microscale linear tidal creeks. • Sediment structure: Three main sediment provinces have been identified: northern sands province, eastern silt and clay province and southern sands province. • Hydrology: The Broome Sandstone contains the most utilised (Broome water supply) and hence most threatened groundwater resource in the Canning Basin. The Broome Sandstone is generally an unconfined aquifer recharged by direct infiltration from rainfall. The Broome sandstone will be discharging groundwater to the surface or subsurface at the margins of the Roebuck plains and tidal creek systems. There will also be deep submarine groundwater discharge occurring at or below the low tide mark and within Roebuck deeps. The Broome Sandstone will be discharging groundwater to the coupled Roebuck Bay/Roebuck Plains system from all landward directions. This may create freshwater dependant ecological niches which could be threatened by regional water use or pollution. Roebuck Plains produces large amounts of sheetwash into the bay after large cyclonic events or prolonged wet season rains. This will be an important vector for nutrients, organic carbon and freshwater into the bay. • Water quality: Water quality appears poor, with TP levels, although there is limited information available from similar marine systems for comparison. Consideration has been given to the impact of urban run-off into the marine ecosystem. Agricultural activities may influence water quality from rangeland run-off during flood events. • Littoral vegetation: Along the sea edge there are mangrove communities. Mangrove detritus is a major source of energy for animals in the mangal and, perhaps, some mudflat species. Behind the mangal is an extensive plain of saline grassland that rises to the pindan plains typical of the western desert. Samphire occurs in the wetter zones. On beach dunes spinifex dominates. • Plankton and diatoms: Stable isotopes of carbon and nitrogen have shown that plankton and diatoms are a major source of energy for shellfish in the Bay. • Benthic invertebrates: Roebuck Bay has one of the most diverse arrays of benthic invertebrate infauna for any intertidal ecosystem. Species numbers are dominated by polychaetes. There is a rich assemblage of bivalves that provide an important source of accessible food for shorebirds. The average density of macrobenthic fauna is around 1287 animals per square metre. • Birds: The bay provides important food resources and refuge for migrating arctic shorebirds. A total of 43 species of waterbirds are recorded for the Bay including 22 species listed in migratory bird agreements. • Fish: The mudflats and mangrove creeks are nurseries for at least 4 fish species, for commercial prawn species and for mudcrabs • Marine fauna: Dugongs have been regular and important inhabitants of Roebuck Bay. Earlier records show evidence of Dugongs feeding on extensive seagrass beds in 1986. Loggerhead Turtles and Green Turtles regularly use the Ramsar site as a seasonal feeding area and as a transit area on migration. Flatback Turtles regularly nest in small numbers around Cape Villaret during the summer months. Ecosystem services • Provisioning services–Wetland products: Commercial and recreational fisheries for a number of species of fish, prawns and crabs. Aboriginal people continue to make extensive use of the Bay's natural resources. • Regulating Services–Pollution control and detoxification: No data • Regulating Services–Climate regulation: No data • Cultural service–Recreation and tourism: Major tourism and bird-watching venue. Broome is an important destination for national and international tourism. Active recreational fishing and crabbing activities, boating, hovercraft. • Cultural services–Spiritual and inspirational: Site has inspirational and aesthetic values that are both regional and nationally recognised through travel to Broome. Roebuck Bay is spiritually significant to Aboriginal people belonging to the Yawuru and Jukun groups and contains a number of specific culturally significant sites.

Summary of the ecological character of Ramsar wetlands
• Cultural services–Scientific and educational: Many scientific research programs, especially on shorebirds and mudflat invertebrates, have been based at Roebuck Bay. they have often involved Broome Bird Observatory, near Fall Point. • Supporting Services–Biodiversity: Key location in global flyway for migratory waders. Nursery values for prawns and fish. Seagrass beds for Dugong.
The Dales
The Dales, Christmas Island Ramsar site (hereafter referred to as The Dales) is located on Christmas Island in the Indian Ocean approximately 2,800 km west of Darwin, 2,600 km north-west of Perth, Australia, 900 km northeast of the Cocos Islands and approximately 360 km south of the western head of Java. The Dales Ramsar site is located entirely within the Christmas Island National Park, in the west of the island, with the western boundary of the site extending to 50 m seaward from the low water mark. The site was listed as a Ramsar site in 2002. The Dales Ramsar site comprises a system of seven watercourses collectively known as “The Dales”. Three of the Dales support permanent springs, No. 1 Dale, Hugh’s Dale (No. 2 Dale) and Anderson Dale (No, 5 Dale). Darling Dale (No. 3 Dale), No. 4 Dale, Sydney’s Dale (No. 6 Dale) and No. 7 Dale all support intermittent streams during the wet season. The following summary of ecosystem components, processes and services has been extracted from Butcher and Hale (Ref. 94). Ecosystem components and processes • Climate: Warm tropical climatic zone. High rainfall (2,000 mm per year); warm to hot year round. • Geomorphic setting: Site is located within the shore terrace on an area of gravel overlying phosphoric soils. Springs are situated at the base of the inland cliffs where spring water flows over a limestone flowstone. • Water quality: Limited site specific data – information from one survey in 2003 for Hugh’s Dale may provide baseline data for time of listing. Water quality is good, with higher concentrations of some trace metals and major ions compared to upstream reference sites, due to the presence of volcanic rocks and significant crab populations. • Terrestrial vegetation: Limited site specific data; descriptions of the vegetation are limited. General descriptions provided by Mitchell (1985) and Du Puy (1993) for vegetation associations indicate five major associations, with tall rainforest the dominant type. • Coral reef: The coral reef is limited and dominated by abiotic and hard corals of low diversity. • Fish: Community predominantly of Indo-Pacific origin. Endemism is low, but a number of species are at the western extent of their range at Christmas Island and there is evidence of hybridisation. One endemic freshwater species recorded from the site. • Invertebrates (non crab fauna): The site supports a low diversity of benthic marine invertebrates, but may also support anchialine fauna although no site specific data has been sourced to confirm this. • Geomorphic setting: The island is a karstic landscape with key geomorphic features including the terrace formations, sea cliffs, and caves and other karst features such as tufa at Hugh’s Dale. • Hydrology: Karstic drainage system of groundwater and surface ephemeral stream flow post heavy rainfall events during the wet season. Spring outflow of groundwater at three of the Dales is permanent. • Land crabs: All 20 species of land crab occur within the boundary of the site. The Dales provide a major migration pathway for crabs to and from the ocean during spawning. The site is important for Blue Crabs in particular. • Waterbirds: Eleven waterbirds, including nine endemic species, one nationally listed vulnerable and one endangered species are found at the site. The site supports breeding seabirds including Abbott’s Booby and Red-footed Booby. Ecosystem services • Cultural service–Recreation and tourism: The Dales is a popular recreational area for both tourists and locals. Two timber board walks have been installed at No. 1 Dale and Hugh’s Dale. The Dales is the most popular sight seeing destination on the island with the waterfall at Hugh’s Dale being the greatest attraction.

Summary of the ecological character of Ramsar wetlands
• Cultural service–Science and education: Parks Australia undertakes and supports a range of research programs across the National Park, many of which are directly relevant to The Dales. For example research investigations include impacts of the Yellow Crazy Ant, Land Crab ecology and Abbott's Booby. • Supporting Services–Food webs: Crab spawning provides a rich food supply to marine biota including whale sharks. In addition the land crabs play a significant role in the energy dynamics of the forest affecting seedling recruitment and ultimately the structure of the forest. The invasion of the yellow crazy ant has significantly affected trophic relationships on Christmas Island. • Supporting Services–Provides physical habitat (for breeding waterbirds): Terrestrial vegetation provides roosting and breeding sites for several species of waterbirds. • Supporting Services–Biodiversity: Supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species. • Supporting Services– Special ecological, physical or geomorphic features: Provides critical habitat for the Blue Crabs and Freshwater Crabs, provides examples of karst features such as tufa deposits at the Hugh's Dale waterfall, and possibly anchialine cave communities. • Supporting Services–Distinct or unique wetland species: Red Crabs are considered keystone species on the island. • Supporting Services–Threatened wetland species, habitats and ecosystems: The Dales Ramsar site supports nesting sites for the endangered Abbotts Booby. The Christmas Island Frigatebird has also been recorded from the site. • Supporting Services– Priority wetland species: Christmas Island supports a number of vagrant species listed under various international agreements. • Supporting Services–Supports near-natural wetland types: Springs and karst systems are representative of the bioregion and considered in near natural condition at the time of listing. • Supporting Services–Ecological connectivity: The streams of The Dales provide critical migration pathways for downward migration Red, Blue and Robber Crabs and return pathways for juvenile Blue Crabs in particular.

2.4 Listed threatened and/or migratory species

The Species of National Environmental Significance (SNES) spatial database (Ref. 14) stores maps and point distribution information about species related to the EPBC Act.

The Biologically Important Areas (BIAs) of Regionally Significant Marine Species (Ref. 15) were identified on a regional basis during the development of the Marine Bioregional Plans. BIAs are spatially defined areas where aggregations of individual species are known to display biologically important behaviours (including breeding, foraging, resting, or migration).

The following information was generated from the Biologically Important Areas of Regionally Significant Marine Species spatial database (Ref. 95), the SNES (Public Grids) database (Ref. 14), and searches of the online PMST (appendix a).

To assist with planning and future management of new marine parks in Australia's Indian Ocean Territories (IOT) (i.e. Cocos (Keeling) Islands, Christmas Island), Parks Australia and Museums Victoria are currently identifying potential BIAs and key ecological features (KEFs) (Ref. 96). Where these potential BIAs intersect with the PA, a description has been included in this document.

2.4.1 Marine mammals

Table 2-5 lists the threatened and/or migratory marine mammals that may be present within the PA. The full list of marine species identified from the PMST is provided in appendix a.

Table 2-6 lists the individual BIAs for marine mammals and their known seasonal presence within the PA; these are shown in Figure 2-1.

A review of the Conservation Advices and/or Recovery Plans identified key threats associated with threatened and/or migratory marine mammals that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are listed in Table 2-7.

In addition to the threatened and/or migratory marine mammal species identified in the tables below, an additional 28 listed marine mammal species (27 cetaceans, one pinniped) were identified as having the potential to occur within the PA (appendix a).

Table 2-5: Threatened and/or migratory marine mammals

Common name	Scientific name	Threatened status	Migratory status
Cetaceans (whales)			
Antarctic Minke Whale, Dark-shoulder Minke Whale	*Balaenoptera bonaerensis*		Migratory
Sei Whale	*Balaenoptera borealis*	Vulnerable	Migratory
Bryde's Whale	*Balaenoptera edeni*		Migratory
Blue Whale	*Balaenoptera musculus*	Endangered	Migratory
Fin Whale	*Balaenoptera physalus*	Vulnerable	Migratory
Pygmy Right Whale	*Caperea marginata*		Migratory
Southern Right Whale	*Eubalaena australis*	Endangered	Migratory
Humpback Whale	*Megaptera novaeangliae*		Migratory
Killer Whale, Orca	*Orcinus orca*		Migratory
Sperm Whale	*Physeter macrocephalus*		Migratory
Cetaceans (dolphins)			
Australian Humpback Dolphin	*Sousa sahulensis as Sousa chinensis*		Migratory
Australian Snubfin Dolphin	*Orcaella heinsohni*		Migratory
Dusky Dolphin	*Lagenorhynchus obscurus*		Migratory
Indo-Pacific Humpback Dolphin	*Sousa chinensis*		Migratory
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	*Tursiops aduncus (Arafura/Timor Sea populations)*		Migratory
Pinnipeds			
Australian Sea-lion, Australian Sea Lion	*Neophoca cinerea*	Endangered	
Sirenians			

Common name	Scientific name	Threatened status	Migratory status
Dugong	*Dugong dugon*		Migratory

Table 2-6: BIAs for regionally significant marine mammals

Common name	Behaviour	Seasonal presence	Occurrence descriptor
Australian Snubfin Dolphin	Breeding	Year-round	Known to occur
	Calving	Year-round	Known to occur
	Foraging	Year-round	Known to occur
	Foraging (high density prey)	Year-round	Known to occur
	Foraging likely	Year-round	Known to occur
	Resting	Year-round	Known to occur
Indo-Pacific Humpback Dolphin	Breeding	Year-round	Known to occur
	Breeding	Year-round	Likely to occur
	Calving	Year-round	Known to occur
	Calving	Year-round	Likely to occur
	Foraging	Year-round	Known to occur
	Foraging	Year-round	Likely to occur
	Foraging (high density prey)	Year-round	Known to occur
	Foraging (high density prey)	Year-round	Likely to occur
	Significant habitat	Year-round	Known to occur
	Significant habitat – unknown behaviour	Year-round	Likely to occur
Indo-Pacific/Spotted Bottlenose Dolphin	Breeding	Not possible to determine yet	Known to occur
	Calving	Not possible to determine yet	Known to occur
	Foraging	Not possible to determine yet	Known to occur
	Foraging likely	Not possible to determine yet	Known to occur
	Migration likely	Not possible to determine yet	Known to occur
Dugong	Breeding	April/May	Known to occur
	Breeding	May – September	Known to occur
	Breeding	Year-round	Known to occur
	Calving	April/May	Known to occur
	Calving	Year-round	Known to occur
	Foraging	April/May	Known to occur
	Foraging	May–September	Known to occur
	Foraging	June-November	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Foraging	Year-round	Likely to occur
	Foraging (high density seagrass beds)	April/May	Known to occur
	Foraging (high density seagrass beds)	June – November	Known to occur
	Foraging (high density seagrass beds)	October – April	Known to occur
	Foraging (high density seagrass beds)	Year-round	Known to occur
	Migration	June – November	Known to occur
	Migration likely	Year-round	Known to occur
	Nursing	April/May	Known to occur
	Nursing	Year-round	Known to occur
Australian Sea Lion	Foraging (male)	Year-round	Likely to occur
	Foraging (male and female)	Year-round	Known to occur
Blue and Pygmy Blue Whale	Foraging (abundant food source)	Arrive as early as November, with number of animals steadily increasing to peak in March–May. After May the number of whales drops, by late June most animals have left, although a few acoustic detections are made into July (Ref. 16)	Known to occur
	Foraging (high-density)	Arrive early as Nov with number of animals increasing to peak in March–May. After May the number of whales drops, late June most animals left, a few acoustic detections are made into July (Ref. 16). Satellite tracking data indicates use mid-March-late April,	Known to occur
	Foraging (on migration)	Arrive early as Nov with number of animals increasing to peak in March–May. After May the number of whales drops, late June most animals left, a few acoustic detections are made into July (Ref. 16). Satellite tracking data	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
		indicates use mid-March-late April.	
Humpback Whale	Calving	Winter	Known to occur
	Migration	Northern migration, late July to September	Known to occur
	Migration	Winter	Known to occur
	Migration (north)	Northern migration, late July to September	Known to occur
	Migration (north and south)	Northern migration, late July to September	Known to occur
	Migration (north and south)	Northern peak July and southward peak October – November (Ref. 16)	Known to occur
	Migration (north and south)	Southbound peak late Sept to mid-Oct. Northward peak mid-June to mid-July	Known to occur
	Migration (south)	Southbound peak late Sept to mid-Oct	Known to occur
	Nursing	Winter	Known to occur
	Resting	Winter	Known to occur
Pygmy Blue Whale	Distribution		Known to occur
	Foraging		Known to occur
	Foraging area (annual high use area)		Known to occur
	Known foraging area		Known to occur
	Migration	Northern migration (enter Perth canyon January to May; pass Exmouth April to August; continue north to Indonesia). Southern migration (follow WA coastline from October to late December)	Known to occur
		Most use between October and December, peaking in November	Known to occur
Southern Right Whale	Migration	Approximately April to October	(Not defined in database)
	Reproduction	Approximately May to September	(Not defined in database)
Sperm Whale	Foraging (abundant food source)	Summer	Known to occur

Table 2-7: Summary of relevant conservation plans—marine mammals

Species	Relevant Plan / Advice	Key threats / Relevant management advice
Blue Whale	Conservation Management Plan for the Blue Whale 2015–2025 (Ref. 17)	Key threats include: • climate variability and change • noise interference • habitat modification • vessel disturbance Relevant management actions include: • Assessing the effect of anthropogenic noise on blue whale behaviour • Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area • EPBC Act Policy Statement 2.1— Interaction between offshore seismic exploration and whales is applied to all seismic surveys • Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica • Ensure all vessel strike incidents are reported in the National Ship Strike Database • Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.
Sei Whale	Conservation Advice Balaenoptera borealis Sei Whale (Ref. 18)	Key threats include: • Climate and oceanographic variability and change • Anthropogenic noise and acoustic disturbance • Habitat degradation including pollution (increasing port expansion and coastal development) • Pollution (persistent toxic pollutants) • Vessel strike. Relevant management actions include: • Assessing and addressing anthropogenic noise: – Once the spatial and temporal distribution (including biologically important areas) of Sei Whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species. • Understanding impacts of climate variability and change – Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica. • Minimising vessel collisions: – Ensure all vessel strike incidents are reported in the national vessel strike database (https://data.marinemammals.gov.au/report/shipstrike).
Fin Whale	Conservation Advice Balaenoptera physalus Fin	Key threats include: • Climate and oceanographic variability and change • Anthropogenic noise and acoustic disturbance

Species	Relevant Plan / Advice	Key threats / Relevant management advice
	Whale (Ref. 19)	• Habitat degradation including pollution (increasing port expansion and coastal development) • Pollution (persistent toxic pollutants) • Vessel strike. Relevant management actions include: • Assessing and addressing anthropogenic noise: – Once the spatial and temporal distribution (including biologically important areas) of Fin Whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species. • Understanding impacts of climate variability and change – Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica. • Minimising vessel collisions: – Ensure all vessel strike incidents are reported in the national vessel strike database
Southern Right Whale	Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011–2021 (Ref. 20)	Key threats include: • entanglement • vessel disturbance • climate variability and change • noise interference • habitat modification. Relevant management actions include: • Assessing and addressing anthropogenic noise – Improve the understanding of what impact anthropogenic noise may have on southern right whale populations by: a) assessing anthropogenic noise in key calving areas b) assessing responses of southern right whales to anthropogenic noise c) if necessary, developing further mitigation measures for noise impacts. • Preparing for potential impacts of climate variability and change – Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.
Australian Sea Lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (Ref. 21)	Key threats listed in the recovery plan are limited to fisheries-related activities, and not relevant to petroleum activities. . Other factors that may be contributing to the lack of recovery include: • human disturbance to colonies • pollution and oil spills • climate change. No relevant management advice has been identified.

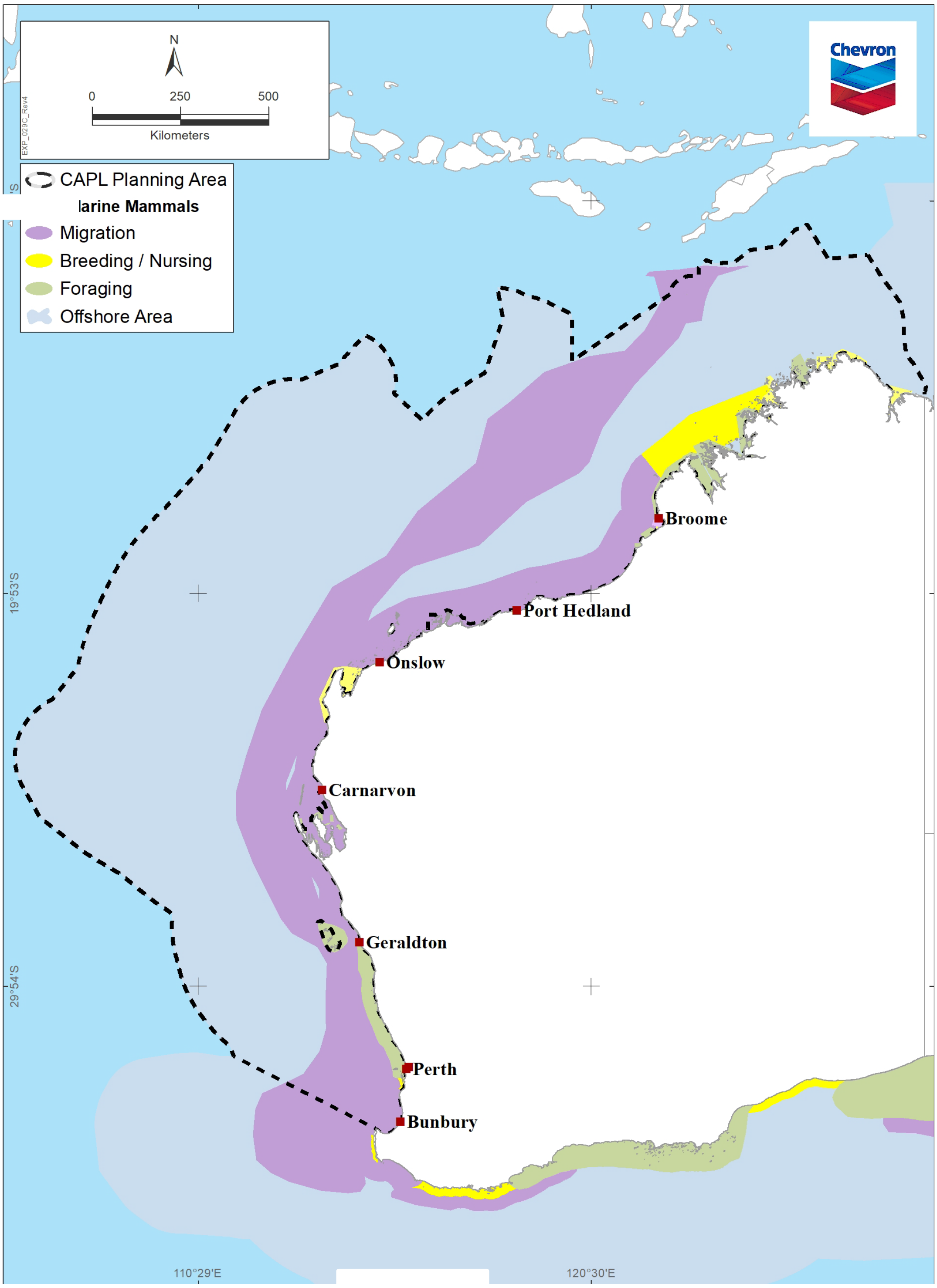


Figure 2-1: BIAs associated with marine mammals

2.4.2 Reptiles

Table 2-8 lists the threatened and/or migratory marine reptile species that may be present within the PA. The full list of marine species identified from the PMST is provided in appendix a.

Table 2-9 lists habitat critical to the survival of a species (Ref. 22) within the PA for marine turtles; these are shown on Figure 2-2.

Table 2-10 lists the BIAs for marine reptiles and their known seasonal presence within the PA; these are also shown on Figure 2-2.

A review of the Conservation Advices and Recovery Plans identified key threats associated with threatened and/or migratory marine reptiles that may be present within the PA. Where relevant to petroleum activities these threats and relevant management advice are listed in Table 2-11.

In addition to the threatened and/or migratory marine reptile species identified in the tables below, an additional 25 listed marine reptile species (all sea snakes except the Freshwater Crocodile [*Crocodylus johnstoni*]) were identified as having the potential to occur within the PA (appendix a). Cogger (Ref. 23; Ref. 24) notes that most sea snakes have shallow benthic feeding patterns and are rarely observed in water >30 m deep, indicating that these species are likely to be present in shallow waters.

Table 2-8: Threatened and/or migratory marine reptiles

Common name	Scientific name	Threatened status	Migratory status
Crocodiles			
Salt-water Crocodile, Estuarine Crocodile	*Crocodylus porosus*		Migratory
Seasnakes			
Short-nosed Seasnake	*Aipysurus apraefrontalis*	Critically Endangered	
Leaf-scaled Seasnake	*Aipysurus foliosquama*	Critically Endangered	
Turtles			
Loggerhead Turtle	*Caretta caretta*	Endangered	Migratory
Green Turtle	*Chelonia mydas*	Vulnerable	Migratory
Leatherback Turtle, Leathery Turtle, Luth	*Dermochelys coriacea*	Endangered	Migratory
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable	Migratory
Olive Ridley Turtle, Pacific Ridley Turtle	*Lepidochelys olivacea*	Endangered	Migratory
Flatback Turtle	*Natator depressus*	Vulnerable	Migratory

Table 2-9: Habitats critical to survival for marine turtles

Common name	Location	Seasonal presence	Occurrence descriptor
Loggerhead Turtle	Exmouth Gulf and Ningaloo Coast. 20 km internesting buffer	Nov–May	Known to occur
	Gnaraloo Bay and beaches. 20 km internesting buffer	Nov–May	Known to occur
	Shark Bay, all coastal and island beaches out to the northern tip of Dirk Hartog Island.	Nov–May	Known to occur

Common name	Location	Seasonal presence	Occurrence descriptor
	20 km internesting buffer		
Green Turtle	Mainland east of Mary Island to mainland adjacent to Murrara Island including all offshore islands. 20 km internesting buffer	Nov–Mar	Known to occur
	Ashmore Reef and Cartier Reef. 20 km internesting buffer	Dec–Jan	Known to occur
	Browse Island. 20 km internesting buffer	Nov–Mar	Known to occur
	Scott Reef. 20 km internesting buffer	Nov–Mar	Known to occur
	Adele Island, Lacepede Islands	Nov–Mar	Known to occur
	Dampier Archipelago. 20 km internesting buffer	Nov–Mar	Known to occur
	Barrow Island, Montebello Islands, Serrurier Island, and Thevenard Island. 20 km internesting buffer	Nov–Mar	Known to occur
	Exmouth Gulf and Ningaloo Coast. 20 km internesting buffer	Nov–Mar	Known to occur
	Cocos (Keeling) Islands. 20km interesting buffer	Oct-Apr	Known to occur
Hawksbill Turtle	Dampier Archipelago, including Delambre Island and Rosemary Island. 20 km internesting buffer	Oct–Feb	Known to occur
	Cape Preston to mouth of Exmouth Gulf including Montebello Islands and Lowendal Islands. 20 km internesting buffer	Oct–Feb	Known to occur
Olive Ridley Turtle	Cape Leveque. 20 km internesting buffer	May–Jul	Known to occur
	Prior Point and Llanggi. 20 km internesting buffer	May–Jul	Known to occur
	Darcy Island. 20 km internesting buffer	May–Jul	Known to occur

Common name	Location	Seasonal presence	Occurrence descriptor
	Vulcan Island. 20 km internesting buffer	May–Jul	Known to occur
Flatback Turtle	Cape Domett and Lacrosse Island in the Cambridge Gulf. 60 km internesting buffer	Aug–Sep	Known to occur
	Lacepede Islands. 60 km internesting buffer	Oct–Mar	Known to occur
	Eco Beach – coastal beach near Broome. 60 km internesting buffer	July	Known to occur
	Eighty Mile Beach – coastal beach. 60 km internesting buffer	July	Known to occur
	Cemetery Beach, Port Hedland. 60 km internesting buffer	Oct–Mar	Known to occur
	Mundabullangana Beach. 60 km internesting buffer	Oct–Mar	Known to occur
	Dampier Archipelago, including Delambre Island and Hauy Island. 60 km internesting buffer	Oct–Mar	Known to occur
	Barrow Island, Montebello Islands, coastal islands from Cape Preston to Locker Island. 60 km internesting buffer	Oct–Mar	Known to occur

Table 2-10: BIAs for regionally significant marine reptiles

Common name	Behaviour	Seasonal presence	Occurrence descriptor
Flatback Turtle	Aggregation		Known to occur
	Foraging	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Foraging	January – Flatbacks, Greens	Known to occur
	Foraging	Observations during July, no evidence of turtle activity Oct–Nov for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Foraging	Year-round	Known to occur
	Internesting		Known to occur
	Internesting buffer		Known to occur
	Internesting buffer	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Internesting buffer	January – Flatbacks, Greens	Known to occur
	Internesting buffer	Summer	Known to occur
	Internesting buffer	Summer (nesting /internesting), year-round	Known to occur
	Mating		Known to occur
	Mating	Summer (nesting/interesting) year-round	Known to occur
	Mating	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Migrating Corridor	Summer (nesting/interesting) year-round	Known to occur
	Nesting		Known to occur
	Nesting	Summer (nesting/interesting) year-round	Known to occur
	Nesting	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Nesting	January – Flatbacks, Greens	Known to occur
	Nesting	Short summer nesting season, predominantly Nov–Mar with peak in January	Known to occur
	Nesting	Summer	Known to occur
Green Turtle	Aggregation	Early summer	Known to occur
	Aggregation		Known to occur
	Basking	Summer	Known to occur
	Foraging	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Foraging	January – Flatbacks, Greens	Known to occur
	Foraging	March–May	Likely to occur
	Foraging	Observations during July, no evidence of turtle activity Oct–Nov for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur
	Foraging	Summer	Known to occur
	Foraging	Summer / possibly year-round	Known to occur
	Foraging	Year-round	Known to occur
	Foraging	Year-round	Likely to occur
	Foraging		Known to occur
	Internesting	Dec–Feb	Known to occur
	Internesting	Peak season Dec–Jan	Known to occur
	Internesting	Summer	Known to occur
	Internesting	Year-round	Likely to occur
	Internesting	Summer (nesting /internesting) year round	Known to occur
	Internesting		Known to occur
	Internesting buffer	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Internesting buffer	January – Flatbacks, Greens	Known to occur
	Internesting buffer	Peak season Dec–Jan	Known to occur
	Internesting buffer	Summer	Known to occur
	Internesting buffer	Summer (nesting /internesting) year-round	Known to occur
	Internesting buffer	Year-round	Known to occur
	Internesting buffer	Year-round	Likely to occur
	Internesting buffer		Known to occur
	Mating	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Mating	Summer	Known to occur
	Mating	Year-round	Likely to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Mating		Known to occur
	Migrating Corridor	Summer (nesting/interesting) year-round	Known to occur
	Nesting	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Nesting	Summer (nesting /internesting) year-round	Known to occur
	Nesting	January – Flatbacks, Greens	Known to occur
	Nesting	Peak season Dec–Jan	Known to occur
	Nesting	Summer	Known to occur
	Nesting	Year-round	Known to occur
	Nesting	Year-round	Likely to occur
	Nesting		Known to occur
Hawksbill Turtle	Foraging	Aggregation inside of NW Is. Early in summer	Known to occur
	Foraging	Observations during July no evidence of turtle activity Oct–Nov for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur
	Foraging	Summer (nesting /internesting) year round	Known to occur
	Foraging	Spring and early summer, peak nesting October	Known to occur
	Foraging	October	Known to occur
	Foraging	Year-round	Known to occur
	Foraging	Year-round	Likely to occur
	Foraging		Likely to occur
	Internesting	Spring and early summer, peak nesting October	Known to occur
	Internesting	Summer (nesting /internesting) year round	Known to occur
	Internesting buffer	Spring and early summer, peak nesting October	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Internesting buffer	Peak nesting in spring and early summer	Known to occur
	Internesting buffer		Known to occur
	Internesting buffer	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Internesting buffer	Year-round	Known to occur
	Internesting buffer	Year-round	Likely to occur
	Internesting buffer	Peak season Dec–Jan	Likely to occur
	Internesting buffer	Peak nesting in spring and early summer	Likely to occur
	Mating	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Mating	Summer (nesting /internesting) year round	Known to occur
	Mating	Spring and early summer, peak nesting October	Known to occur
	Mating	Year-round	Known to occur
	Migration corridor	Summer (nesting /internesting) year round	Known to occur
	Nesting	Summer (nesting /internesting) year round	Known to occur
	Nesting	Green Turtle aggregation inside of NW Is. Early in summer	Known to occur
	Nesting	Peak nesting in spring and early summer	Known to occur
	Nesting	Peak season Dec–Jan	Known to occur
	Nesting	Spring and early summer, peak nesting October	Known to occur
	Nesting	Year-round	Known to occur
	Nesting	Year-round	Likely to occur
	Nesting		Known to occur
Loggerhead Turtle	Foraging	Year-round	Known to occur
	Foraging		Known to occur
	Internesting	Dec–Mar	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Internesting buffer	Dec–Mar	Known to occur
	Internesting buffer	Peak season monitored	Known to occur
	Internesting buffer		Known to occur
	Nesting	Dec–Mar	Known to occur
	Nesting	Peak season monitored	Known to occur
	Nesting		Known to occur
Olive Ridley Turtle	Foraging		Known to occur

Table 2-11: Summary of relevant conservation plans—marine reptiles

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
Loggerhead Turtle Green Turtle Leatherback Turtle Hawksbill Turtle Flatback Turtle	Recovery Plan for Marine Turtles in Australia (Ref. 25)	Key threats include: • climate change and variability • marine debris • chemical and terrestrial discharge • light pollution • habitat modification • vessel disturbance • noise interference • diseases and pathogens. Relevant management actions include: • A2: Adaptively manage turtle stocks to reduce risk and build resilience to climate change and variability – Continue to meet Australia's international commitments to address the causes of climate change. • A3: Reduce the impacts from marine debris – Compare marine debris hotspots with important foraging areas, post hatchling dispersal and adult migratory pathways to identify high priority areas for mitigation to reduce turtle/debris interactions. – Support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life. • A4: Minimise chemical and terrestrial discharge: – Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows, or coral reefs – Quantify the impacts of decreased water quality on stock viability – Quantify the accumulation and effects of anthropogenic toxins in marine turtles, their

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
		foraging habitats, and subsequent stock viability. • A8: Minimise light pollution: – Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats – Develop and implement best practice light management guidelines for existing and future developments adjacent to marine turtle nesting beaches – Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution.
Leatherback Turtle	Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle) (Ref. 26)	Key threats include: • ingestion of marine debris • vessel disturbance / boat strike • degradation of foraging areas • changes to breeding sites. Relevant management actions include: • Ensure there is no anthropogenic disturbance in areas where the Short-nosed Sea Snake occurs, excluding necessary actions to manage the conservation of the species.
Short-nosed Sea Snake	Approved Conservation Advice for Aipysurus apraefrontalis (Short-nosed Sea Snake) (Ref. 27)	Key threats include: • oil and gas exploration, including seismic surveys and exploration drilling Relevant management actions include: • Ensure there is no anthropogenic disturbance in areas where the Short-nosed Sea Snake occurs, excluding necessary actions to manage the conservation of the species.
Leaf-scaled Sea Snake	Approved Conservation Advice for Aipysurus foliosquama (Leaf-scaled Sea Snake) (Ref. 28)	Key threats include: • Degradation of reef habitat • oil and gas exploration, including seismic surveys and exploration drilling Relevant management actions include: • Ensure there is no disturbance in areas where the Leaf-scaled Sea Snake occurs, excluding necessary actions to manage the conservation of the species.

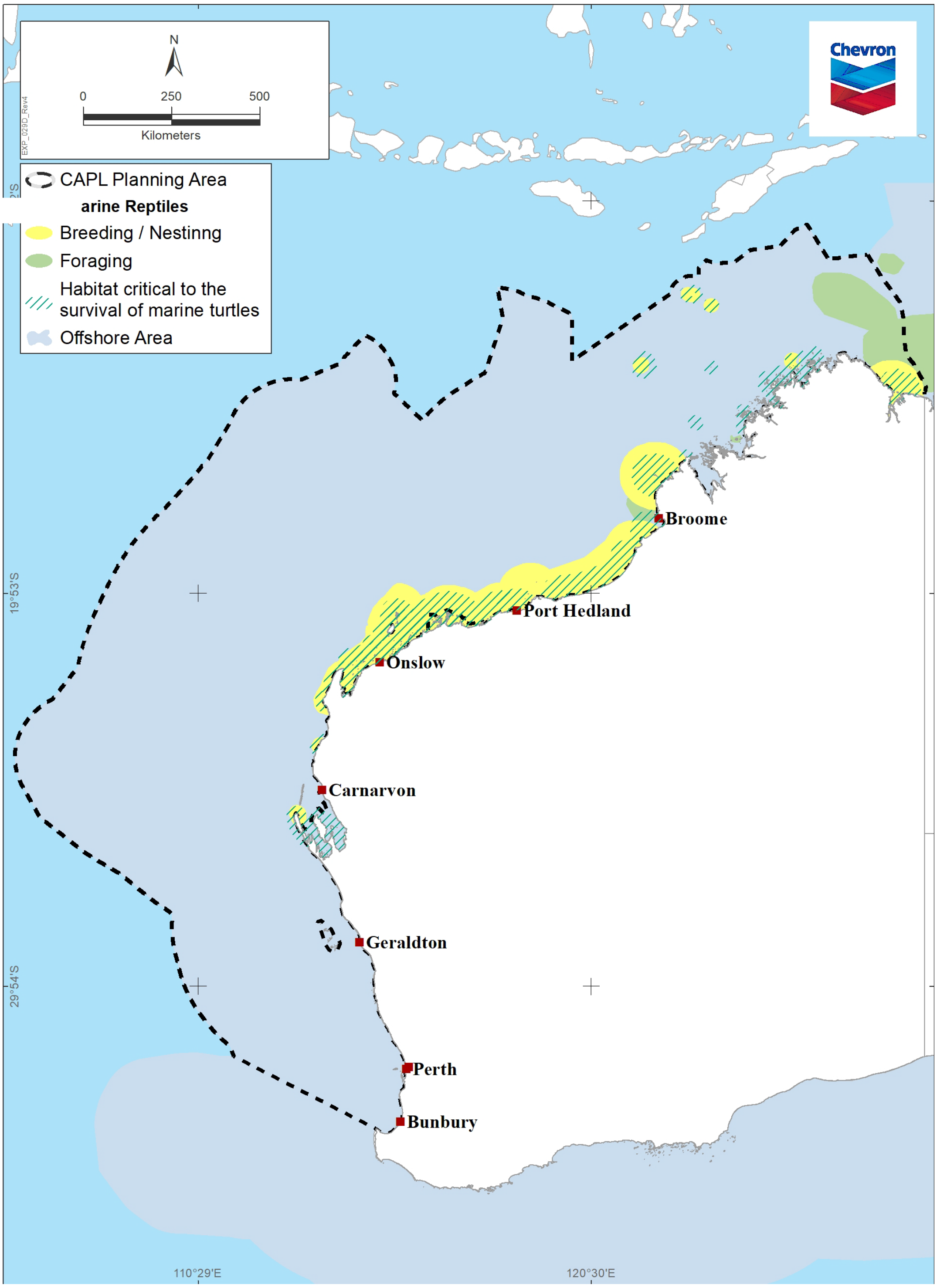


Figure 2-2: BIAs associated with marine reptiles

2.4.3 Fishes, including sharks and rays

Table 2-12 lists the threatened and/or migratory fishes (including sharks and rays) that may be present within the PA (appendix a). The full list of marine species identified from the PMST is provided in appendix a.

Table 2-13 lists the BIAs for fishes (including sharks and rays) and their known seasonal presence within the PA; these are shown in Figure 2-3. Proposed BIAs within the IOT are shown in Figure 2-4 and Figure 2-5.

Almost all syngnathids live in nearshore and inner shelf habitats, usually in shallow coastal waters, among seagrasses, mangroves, coral reefs, macroalgae-dominated reefs, and sand or rubble habitats (Ref. 29; Ref. 30; Ref. 31; Ref. 32). Although two species have been identified in the North-west Marine Region in deeper waters (Winged Seahorse [*Hippocampus alatus*] and Western Pipehorse [*Solegnathus* sp. 2]; Ref. 33), these species were not identified by the SNES search of the PA (Ref. 14).

A review of the Conservation Advices and Recovery Plans identified key threats associated with threatened and/or migratory fishes (including sharks and rays) that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are included in Table 2-14.

In addition to the threatened and/or migratory marine fish species identified in the tables below, an additional 71 listed marine fish species (all syngnathids) were identified as having the potential to occur within the PA (appendix a). Bray (Ref. 97) notes that syngnathids are mostly benthic on coastal reefs, amongst marine algae and seagrass beds, or on sandy and rubble substrates and in caves and crevices. Syngnathids are mostly found in water depths above 50 m (Ref. 97).

Table 2-12: Threatened and migratory fishes, including sharks and rays

Common name	Scientific name	Threatened status	Migratory status
Fish			
Narrow Sawfish, Knifetooth Sawfish	*Anoxypristis cuspidate*		Migratory
Blackstriped Dwarf Galaxias, Black-stripe Minnow^	*Galaxiella nigrostriata*	Endangered	
Orange Roughy, Deep-sea Perch, Red Roughy	*Hoplostethus atlanticus*	Conservation Dependent	
Blind Gudgeon*	*Milyeringa veritas*	Vulnerable	
Balston's Pygmy Perch^	*Nannatherina balstoni*	Vulnerable	
Dwarf Sawfish, Queensland Sawfish	*Pristis clavata*	Vulnerable	Migratory
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish#	*Pristis pristis*	Vulnerable	Migratory
Green Sawfish, Dindagubba, Narrowsnout Sawfish	*Pristis zijsron*	Vulnerable	Migratory
Southern Bluefin Tuna	*Thunnus maccoyii*	Conservation Dependent	
Blind Cave Eel*	*Ophisternon candidum*	Vulnerable	

Common name	Scientific name	Threatened status	Migratory status
Sharks			
Grey Nurse Shark (west coast population)	*Carcharias taurus (west coast population)*	Vulnerable	
Oceanic Whitetip Shark	*Carcharhinus longimanus*		Migratory
White Shark, Great White Shark	*Carcharodon carcharias*	Vulnerable	Migratory
Southern Dogfish, Endeavour Dogfish, Little Gulper Shark	*Centrophorus zeehaani*	Conservation Dependent	
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark	*Galeorhinus galeus*	Conservation Dependent	
Northern River Shark, New Guinea River Shark#	*Glyphis garricki*	Endangered	
Shortfin Mako, Mako Shark	*Isurus oxyrinchus*		Migratory
Longfin Mako	*Isurus paucus*		Migratory
Porbeagle, Mackerel Shark	*Lamna nasus*		Migratory
Whale Shark	*Rhincodon typus*	Vulnerable	Migratory
Scalloped Hammerhead	*Sphyrna lewini*	Conservation Dependent	
Rays			
Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	*Manta alfredi*		Migratory
Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray	*Manta birostris*		Migratory

** Subterranean fauna species identified in the Protected Matters Search Report (appendix a) but not expected to be exposed to CAPL's activities.*
 # Species mainly located inland (freshwater and estuarine habitats) identified in the Protected Matters Search Report but with the potential to be present offshore (neritic and intertidal zones) and exposed to CAPL's activities.
^ Freshwater species located inland identified in the Protected Matters Search Report but not expected to be exposed to CAPL's activities.

Table 2-13: BIAs for regionally significant fishes, including sharks and rays

Common name	Behaviour	Seasonal presence	Occurrence descriptor
Dwarf Sawfish	Foraging	All seasons	Known to occur
	Foraging		Known to occur
	Juvenile	All seasons	Known to occur
	Nursing	All seasons	Known to occur
	Nursing		Known to occur
	Pupping	All seasons	Known to occur
	Pupping		Known to occur
Freshwater Sawfish	Foraging	All seasons	Known to occur
	Foraging	Pupping occurs from Jan–May	Known to occur
	Juvenile	Pupping occurs from Jan–May	Known to occur
	Nursing	All seasons	Known to occur
	Nursing	All seasons	Likely to occur
	Pupping	Pupping occurs from Jan–May	Known to occur
	Pupping	Pupping occurs from Jan–May	Likely to occur
Green Sawfish	Foraging		Known to occur
	Nursing		Known to occur
	Pupping		Known to occur
Whale Shark^	Foraging	Spring	Known to occur
	Foraging (high density prey)	Apr–Jun, autumn	Known to occur
Southern Bluefin Tuna Breeding#	Spawning	Sep-Apr, peak Oct-Feb	Known to occur

^ Includes proposed Christmas Island foraging BIA (Ref. 96).
 # Proposed Christmas Island Bluefin Tuna Breeding BIA (Ref. 96).

Table 2-14: Summary of relevant conservation plans—fishes, including sharks and rays

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
Green Sawfish Dwarf Sawfish Northern River Shark	Sawfish and River Sharks Multispecies Recovery Plan (Ref. 34)	Key threats include: • habitat degradation and modification. Other potential threats to the species include marine debris. Relevant management actions include: • 5a. Ensure all future developments will not significantly impact upon sawfish and river shark habitats critical to the survival of the species, or impede upon the migration of individual sawfish or river sharks.
	Approved Conservation Advice for	No key threats related to petroleum activities were identified. The main potential threats to Green Sawfish include:

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
	Green Sawfish (Ref. 35)	• habitat degradation through coastal development. No relevant management advice has been identified.
	Approved Conservation Advice for *Pristis clavata* (Dwarf Sawfish) (Ref. 36)	No key threats related to petroleum activities were identified. The main potential threats to Dwarf Sawfish include: • habitat degradation due to increasing human development in northern Australia. No relevant management advice has been identified.
	Approved Conservation Advice for *Glyphis garricki* (Northern River Shark) (Ref. 37)	The main identified threats to Northern River Sharks include: • habitat degradation and modification. Relevant management actions include: • Implement measures to reduce adverse impacts of habitat degradation and/or modification.
		•
Whale Shark	Conservation Advice for the Whale Shark 2015–2020 (Ref. 39)	Key threats include: • boat strike from large vessels • habitat disruption from mineral exploration, production, and transportation The most significant threat to Whale Sharks is Other less-important threats include: • marine debris climate change. No relevant management advice has been identified.
Grey Nurse Shark [west coast population]	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (Ref. 40)	No key threats related to petroleum activities were identified. • The main potential threats include: pollution and disease and ecosystem effects as a result of habitat modification and climate change Relevant management actions include: • 8.3: Use Biologically Important Areas (BIAs) to help inform the development of appropriate conservation measures, including through the application of advice in the marine bioregional plans on the types of actions which are likely to have a significant impact on the species and updating such conservation measures as new information becomes available
Great White Shark	Recovery Plan for the White Shark (*Carcharodon Carcharias*) (Ref. 41)	Key threats listed in the recovery plan are limited to fisheries and shark control-related activities, and are not relevant to petroleum activities. Other potential threats to the species include: • ecosystem effects as a result of habitat modification and climate change (including changes in sea temperature. No relevant management advice has been identified.
Blind Gudgeon	Approved Conservation Advice for *Milyeringa veritas* (Blind	The main identified threats to the Blind Gudgeon include: • sedimentation from mining and construction • point source pollution from sewage

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
	Gudgeon) (Ref. 42)	• dumping and mining • diffuse pollution from urban development and petroleum infrastructure. No relevant management advice has been identified.
Balston's Pygmy Perch	Approved Conservation Advice for *Nannatherina balstoni* (Balston's Pygmy Perch) (Ref. 43)	The main identified threat to the Balston's Pygmy Perch includes: • habitat alteration and the introduction of exotic fish species. No relevant management advice has been identified.

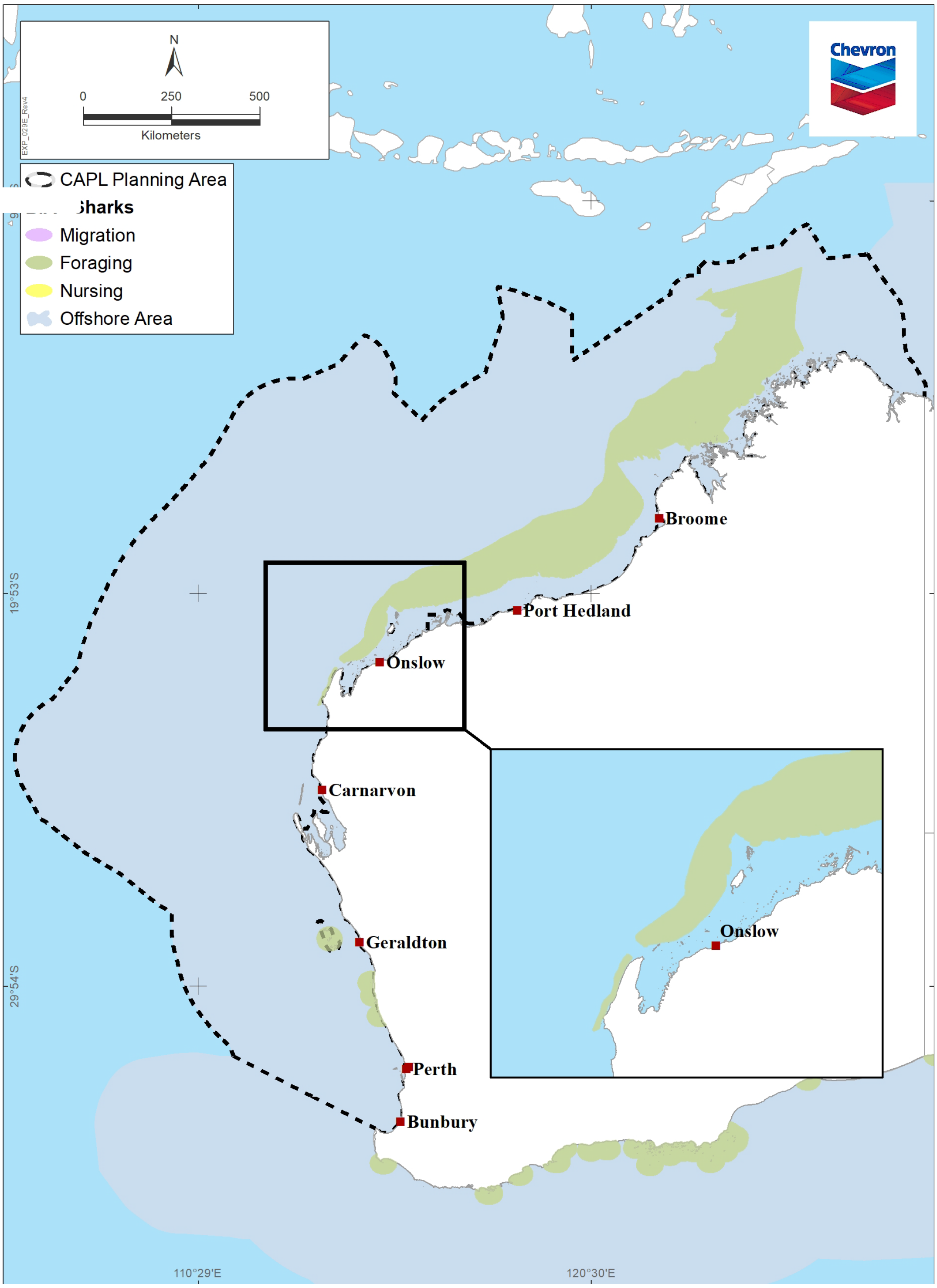
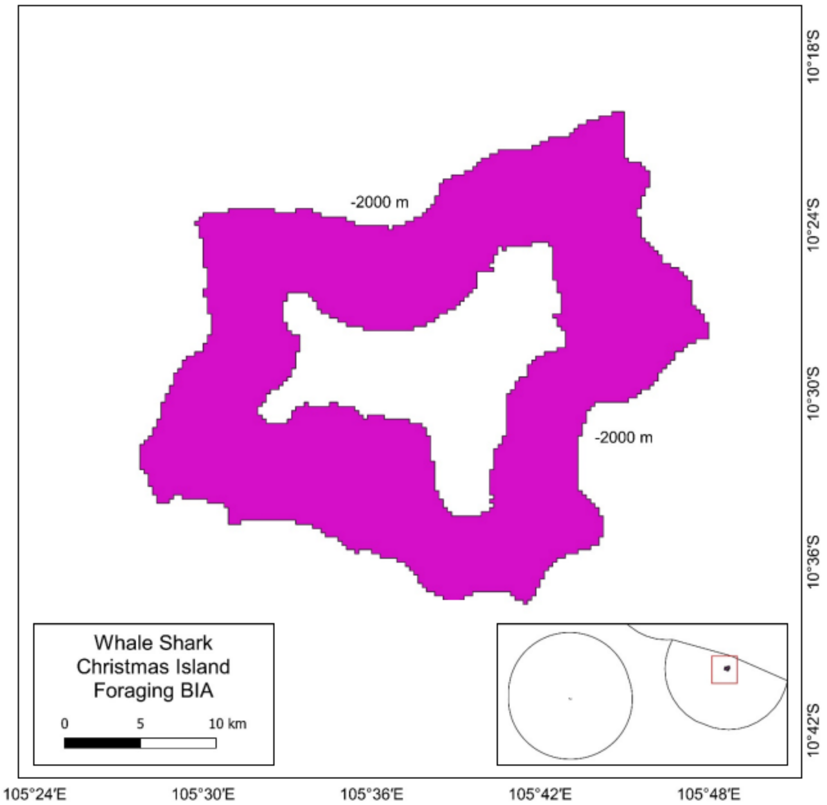
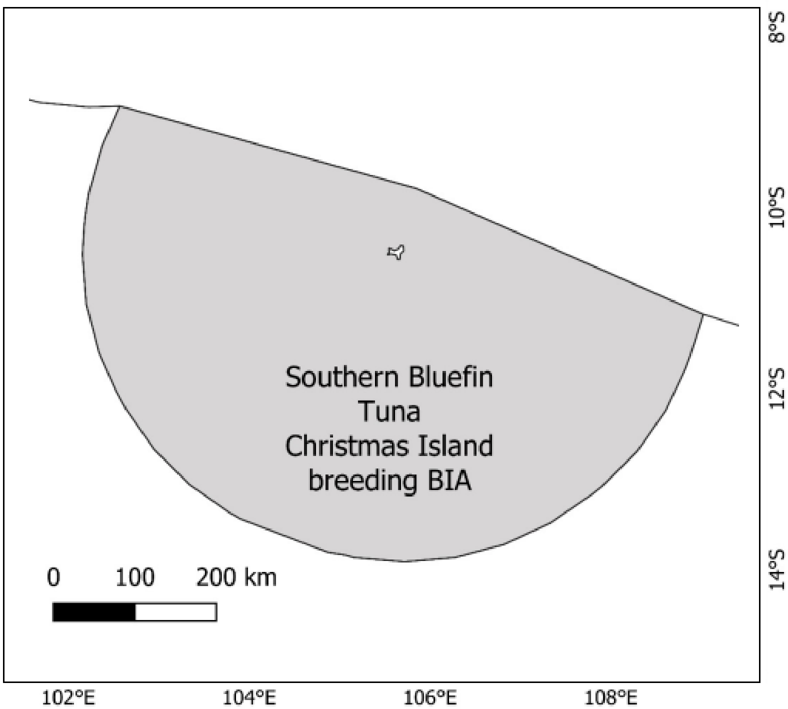


Figure 2-3: BIAs associated with fishes, including sharks and rays



Source: Ref. 96

Figure 2-4: Proposed Whale Shark foraging BIA around Christmas Island



Source: Ref. 96

Figure 2-5: Proposed Southern Bluefin Tuna Christmas Island Breeding BIA

2.4.4 Seabirds and shorebirds

Table 2-15 lists the threatened and/or migratory seabirds and shorebirds that may be present within the PA. The full list of marine species identified from the PMST is provided in appendix a.

Table 2-16 lists the BIAs for seabirds and shorebirds and their known seasonal presence within the PA; these are shown in Figure 2-6.

A review of Conservation Advices and Recovery Plans identified key threats associated with threatened and/or migratory seabirds and shorebirds that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are included in Table 2-17.

In addition to the threatened and/or migratory marine seabirds and shorebird species identified in the tables below, an additional 24 listed marine seabirds and shorebird species were identified as having the potential to occur within the PA (appendix a).

Table 2-15: Threatened and/or migratory seabirds and shorebirds

Common name	Scientific name	Threatened status	Migratory status
Oriental Reed-warbler*	*Acrocephalus orientalis*		Migratory
Common Sandpiper*	*Actitis hypoleucos*		Migratory
Common Noddy	*Anous stolidus*		Migratory
Australian Lesser Noddy	*Anous tenuirostris melanops*	Vulnerable	
Fork-tailed Swift	*Apus pacificus*		Migratory
Flesh-footed Shearwater, Fleshy-footed Shearwater	*Ardenna carneipes*		Migratory
Wedge-tailed Shearwater	*Ardenna pacifica*		Migratory
Ruddy Turnstone*	*Arenaria interpres*		Migratory
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	
Sharp-tailed Sandpiper*	*Calidris acuminata*		Migratory
Sanderling*	*Calidris alba*		Migratory
Red Knot, Knot*	*Calidris canutus*	Endangered	Migratory
Curlew Sandpiper*	*Calidris ferruginea*	Critically Endangered	Migratory
Pectoral Sandpiper*	*Calidris melanotos*		Migratory
Red-necked Stint*	*Calidris ruficollis*		Migratory
Long-toed Stint*	*Calidris subminuta*		Migratory
Great Knot*	*Calidris tenuirostris*	Critically Endangered	Migratory
Streaked Shearwater	*Calonectris leucomelas*		Migratory
Forest Red-tailed Black-Cockatoo, Karrak^	*Calyptorhynchus banksii naso*	Vulnerable	

Common name	Scientific name	Threatened status	Migratory status
Baudin's Cockatoo, Long-billed Black-Cockatoo^	*Calyptorhynchus baudinii*	Endangered	
Carnaby's Cockatoo, Short-billed Black-Cockatoo^	*Calyptorhynchus latirostris*	Endangered	
Red-rumped Swallow#	*Cecropis daurica*		Migratory
Double-banded Plover*	*Charadrius bicinctus*		Migratory
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	Vulnerable	Migratory
Lesser Sand Plover, Mongolian Plover	*Charadrius mongolus*	Endangered	Migratory
Oriental Plover, Oriental Dotterel*	*Charadrius veredus*		Migratory
Oriental Cuckoo, Horsfield's Cuckoo	*Cuculus optatus*		Migratory
Amsterdam Albatross	*Diomedea amsterdamensis*	Endangered	Migratory
Tristan Albatross	*Diomedea dabbenena*	Endangered	Migratory
Southern Royal Albatross	*Diomedea epomophora*	Vulnerable	Migratory
Wandering Albatross	*Diomedea exulans*	Vulnerable	Migratory
Northern Royal Albatross	*Diomedea sanfordi*	Endangered	Migratory
Red Goshawk	*Erythrotriorchis radiatus*	Endangered	
Gouldian Finch	*Erythrura gouldiae*	Endangered	
Grey Falcon^	*Falco hypoleucos*	Vulnerable	
Crested Shrike-tit (northern), Northern Shrike-tit	*Falcunculus frontatus whitei*	Vulnerable	
Lesser Frigatebird, Least Frigatebird	*Fregata ariel*		Migratory
Great Frigatebird, Greater Frigatebird	*Fregata minor*		Migratory
Swinhoe's Snipe*	*Gallinago megala*		Migratory
Pin-tailed Snipe*	*Gallinago stenura*		Migratory
Partridge Pigeon (western)^	*Geophaps smithii blaauwi*	Vulnerable	
Oriental Pratincole*	*Glareola maldivarum*		Migratory
Blue Petrel	*Halobaena caerulea*	Vulnerable	
Barn Swallow#	*Hirundo rustica*		Migratory
Caspian Tern	*Hydroprogne caspia*		Migratory
Malleefowl^	*Leipoa ocellata*	Vulnerable	

Common name	Scientific name	Threatened status	Migratory status
Broad-billed Sandpiper*	*Limicola falcinellus*		Migratory
Asian Dowitcher*	*Limnodromus semipalmatus*		Migratory
Bar-tailed Godwit*	*Limosa lapponica*		Migratory
Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit*	*Limosa lapponica baueri*	Vulnerable	Migratory
Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri)^	*Limosa lapponica menzbieri*	Critically Endangered	
Black-tailed Godwit*	*Limosa limosa*		Migratory
Southern Giant-Petrel, Southern Giant Petrel	*Macronectes giganteus*	Endangered	Migratory
Northern Giant Petrel	*Macronectes halli*	Vulnerable	Migratory
White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren^	*Malurus leucopterus edouardi*	Vulnerable	
White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren^	*Malurus leucopterus*	Vulnerable	
Grey Wagtail#	*Motacilla cinerea*		Migratory
Yellow Wagtail#	*Motacilla flava*		Migratory
Eastern Curlew, Far Eastern Curlew*	*Numenius madagascariensis*	Critically Endangered	Migratory
Little Curlew, Little Whimbrel*	*Numenius minutus*		Migratory
Whimbrel*	*Numenius phaeopus*		Migratory
Bridled Tern	*Onychoprion anaethetus*		Migratory
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	Vulnerable	
Osprey*	*Pandion haliaetus*		Migratory
Abbott’s Booby	*Papasula abbotti*	Endangered	
Night Parrot^	*Pezoporus occidentalis*	Endangered	
White-tailed Tropicbird	*Phaethon lepturus*		Migratory
Red-tailed Tropicbird	*Phaethon rubricauda*		Migratory
Red-necked Phalarope*	*Phalaropus lobatus*		Migratory

Common name	Scientific name	Threatened status	Migratory status
Christmas Island White-tailed Tropicbird, Golden Bosunbird	*Phaethon lepturus fulvus*	Endangered	
Ruff (Reeve) *	*Philomachus pugnax*		Migratory
Sooty Albatross	*Phoebetria fusca*	Vulnerable	Migratory
Pacific Golden Plover*	*Pluvialis fulva*		Migratory
Grey Plover*	*Pluvialis squatarola*		Migratory
Princess Parrot, Alexandra's Parrot^	*Polytelis alexandrae*	Vulnerable	
Soft-plumaged Petrel	*Pterodroma mollis*	Vulnerable	
Rufous Fantail#	*Rhipidura rufifrons*		Migratory
Australian Painted Snipe	*Rostratula australis*	Endangered	
Roseate Tern	*Sterna dougallii*		Migratory
Little Tern	*Sternula albifrons*		Migratory
Australian Fairy Tern	*Sternula nereis*	Vulnerable	
Masked Booby	*Sula dactylatra*		Migratory
Brown Booby	*Sula leucogaster*		Migratory
Red-footed Booby	*Sula sula*		Migratory
Indian Yellow-nosed Albatross	*Thalassarche carteri*	Vulnerable	Migratory
Shy Albatross	*Thalassarche cauta*	Endangered	Migratory
White-capped Albatross	*Thalassarche cauta steadi*	Vulnerable	Migratory
Campbell Albatross, Campbell Black-browed Albatross	*Thalassarche impavida*	Vulnerable	Migratory
Black-browed Albatross	*Thalassarche melanophris*	Vulnerable	Migratory
Greater Crested Tern*	*Thalasseus bergii*		Migratory
Grey-tailed Tattler*	*Tringa brevipes*		Migratory
Wood Sandpiper*	*Tringa glareola*		Migratory
Common Greenshank, Greenshank*	*Tringa nebularia*		Migratory
Marsh Sandpiper, Little Greenshank*	*Tringa stagnatilis*		Migratory
Common Redshank, Redshank*	*Tringa totanus*		Migratory
Painted Button-quail (Houtman Abrolhos)	*Turnix varius scintillans*	Endangered	
Masked Owl (northern)^	*Tyto novaehollandiae kimberli*	Vulnerable	

Common name	Scientific name	Threatened status	Migratory status
Terek Sandpiper*	*Xenus cinereus*		Migratory
Buff-banded Rail, Ayam Hutan	*Hypotaenidia philippensis andrewsi*	Endangered	
Christmas Island Emerald Dove, Emerald Dove (Christmas Island)^	*Chalcophaps indica natalis*	Endangered	
Christmas Island Frigatebird, Andrew's Frigatebird	*Fregata andrewsi*	Endangered	Migratory
Christmas Island Goshawk^	*Accipiter hiogaster natalis*	Endangered	
Christmas Island Hawk-Owl, Christmas Boobook^	*Ninox natalis*	Vulnerable	
Christmas Island Thrush^	*Turdus poliocephalus erythropleurus*	Endangered	
Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	Vulnerable	
Sooty Shearwater	*Ardenna grisea*		Migratory
Southern Whiteface ^	*Aphelocephala leucopsis*	Vulnerable	

** Migratory Wetland Species*
 # Migratory Terrestrial Species (unlikely to be encountered in the PA)
^ Species mainly located inland (terrestrial habitats) identified in the Protected Matters Search Report but with the potential to be present in coastal areas and exposed to CAPL's activities.

Table 2-16: BIAs for regionally significant seabirds and shorebirds

Common name	Behaviour	Seasonal presence	Occurrence descriptor
Abbott's Booby^	Foraging	Aug-Oct	Known to occur
Australian Lesser Noddy	Foraging (provisioning young)	Year-round	Known to occur
Bridled Tern	Foraging (in high numbers)	Almost entirely a breeding visitor, arriving late September or October and leaving between late February and early May	Known to occur
Brown Booby	Breeding	Breeding Feb–Oct (but mainly in autumn)	Known to occur
Caspian Tern	Foraging (provisioning young)		Known to occur
Common Noddy	Foraging	Breeding visitor in Abrolhos (mid-August to late April) and further north (May to at least November)	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
	Foraging (provisioning young)	Breeding visitor in Abrolhos (mid-August to late April) and further north (May to at least November)	Known to occur
Fairy Tern	Breeding	Breeding from July to late September; birds from South-West Marine Region (SWMR) dispersing northwards in winter	Known to occur
	Foraging (in high numbers)	Year-round, but southern birds disperse north in winter	Known to occur
Flesh-footed Shearwater	Aggregation	Late April to late June and late August to early November	Known to occur
Greater Frigatebird	Breeding	Breeding in May–June and August	Known to occur
Great-winged Petrel (macroptera race)	Foraging (provisioning young)	Late January to early December	Known to occur
Lesser Crested Tern	Breeding	Breeding Mar–Jun	Known to occur
Lesser Frigatebird	Breeding	Breeding Mar–Sep	Known to occur
Little Penguin	Foraging (provisioning young)		Known to occur
Little Shearwater	Foraging (in high numbers)	Early January to early December, mainly April to November	Known to occur
Little Tern	Breeding	Breeding recorded in June, July, and October	Known to occur
	Resting	Breeding recorded in June, July, and October	Known to occur
Pacific Gull	Foraging (in high numbers)		Former Range
	Foraging (in high numbers)		Known to occur
Red-footed Booby	Breeding	Breeding in May-June	Known to occur
Roseate Tern	Breeding	Breeding from mid-March to July; Also birds from SWMR dispersing north in winter	Known to occur
	Foraging	Winter	Known to occur
	Foraging (provisioning young)	Winter	Known to occur
	Resting	Breeding from mid-March to July; birds from SWMR	Known to occur

Common name	Behaviour	Seasonal presence	Occurrence descriptor
		dispersing north in winter	
Soft-plumaged Petrel	Foraging (in high numbers)	Mainly March to late September	Known to occur
Sooty Tern	Foraging	Late Aug to early May	Known to occur
Wedge-tailed Shearwater	Breeding	Breeding visitor arriving in mid-August and leaving in April in Pilbara and mid-May in Shark Bay	Known to occur
	Foraging (in high numbers)	Mid-August–May	Known to occur
White-faced Storm Petrel	Foraging (in high numbers)		Known to occur
White-tailed Tropicbird	Breeding	Breeding recorded in May and October	Known to occur

^ *Proposed foraging BIA for nesting Abbott's Booby around Christmas Island (Ref. 96).*

Table 2-17: Summary of relevant conservation plans—seabirds and shorebirds

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
Australian Lesser Noddy	Conservation Advice for *Anous tenuirostris melanops* Australian Lesser Noddy (Ref. 44)	No key threats related to petroleum activities were identified. Other threats include: • Pollution • oil spills. No relevant management advice was identified.
Forest Red-tailed Black-Cockatoo Baudin's Cockatoo	Forest Black-Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) Recovery Plan (Ref. 45)	No key threats related to petroleum activities were identified. No relevant management advice was identified.
	Approved Conservation Advice for *Calyptorhynchus banksii naso* (Forest Red-tailed Black-Cockatoo) (Ref. 46)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
	Conservation Advice *Calyptorhynchus baudinii* Baudin's Cockatoo (Ref. 47)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
Carnaby's Cockatoo	Carnaby's Cockatoo (*Calyptorhynchus*	Key threats include: • loss of breeding habitat

Species	Relevant Plan / Advice	Key Threats / Relevant Management Advice
	latirostris) Recovery Plan (Ref. 48)	• loss of non-breeding foraging and night roosting habitat • climate change No relevant management advice was identified.
Cocos buff-banded rail	Cocos buff-banded rail (Cocos (Keeling) Islands) Recovery plan (Ref. 98).	Key threats include: • habitat modification No relevant management advice was identified.
Malleefowl	National Recovery Plan for Malleefowl *Leipoa ocellate* (Ref. 49)	Key threats include: • disease, inbreeding, and chemical exposure • climate change. No relevant management advice was identified.
Southern Giant Petrel Northern Giant Petrel Indian Yellow-nosed Albatross Shy Albatross White-capped Albatross Campbell Albatross Black-browed Albatross	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (Ref. 50)	Key threats include: • marine pollution • climate change • feral pest species • human disturbance at the nest • parasites and diseases • loss of nesting habitat • climate change. No relevant management advice was identified.
White-winged Fairy-wren (Barrow Island)	Approved Conservation Advice for *Malurus leucopterus edouardi* (White-winged Fairy-wren [Barrow Island]) (Ref. 51)	The main potential threats to the White-winged Fairy-wren (Barrow Island) include: • introduction of non-endemic fauna, flora, or pathogens • destruction of birds. No relevant management advice was identified.
White-winged Fairy-wren (Dirk Hartog Island)	Approved Conservation Advice for *Malurus leucopterus* (White-winged Fairy-wren (Dirk Hartog Island)) (Ref. 52)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
Fairy Prion (southern)	Conservation Advice *Pachyptila turtur subantarctica* Fairy Prion (southern) (Ref. 53)	Key threats include: • habitat loss, disturbance, and modification. No relevant management advice was identified.
Abbott's Booby	Conservation Advice *Papasula abbotti* Abbott's Booby (Ref. 54)	Key threats include: • climate change • introduction of a new disease • marine debris - plastics No relevant management advice was identified.

Species	**Relevant Plan / Advice**	**Key Threats / Relevant Management Advice**
Night Parrot	Conservation Advice *Pezoporus occidentalis* Night Parrot (Ref. 55)	No key threats related to petroleum activities were identified. No relevant management advice was identified.
Princess Parrot	Conservation Advice *Polytelis alexandrae* Princess Parrot (Ref. 56)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
Soft-plumaged Petrel	Conservation Advice *Pterodroma Mollis* Soft-plumaged Petrel (Ref. 57)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
Round Island Petrel	Conservation advice for *Pterodroma arminjoniana* round island petrel (Ref. 99)	No key threats related to petroleum activities were identified. No relevant management advice was identified.
Australian Painted Snipe	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (Ref. 58)	Key threats include: • habitat loss, disturbance, and modification. No relevant management advice was identified. •
Australian Fairy Tern	Approved Conservation Advice for *Sternula nereis* (Fairy Tern) (Ref. 59)	Key threats include: • disturbance by humans and direct destruction of nests • increasing salinity in waters adjacent to colonies The main potential threat is: • oil spills. Relevant management actions include: • ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills, such as the breeding colonies in Victoria.
Painted Button-quail (Houtman Abrolhos)	Approved Conservation Advice for *Turnix varia scintillans* (Painted Button-quail (Houtman Abrolhos)) (Ref. 60)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.
Masked Owl (northern)	Conservation Advice *Tyto novaehollandiae kimberli* Masked Owl (northern) (Ref. 61)	No key threats related to petroleum activities were identified. • No relevant management advice was identified.

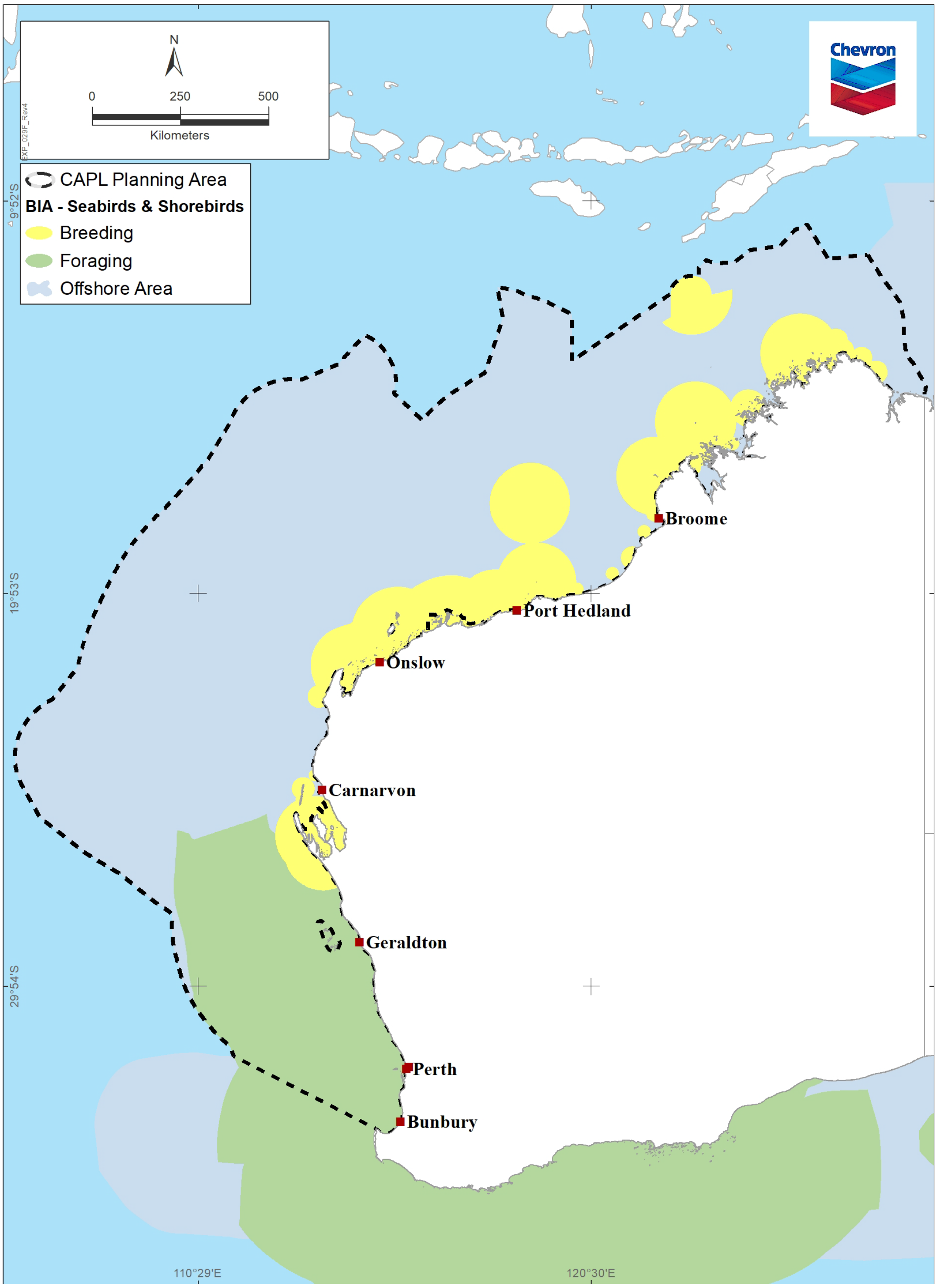
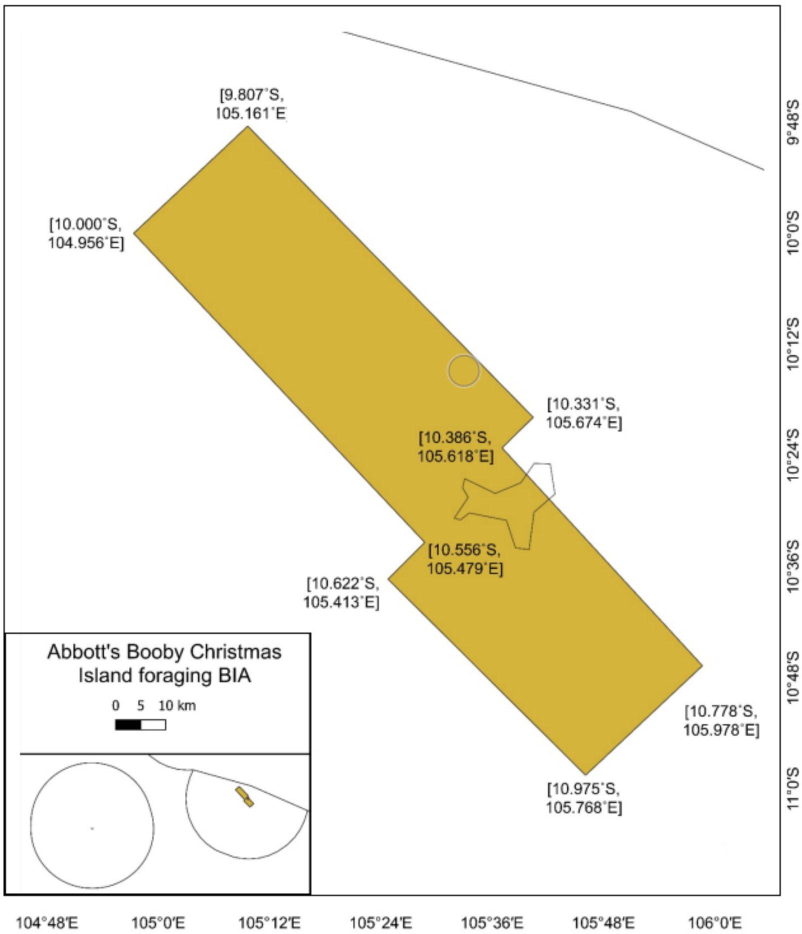


Figure 2-6: BIAs associated with seabirds and shorebirds



Source: Ref. 96

Figure 2-7: Proposed foraging BIA for nesting Abbott's Booby around Christmas Island

2.5 Listed threatened ecological communities

In Australia, three categories exist for listing threatened ecological communities (TECs) under the EPBC Act: critically endangered, endangered, and vulnerable.

A search of the TEC spatial database (Ref. 62) and a protected matters search (appendix a) identified TECs occur in the PA[5] (Table 2-18).

Table 2-18: Threated ecological communities

TEC	Summary of significance
Monsoon Vine Thickets on the coastal sand dunes of Dampier Peninsula	The Monsoon Vine Thickets on the coastal sand dunes of Dampier Peninsula ecological community represents certain occurrences of Monsoon Vine thickets in the south-west Kimberley region of WA (within the Dampierland bioregion). The ecological community is predominantly restricted to the coastlines of the Dampier Peninsula from Broome in the south to One Arm Point in the north and on the north-eastern coast of the Peninsula from One Arm Point to Goodenough Bay. The coastal dune environment, being largely of sand, has minimal soil development and is susceptible to erosion from various sources including rising tides, strong winds, and cyclonic activity. Tides of the Dampier

[5] Only TECs with a coastal and/or marine interface have been identified and described.

TEC	Summary of significance
	Peninsula range up to 11 m and are a major factor affecting the coastal environment where the ecological community occurs. (Ref. 63)
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	The Rockingham-Becher Plain has been formed through the accumulation of Holocene sediments and contains a continuous depositional history from 7000 BP to present. Wetlands occur within the swales where the water table is close to or at the ground surface in the wetter months of the year. The most typical form is that of the Becher Suite, which is made up of over 250 very small to small sumplands and damplands, many of which contain occurrences of this community. The present known distribution of the sedgelands in Holocene dune swale community as is ~193 ha and is almost entirely located within linear wetland depressions (swales) occurring between parallel sand ridges of the Rockingham-Becher Plain. Additional occurrences include a small area at Yanchep and a small area at Dalyellup. Holocene dunes with wetlands around Preston Beach, south of Lancelin, and at Cheynes Beach may also contain occurrences of this community. (Ref. 64)
Subtropical and Temperate Coastal Saltmarsh	The Subtropical and Temperate Coastal Saltmarsh ecological community occurs within a relatively narrow margin of the Australian coastline, within the subtropical and temperate climatic zones south of the South-east Queensland IBRA bioregion boundary at 23° 37′ latitude along the east coast and south of (and including) Shark Bay at 26° on the west coast. Coastal saltmarsh occurring on islands within the geographic range is also included within the ecological community. The Coastal Saltmarsh ecological community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, sedges, rushes, and shrubs. Succulent herbs, shrubs, and grasses generally dominate, and vegetation is generally <0.5 m high (with the exception of some reeds and sedges). (Ref. 65)

2.6 Commonwealth marine areas

The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone (EEZ) and/or over the continental shelf of Australia, which is not State or Territory waters.

The Commonwealth marine area stretches from three to 200 nautical miles from the coast. Marine protected areas are marine areas that are recognised to have high conservation value (Ref. 66).

2.6.1 Australian Marine Parks

Australian Marine Parks (AMPs), proclaimed under the EPBC Act in 2007 and 2013, are located in Commonwealth waters that start at the outer edge of state and territory waters, generally three nautical miles (~5.5 km) from the shore, and extend to the outer boundary of Australia's EEZ, 200 nautical miles (~370 km) from the shore (Ref. 67).

Table 2-19, Table 2-20, and Table 2-21 summarise the north-west, south-west, and north AMPs present within the PA, including their zones, areas, and International Union for Conservation of Nature (IUCN) categories. Table 2-22 summaries the IOT AMPs present within the PA.

Table 2-19: Summary of AMPs (North-west Marine Parks)

AMP	Zones, IUCN categories, and zone area	Description	Values^
Argo–Rowley Terrace	National Park Zone (II) 36 050 km² Multiple Use Zone (VI) 108 812 km² Special Purpose Zone (Trawl) (VI) 1141 km²	The Argo–Rowley Terrace Marine Park is ~270 km north-west of Broome, WA, and extends to the limit of Australia's EEZ. The Marine Park is adjacent to the Mermaid Reef Marine Park and the WA Rowley Shoals Marine Park. The Marine Park covers an area of 146 003 km^2 and has water depths between 220 m and 6000 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Argo–Rowley Terrace Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of: • Northwest Transition—an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Key topographic features include Mermaid, Clerke, and Imperieuse reefs, which collectively are a biodiversity hotspot • Timor Province—an area dominated by warm, nutrient-poor waters. Canyons are an important feature in this area of the Marine Park and are generally associated with high productivity and aggregations of marine life. Key ecological features of the Marine Park are: • Canyons linking the Argo Abyssal Plain with the Scott Plateau—an area likely to result in upwelling of nutrient-rich water and aggregations of marine life • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals—an area of enhanced productivity and high species richness, thought to be facilitated by internal wave action generated by internal tides. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include resting and breeding habitat for seabirds and a migratory pathway for the Pygmy Blue Whale. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan there is limited information about the cultural significance of this Marine Park. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan. Historic shipwrecks The Marine Park contains two known shipwrecks listed under the *Historic Shipwrecks Act 1976*: Alfred (wrecked in 1908) and Pelsart (wrecked in 1908).

AMP	Zones, IUCN categories, and zone area	Description	Values^
			Social and economic values Commercial fishing and mining are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Ashmore Reef	Sanctuary Zone (Ia) 550 km² Recreational Use Zone (IV) 34 km²	The Ashmore Reef Marine Park is ~630 km north of Broome and 110 km south of the Indonesian island of Roti. The Marine Park is in Australia's External Territory of Ashmore and Cartier Islands and is within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 583 km² and water depths from <15 m to 500 m. The Marine Park has three vegetated sand cays that are permanently above water: West, Middle, and East islands. The Marine Park was originally proclaimed under the Commonwealth *National Parks and Wildlife Conservation Act 1975* on 16 August 1983 as the Ashmore Reef National Nature Reserve, and proclaimed under the EPBC Act on 14 December 2013; it was renamed Ashmore Reef Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the Timor Province—a bioregion with a depth range from ~200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Ashmore Reef is an important feature of the bioregion. Endemism in demersal fish communities of the continental slope is high with two distinct communities identified: one on the upper slope, the other mid slope. Key ecological features of the Marine Park are: • Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life • continental slope demersal fish communities—an area of high-diversity demersal fish assemblages. The marine environment of the Marine Park includes habitats associated with two extensive lagoons, sand flats, shifting sand cays, extensive reef flat, and large areas of seagrass. The reef ecosystems are comprised of hard and soft corals, gorgonians, sponges, and a range of encrusting organisms, with the highest number of coral species of any reef off the Western Australian coast. The Marine Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding, foraging, and resting habitat for seabirds; resting and foraging habitat for migratory shorebirds; foraging, mating, nesting, and internesting habitat for marine turtles; foraging habitat for Dugong; and a migratory pathway for Pygmy Blue Whales. Ashmore Reef Ramsar site The Ashmore Reef Ramsar site includes the largest of the atolls in the region. West Island, Middle Island, and East Island represent the only vegetated islands in the region. Ashmore Reef Ramsar site supports internationally significant populations of seabirds and shorebirds, is important for turtles (Green, Hawksbill and Loggerhead) and Dugong, and has the highest diversity of hermatypic (reef-building) corals on the West Australian coast. It is known for

AMP	Zones, IUCN categories, and zone area	Description	Values^
			its abundance and diversity of sea snakes. However, since 1998 populations of sea snakes at Ashmore Reef have been in decline. **Cultural values** Indigenous Australians Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan there is limited information about the cultural significance of this Marine Park. Indonesian The Marine Park contains Indonesian artefacts and grave sites and Ashmore lagoon is still accessed as a rest or staging area for traditional Indonesian fishers travelling to and from fishing grounds within the MoU Box. **Heritage values** No international or national heritage listings apply to the Marine Park at commencement of this plan. Commonwealth heritage Ashmore Reef was listed on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B and C. **Social and economic values** Tourism, recreation and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Carnarvon Canyon	Habitat Protection Zone (IV) 6177 km²	The Carnarvon Canyon Marine Park is ~300 km north-west of Carnarvon. It covers an area of 6177 km² with a water depth range of 1500–6000 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Carnarvon Canyon Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the Central Western Transition — a bioregion characterised by large areas of continental slope; a range of topographic features such as terraces, rises, and canyons; seasonal and sporadic upwelling; and benthic slope communities comprising tropical and temperate species. It includes the Carnarvon Canyon, a single-channel canyon covering the entire depth range of the Marine Park. Ecosystems of the Marine Park are influenced by tropical and temperate currents, deep-water environments, and proximity to the continental slope and shelf. The soft-bottom environment at the base of the Carnarvon Canyon is likely to support species that are typical of the deep sea floor (e.g. holothurians, polychaetes, sea pens). The Marine Park supports a range of species, including

AMP	Zones, IUCN categories, and zone area	Description	Values^
			species listed as threatened, migratory, marine, or cetacean under the EPBC Act. There is limited information about species' use of this Marine Park. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. **Social and economic values** Commercial fishing is an important activity in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Cartier Island	Sanctuary Zone (Ia) 172 km²	The Cartier Island Marine Park is ~45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, WA. Both Marine Parks are located in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 172 km² with water depths from <15 m to 500 m. The Marine Park was originally proclaimed under the Commonwealth *National Parks and Wildlife Conservation Act 1975* on 21 June 2000 as the Cartier Island Marine Reserve, and	**Natural values** The Marine Park includes examples of ecosystems representative of the Timor Province—a bioregion with a depth range from ~200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Endemism of demersal fish communities of the continental slope is high with two distinct communities identified, one on the upper slope, the other mid slope. Key ecological features represented in the Marine Park are: • Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life • Continental slope demersal fish communities—an area of high diversity in demersal fish assemblages. The Marine Park includes an unvegetated sand island (Cartier Island); mature reef flat; a small, submerged pinnacle (Wave Governor Bank); and two shallow pools to the north-east of the island. It is also an area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges, and a range of encrusting organisms. The reef crests are generally algal dominated, while the reef flats feature ridges of coral rubble and large areas of seagrass. The Marine Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically

AMP	Zones, IUCN categories, and zone area	Description	Values^
		proclaimed under the EPBC Act on 14 December 2013; it was renamed Cartier Island Marine Park on 9 October 2017.	important areas within the Marine Park include breeding and foraging habitat for seabirds; internesting, nesting, and foraging habitat for marine turtles; and foraging habitat for Whale Sharks. The Marine Park is important for a range of other species and internationally significant for its abundance and diversity of sea snakes, some of which are listed species under the EPBC Act. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan. Historic shipwrecks The Marine Park contains one known shipwreck listed under the *Historic Shipwrecks Act 1976*: the Ann Millicent (wrecked in 1888). **Social and economic values** Scientific research is an important activity in the Marine Park.
Dampier	National Park Zone (II) 73 km² Habitat Protection Zone (IV) 104 km² Multiple Use Zone (VI) 1074 km²	The Dampier Marine Park is ~10 km north-east of Cape Lambert and 40 km from Dampier extending westwards from the WA state water boundary. The Marine Park covers an area of 1252 km² and a water depth range between <15 m and 70 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Dampier Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. The Marine Park supports a range of species including those listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and foraging habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for Humpback Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years.

AMP	Zones, IUCN categories, and zone area	Description	Values^
			The Ngarluma, Yindjibarndi, Yaburara, and Mardudhunera people have responsibilities for sea country in the Marine Park. The native title holders for these people are represented by the Ngarluma Aboriginal Corporation and Yindjibarndi Aboriginal Corporation. These Prescribed Body Corporates represent traditional owners with native title over coastal area adjacent to the Marine Park are the points of contact for their respective areas of responsibility for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Pilbara and Yamatji regions. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is approximately 10 km north of the Dampier Archipelago (including Burrup Peninsula) national heritage listing, which has significant Indigenous heritage values including rock art sites. **Social and economic values** Port activities, commercial fishing and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Eighty Mile Beach	Multiple Use Zone (VI) 10 785 km²	The Eighty Mile Beach Marine Park is located ~74 km north-east of Port Hedland, adjacent to the Western Australian Eighty Mile Beach Marine Park. The Marine Park covers an area of 10 785 km² and a water depth ranges between less than 15 m and 70 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Eighty Mile Beach Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding, foraging, and resting habitat for seabirds; internesting and nesting habitat for marine turtles; foraging, nursing, and pupping habitat for sawfish; and a migratory pathway for Humpback Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years.

AMP	Zones, IUCN categories, and zone area	Description	Values^
			The sea country of the Nyangumarta, Karajarri and Ngarla people extends into Eighty Mile Beach Marine Park. Sea country is culturally significant and important to their identity. They have an unbroken, deep spiritual connection to their sea country, with traditional practices continuing today. Staple foods of living cultural value for the Nyangumarta, Karajarri and Ngarla people include saltwater fish, turtles, dugong, crabs and oysters. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities. The native title holders for the Nyangumarta, Karajarri and Ngarla people are represented by the Karajarri Aboriginal Corporation, Nyangumarta Karajarri Aboriginal Corporation, Nyangumarta Warrarn Aboriginal Corporation, and Wanparta Aboriginal Corporation. These Prescribed Body Corporates represent traditional owners with native title over coastal area adjacent to the Marine Park and are the points of contact for their respective areas of responsibility for sea country in the Marine Park. The Kimberley Land Council and the Yamatji Marlpa Aboriginal Corporation are the Native Title Representative Bodies for Kimberley and Pilbara regions. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan. Historic shipwrecks The Marine Park contains three known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*; Lorna Doone (wrecked in 1923), Nellie (wrecked in 1908), and Tifera (wrecked in 1923) **Social and economic values** Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Gascoyne	National Park Zone (II) 9132 km² Habitat Protection Zone (IV) 38 982 km² Multiple Use Zone (VI) 33 652 km²	The Gascoyne Marine Park is located ~20 km off the west coast of the Cape Range Peninsula, adjacent to the Ningaloo Reef Marine Park and the Western Australian Ningaloo Marine Park, and extends to the limit	**Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Shelf Transition—continental shelf with water depths up to 100 m, and a significant transition zone between tropical and temperate species • Central Western Transition—characterised by large areas of continental slope; a range of topographic features such as terraces, rises, and

AMP	Zones, IUCN categories, and zone area	Description	Values^
		of Australia's EEZ. The Marine Park covers an area of 81 766 km² and water depths between 15 m and 6000 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Gascoyne Marine Park on 9 October 2017.	canyons; seasonal and sporadic upwelling; and benthic slope communities comprising tropical and temperate species • Northwest Province—an area of continental slope comprising diverse and endemic fish communities. Key ecological features of the Marine Park are: • Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula—an area resulting in upwelling of nutrient-rich water and aggregations of marine life • Commonwealth waters adjacent to Ningaloo Reef—an area where the Leeuwin and Ningaloo currents interact resulting in enhanced productivity and aggregations of marine life • Continental slope demersal fish communities—an area of high diversity of demersal fish assemblages on the continental slope • Exmouth Plateau—a regionally and nationally unique deep-sea plateau in tropical waters. Ecosystems represented in the Marine Park are influenced by the interaction of the Leeuwin Current, Leeuwin Undercurrent, and the Ningaloo Current. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds; internesting habitat for marine turtles; a migratory pathway for Humpback Whales; and foraging habitat and migratory pathway for Pygmy Blue Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Gnulli people have responsibilities for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region. **Heritage values** World heritage The Ningaloo Coast was listed as an area of outstanding universal value under the World Heritage Convention in 2011, meeting world heritage listing criteria vii

AMP	Zones, IUCN categories, and zone area	Description	Values^
			and x. The Ningaloo Coast World Heritage Property is adjacent to the Marine Park. Commonwealth heritage The Ningaloo Marine Area (Commonwealth waters) was established on the Commonwealth Heritage List in 2004, meeting the Commonwealth heritage listing criteria A, B and C. The Ningaloo Marine Area is adjacent to the Marine Park. National heritage The Ningaloo Coast was established on the National Heritage List in 2010, meeting the national heritage listing criteria A, B, C, D, and F and is adjacent to the Marine Park. Historic shipwrecks The Marine Park contains more than five known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Commercial fishing, mining and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Kimberley	National Park Zone (II) 6392 km² Habitat Protection Zone (IV) 5665 km² Multiple Use Zone (VI) 62 411 km²	The Kimberley Marine Park is located ~100 km north of Broome, extending from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. The Marine Park is adjacent to the Western Australian Lalang-garram/Camden Sound Marine Park and the North Kimberley Marine Park. The Marine Park covers an area of 74 469 km² and water depths from less than 15 m to 800 m. The Marine Park was	**Natural values** The Marine Park includes examples of ecosystems representative of: • Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and an ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. • Northwest Shelf Transition—straddles the North-west and North Marine Regions and in the Northwest includes shelf break, continental slope, and the majority of the Argo Abyssal Plain and is subject to a high incidence of cyclones. Benthic biological communities in the deeper parts of the bioregion have not been extensively studied, although high levels of species diversity and endemism occur among demersal fish communities on the continental slope. • Timor Province—water depths (of the bioregion) ranging from ~200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and

AMP	Zones, IUCN categories, and zone area	Description	Values^
		proclaimed under the EPBC Act on 14 December 2013 and renamed Kimberley Marine Park on 9 October 2017.	islands of the bioregion are regarded as biodiversity hotspots. Endemism in demersal fish communities of the continental slope is high; two distinct communities have been identified on the upper and mid slopes. Key ecological features of the Marine Park are: • the ancient coastline at the 125 m depth contour—where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments • the continental slope demersal fish communities—characterised by high diversity of demersal fish assemblages. The Marine Park supports a range of species, including protected species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and foraging habitat for seabirds; internesting and nesting habitat for marine turtles; breeding, calving, and foraging habitat for inshore dolphins; calving, migratory pathway, and nursing habitat for Humpback Whales; migratory pathway for Pygmy Blue Whales; foraging habitat for dugong; and foraging habitat for Whale Sharks. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. The Wunambal Gaambera people's country includes daagu (deep waters), with about 3400 km^2 of their sea country located in the Marine Park. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have an unbroken connection to their sea country, having deep spiritual connection through Wunggurr (creator snakes) that still live in the sea. Staple foods of living cultural value include saltwater fish, turtles, dugong, crabs and oysters. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities. The national heritage listing for the West Kimberley recognises the following key cultural heritage values: Wanjina Wunggurr Cultural Tradition which incorporates many sea country cultural sites;

AMP	Zones, IUCN categories, and zone area	Description	Values^
			• log-raft maritime tradition, which involved using tides and currents to access warruru (reefs) far offshore to fish; • interactions with Makassan traders around sea foods over hundreds of years; and • important pearl resources that were used in traditional trade through the wunan and in contemporary commercial agreements. The Wunambal Gaambera, Dambimangari and Bardi Jawi people consider that these values extend into the Kimberley Marine Park. The Wanjina Wunggurr is law of the Wunambal Gaambera and Dambimangari people and it is recognised that all of the sea country, land, plants and animals were put there by Wanjina Wunggurr. Under Wanjina Wunggurr law, the Wunambal Gaambera and Dambimangari people have a responsibility to manage country, to maintain the health of the country and all living things. The Wunambal Gaambera, Bardi Jawi, Mayala and the Nyul Nyul people have had native title determined over parts of their sea country included in this Park. The native title holders for these people are represented by the Wunambal Gaambera Aboriginal Corporation, Bardi and Jawi Niimidiman Aboriginal Corporation and the Kimberley Land Council. These representative bodies are the points of contact for their respective areas of sea country for the Marine Park. The Kimberley Land Council is the Native Title Representative Body for Kimberley region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the national heritage place of The West Kimberley. Historic shipwrecks The Marine Park contains more than 40 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Mermaid Reef	National Park Zone (II) 540 km²	The Mermaid Reef Marine Park is located ~280 km	**Natural values**

AMP	Zones, IUCN categories, and zone area	Description	Values^
		north-west of Broome, adjacent to the Argo–Rowley Terrace Marine Park and ~13 km from the Western Australian Rowley Shoals Marine Park. The Marine Park covers an area of 540 km² and water depths from less than 15 m to 500 m. The Marine Park was originally proclaimed under the Commonwealth *National Parks and Wildlife Conservation Act 1975* on 10 April 1991 as the Mermaid Reef Marine National Nature Reserve, and proclaimed under the EPBC Act on 14 December 2013 and renamed Mermaid Reef Marine Park on 9 October 2017.	The Marine Park includes examples of ecosystems representative of the Northwest Transition—an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain. A key ecological feature of the Marine Park is the Mermaid Reef and Commonwealth waters surrounding Rowley Shoals—an area of enhanced productivity and high species richness thought to be facilitated by internal wave action generated by internal tides in the lagoon. Ecosystems of the Marine Park are associated with emergent reef flat, deep reef flat, lagoon, and submerged sand habitats. The Marine Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds and a migratory pathway for the Pygmy Blue Whale. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. **Heritage values** No international or national listings apply to the Marine Park at commencement of this plan. Commonwealth heritage Mermaid Reef–Rowley Shoals was established on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B, C and D. Historic shipwrecks The Marine Park contains one known shipwreck listed under the *Historic Shipwrecks Act 1976*: Lively (wrecked in 1810). **Social and economic values** Tourism, recreation, and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Montebello	Multiple Use Zone (VI) 3413 km²	The Montebello Marine Park is located offshore of Barrow Island and 80 km west of	**Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides,

AMP	Zones, IUCN categories, and zone area	Description	Values^
		Dampier extending from the Western Australian state water boundary, and is adjacent to the Western Australian Barrow Island and Montebello Islands Marine Parks. The Marine Park covers an area of 3413 km² and water depths from <15 m to 150 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Montebello Marine Park on 9 October 2017.	cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. A key ecological feature of the Marine Park is the ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitat in areas otherwise dominated by soft sediments. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds; internesting, foraging, mating, and nesting habitat for marine turtles; a migratory pathway for Humpback Whales; and foraging habitat for Whale Sharks. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Pilbara region. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the Western Australia Barrow Island and the Montebello– Barrow Island Marine Conservation Reserves which have been nominated for national heritage listing. Historic shipwrecks The Marine Park contains two known shipwrecks listed under the *Historic Shipwrecks Act 1976*: Trial (wrecked in 1622), the earliest known shipwreck in Australian waters and Tanami (unknown date). **Social and economic values** Tourism, commercial fishing, mining and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Ningaloo	National Park Zone (II) 116 km² Recreational Use Zone (IV) 2319 km²	The Ningaloo Marine Park stretches ~300 km along the west coast of the Cape Range Peninsula, and is adjacent to the Western	**Natural values** The Marine Park includes examples of ecosystems representative of:

AMP	Zones, IUCN categories, and zone area	Description	Values^
		Australian Ningaloo Marine Park and Gascoyne Marine Park. The Marine Park covers an area of 2435 km² and a water depth range of 30 m to more than 500 m. The Marine Park was originally proclaimed under the *National Parks and Wildlife Conservation Act 1975* on 20 May 1987 as the Ningaloo Marine Park (Commonwealth Waters), and proclaimed under the EPBC Act on 14 December 2013 and renamed Ningaloo Marine Park on 9 October 2017.	• Central Western Shelf Transition—continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species • Central Western Transition—characterised by large areas of continental slope; a range of topographic features such as terraces, rises, and canyons; seasonal and sporadic upwelling; and benthic slope communities comprising tropical and temperate species • Northwest Province—an area of continental slope comprising diverse and endemic fish communities • Northwest Shelf Province—a dynamic environment, influenced by strong tides, cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. Key ecological features of the Marine Park are: • Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula—an area resulting in upwelling of nutrient-rich water and aggregations of marine life • Commonwealth waters adjacent to Ningaloo Reef—an area where the Leeuwin and Ningaloo currents interact, resulting in enhanced productivity and aggregations of marine life • Continental slope demersal fish communities—an area of high diversity among demersal fish assemblages on the continental slope. Ecosystems represented in the Marine Park are influenced by interaction of the Leeuwin Current, Leeuwin Undercurrent, and the Ningaloo Current. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and or foraging habitat for seabirds; internesting habitat for marine turtles; a migratory pathway for Humpback Whales; foraging habitat and migratory pathway for Pygmy Blue Whales; breeding, calving, foraging, and nursing habitat for dugong; and foraging habitat for Whale Sharks. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and

AMP	Zones, IUCN categories, and zone area	Description	Values^
			managing their sea country for tens of thousands of years. The Gnulli people have responsibilities for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region. **Heritage values** World heritage The Marine Park is within the Ningaloo Coast World Heritage Property, recognised for its outstanding universal heritage values, meeting world heritage listing criteria vii and x. In addition to the Marine Park, the world heritage area includes the Western Australian Ningaloo Marine Park, the Murion Islands, the Western Australian Cape Range National Park and other terrestrial areas. The area is valued for high terrestrial species endemism, marine species diversity and abundance, and the interconnectedness of large-scale marine, coastal and terrestrial environments. The area connects the limestone karst system and fossil reefs of the ancient Cape Range to the nearshore reef system of Ningaloo Reef, to the continental slope and shelf in Commonwealth waters. National heritage The Ningaloo Coast overlaps the Marine Park and was established on the National Heritage List in 2010, meeting the national heritage listing criteria A, B, C, D, and F. Commonwealth heritage The Ningaloo Marine Area (Commonwealth waters) was established on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B and C. The Ningaloo Marine Area overlaps the Marine Park. Historic shipwrecks The Marine Park contains more than 15 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Tourism and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Roebuck	Multiple Use Zone (VI) 304 km²	The Roebuck Marine Park is located ~12 km offshore of Broome, and is adjacent to the Western Australian	**Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides,

AMP	Zones, IUCN categories, and zone area	Description	Values^
		Yawuru Nagulagun/Roebuck Bay Marine Park. The Marine Park covers an area of 304 km² and a water depth range of less than 15 m to 70 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Roebuck Marine Park on 9 October 2017.	cyclonic storms, long-period swells, and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important sea floor feature and migratory pathway for Humpback Whales. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and resting habitat for seabirds; foraging and internesting habitat for marine turtles; a migratory pathway for Humpback Whales; and foraging habitat for dugong. **Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and resting habitat for seabirds, foraging and internesting habitat for marine turtles, a migratory pathway for humpback whales and foraging habitat for dugong. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. Yawuru people have always recognised the waters of Roebuck Bay as nagula (Yawuru sea country), and have customary responsibilities to care for it. They have a deep spiritual connection to offshore landscapes from Bugarrigarra (creator beings), and believe that snake-like metaphysical beings inhabit the sea. Cultural sites in sea country are also a source of law. The Yawuru people harvest marine resources according to the six Yawuru seasons. They have harvested pearl shell for food and cultural purposes. Fish are a staple food source, and fishing a form of cultural expression, connecting people to their country, modelled on tradition and based in traditional law. Access to sea country by families is important to cultural traditions, livelihoods and future socio-economic development opportunities. The Yawuru Native Title Holders Aboriginal Corporation is the Prescribed Body Corporate representing traditional owners with native title over coastal areas adjacent to the Marine Park, and is

<table>
<tr><th>AMP</th><th>Zones, IUCN categories, and zone area</th><th>Description</th><th>Values^</th></tr>
<tr><td></td><td></td><td></td><td>the point of contact for sea country in the Marine Park. The Kimberley Land Council is the Native Title Representative Body for the Kimberley region.
Heritage values
No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the West Kimberley National Heritage Place.
Social and economic values
Tourism, commercial fishing, pearling and recreation, including fishing, are important activities that occur in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.</td></tr>
<tr><td>Shark Bay</td><td>Multiple Use Zone (VI)
7443 km²</td><td>The Shark Bay Marine Park is located ~60 km offshore of Carnarvon, adjacent to the Shark Bay World Heritage Property and National Heritage place. The Marine Park covers an area of 7443 km², extending from the Western Australian state water boundary, and a water depth range between 15 m and 220 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Shark Bay Marine Park on 9 October 2017.</td><td>Natural value
The Marine Park includes examples of ecosystems representative of:
Central Western Shelf—a predominantly flat, sandy, and low-nutrient area, in water depths 50–100 m. The bioregion is a transitional zone between tropical and temperate species
Central Western Transition—characterised by large areas of continental slope; a range of topographic features such as terraces, rises, and canyons; seasonal and sporadic upwelling; and benthic slope communities comprising tropical and temperate species.
Ecosystems represented in the Marine Park are influenced by the Leeuwin, Ningaloo, and Capes currents. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for Humpback Whales. The Marine Park and adjacent coastal areas are also important for Shallow-water Snapper.
Cultural values
Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Gnulli and Malgana people have responsibilities for sea country in the Marine Park.
The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region.
Heritage values</td></tr>
</table>

AMP	Zones, IUCN categories, and zone area	Description	Values^
			No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan, but the Marine Park is adjacent to the Shark Bay, Western Australia World Heritage Property and Shark Bay, Western Australia National Heritage Place. Historic shipwrecks The Marine Park contains approximately 20 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Tourism, commercial fishing, mining and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

^ Source: Ref. 67.

Table 2-20: Summary of AMPs (South-west Marine Parks)

AMP	Zones, IUCN categories and zone area	Description	Values^
Abrolhos	Habitat Protection Zone (IV) 23,239 km² Multiple Use Zone (VI) 56,545 km² National Park Zone (II) 2548 km² Special Purpose Zone (VI) 5729 km²	Abrolhos Marine Park is located adjacent to the Western Australian Houtman Abrolhos Islands, covering a large offshore area extending from the Western Australian state water boundary to the edge of Australia's exclusive economic zone. It is located ~27 km south-west of Geraldton and extends north to ~330 km west of Carnarvon. The northernmost part of the shelf component of the Marine Park, north of Kalbarri, is adjacent to the Shark Bay World Heritage	Natural values The Marine Park includes examples of ecosystems representative of: • Central Western Province—characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations, including west of the Houtman Abrolhos Islands • Central Western Shelf Province—a predominantly flat, sandy, and low-nutrient area, in water depths between 50 and 100 m. Significant sea floor features of this area include a deep hole and associated area of banks and shoals offshore of Kalbarri. The area is a transitional zone between tropical and temperate species • Central Western Transition—a deep ocean area characterised by large areas of continental slope, a range of significant sea floor features including the Wallaby Saddle, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species

AMP	Zones, IUCN categories and zone area	Description	Values^
		Area. The Marine Park covers an area of 88,060 km² and a water depth range between less than 15 m and 6000 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Abrolhos Marine Park on 9 October 2017.	• South-west Shelf Transition—a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. Key ecological features of the Marine Park are: • Commonwealth marine environment surrounding the Houtman Abrolhos Islands—the islands are among Australia's most important seabird breeding sites, with extensive foraging grounds in Commonwealth waters. The islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward movement of species by the Leeuwin Current; • Demersal slope and associated fish communities of the Central Western Province—an area that provides important habitat for demersal fish communities and is characterised by high species diversity and endemism; • Mesoscale eddies—important transporters of nutrients and plankton communities that form at predictable locations off the western and south-western shelf break; • Perth Canyon and adjacent shelf break, and other west-coast canyons—unique seafloor features give rise to ecologically important events of localised productivity and aggregations of marine life; • Western rock lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles; • Ancient coastline between 90 m and 120 m depth—high benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment; and • Wallaby Saddle—a unique seafloor feature that is associated with enhanced biological productivity in an area of generally low productivity. The saddle is the site of upwellings of deeper, more nutrient-rich waters and aggregations of marine species including large predators such as sperm whales. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging and breeding habitat for

AMP	Zones, IUCN categories and zone area	Description	Values^
			seabirds, foraging habitat for Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales. The Marine Park is adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Nanda and Naaguja People have responsibilities for sea country in the Marine Park. Traditional owners have strong stories that connect ocean and land. Artefacts from ancestors are abundant on islands in the adjacent state marine park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region. **Heritage values** No international heritage listings apply to the Marine Park at the commencement of this plan, however, the Marine Park is adjacent to the Western Australian Shark Bay World Heritage Property, listed as an area of outstanding universal value under the World Heritage Convention in 1991, meeting world heritage listing criteria vii, viii, ix, and x. No Commonwealth or national heritage listings apply to the Marine Park at the commencement of this plan; however the Marine Park is adjacent to the Western Australian Shark Bay National Heritage Place. Historic shipwrecks The Marine Park contains 11 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. The *Zuytdorp* (wrecked in 1712) historic shipwreck protected zone lies in state waters adjacent to the northernmost part of the shelf component of the Marine Park, north of Kalbarri. The *HMAS Sydney II* and *HSK Kormoran* Shipwreck Sites (1941) lie at 2500 m depth about 75 km east of the northern part of the Marine Park. This site is on the National Heritage List and a historic shipwreck protected zone. The *Batavia* (wrecked on the adjacent Abrolhos Islands in 1629) Shipwreck Site and Survivor Camps Area are on the National Heritage List.

AMP	Zones, IUCN categories and zone area	Description	Values^
			Social and economic values Tourism, commercial fishing, mining, recreation including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Geographe	National Park Zone (II) 15 km² Habitat Protection Zone (IV) 21 km² Multiple Use Zone (VI) 291 km² Special Purpose Zone (Mining Exclusion) (VI) 650 km²	The Geographe Marine Park is located in Geographe Bay, ~8 km west of Bunbury and 8 km north of Busselton, adjacent to the Western Australian Ngari Capes Marine Park. The Marine Park covers an area of 977 km^2, extending from the Western Australian state water boundary, and a water depth range between 15 m and 70 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Geographe Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the South-west Shelf Province—an area of diverse marine life, influenced by the warm waters of the Leeuwin Current. The bioregion includes globally important biodiversity hotspots, such as the waters off Geographe Bay. Key ecological features of the Marine Park are: • Commonwealth marine environment within and adjacent to Geographe Bay—the sheltered waters of Geographe Bay support extensive seagrass beds that in turn provide important nursery habitat for a range of marine species • Western Rock Lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western Rock Lobsters are an important part of the food web on the inner shelf, particularly as juveniles. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for seabirds, a migratory pathway for Humpback and Pygmy Blue Whales, and a calving buffer area for Southern Right Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Noongar people have responsibility for sea country in the Marine Park. Traditional owners have maintained cultural responsibilities for sea country as passed down from elders, to keep the oceans healthy, to support spiritual wellbeing and to uphold and protect obligatory cultural responsibilities for future generations. The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region.

<table>
<tr><th>AMP</th><th>Zones, IUCN categories and zone area</th><th>Description</th><th>Values^</th></tr>
<tr><td></td><td></td><td></td><td>Heritage values
No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan.
Historic shipwrecks
The Marine Park contains eight known shipwrecks listed under the Historic Shipwrecks Act 1976.
Social and economic values
Tourism, commercial fishing and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.</td></tr>
<tr><td>Jurien</td><td>National Park Zone (II)
31 km²
Special Purpose Zone (VI)
1820 km²</td><td>The Jurien Marine Park is located ~148 km north of Perth and 155 km south of Geraldton, adjacent to the Western Australian Jurien Bay Marine Park. The Marine Park covers an area of 1851 km² of continental shelf, extending from the Western Australian state water boundary, and a water depth range between 15 m and 220 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Jurien Marine Park on 9 October 2017.</td><td>Natural values
The Marine Park includes examples of ecosystems representative of:
• South-west Shelf Transition—consists of a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the bioregion’s western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
Key ecological features of the Marine Park are:
• Ancient coastline between 90 m and 120 m depth—high benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment
• Demersal slope and associated fish communities of the Central Western Province—an area that provides important habitat for demersal fish communities and is characterised by high species diversity and endemism
• Western Rock Lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western Rock Lobsters are an important part of the food web on the inner shelf, particularly as juveniles.
The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for seabirds, Australian Sea Lions, and White Sharks; and a migratory pathway for Humpback and Pygmy Blue Whales.</td></tr>
</table>

AMP	Zones, IUCN categories and zone area	Description	Values^
			Cultural values Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Noongar people have responsibilities for sea country in the Marine Park. Traditional owners have strong stories that connect ocean and land. Artefacts from ancestors are abundant on islands in the adjacent state marine park. The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. Historic shipwrecks The Marine Park contains two known shipwrecks listed under the *Historic Shipwrecks Act 1976— SS Cambewarra* (wrecked in 1914), *Oleander* (wrecked in 1884). **Social and economic values** Tourism, commercial fishing, mining and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Perth Canyon	National Park Zone (II) 1241 km² Habitat Protection Zone (IV) 4352 km² Multiple Use Zone (VI) 1816 km²	The Perth Canyon Marine Park is located ~52 km west of Perth and ~19 km west of Rottnest Island. The Marine Park covers an area of 7409 km² and water depths range between 120 m and 5000 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Perth Canyon Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Province—characterised by a narrow continental slope incised by many submarine canyons, including Perth Canyon, and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are the several eddies that form off the Leeuwin Current at predictable locations, including the Perth Canyon • South-west Shelf Province—marine life in this area is diverse and influenced by the warm waters of the Leeuwin Current • South-west Transition—significant features of this area include the submarine canyons that incise the northern parts of the slope and the deep-water mixing that results from the dynamics of major ocean currents when these meet the sea floor, particularly in the Perth Canyon

AMP	Zones, IUCN categories and zone area	Description	Values^
			• South-west Shelf Transition—consists of a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. Key ecological features of the Marine Park are: • Perth Canyon and adjacent shelf break, and other west coast canyons—unique sea floor features give rise to ecologically important events of localised productivity and aggregations of marine life. The Perth Canyon is prominent among these canyons because of its large size and ecological importance. The upwelling of deep ocean currents in the canyon creates a nutrient-rich cold-water habitat that attracts feeding aggregations of deep-diving mammals, such as Pygmy Blue Whales and large predatory fish that feed on aggregations of small fish, krill, and squid • Demersal slope and associated fish communities of the Central Western Province—an area that provides important habitat for demersal fish communities and is characterised by high species diversity and endemism • Western Rock Lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western Rock Lobsters are an important part of the food web on the inner shelf, particularly as juveniles • Mesoscale eddies—important transporters of nutrients and plankton communities that form at predictable locations off the western and south-western shelf break. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for seabirds, Antarctic Blue, Pygmy Blue, and Sperm Whales; a migratory pathway for Humpback, Antarctic Blue, and Pygmy Blue Whales; and a calving buffer area for Southern Right Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years.

AMP	Zones, IUCN categories and zone area	Description	Values^
			The Swan River traditional owners have responsibilities for sea country in the Marine Park. Traditional owners have maintained cultural responsibilities for sea country as passed down from elders, to keep the oceans healthy, to support spiritual wellbeing and to uphold and protect obligatory cultural responsibilities for future generations. The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. **Social and economic values** Tourism, commercial shipping, commercial fishing, recreation, including fishing, and defence training are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
South-west Corner	National Park Zone (II) 54 841 km² Habitat Protection Zone (IV) 95 088 km² Multiple Use Zone (VI) 106 602 km² Special Purpose Zone (Mining Exclusion) (VI) 9550 km² Special Purpose Zone (VI) 5753 km²	The South-west Corner Marine Park is located adjacent to the Western Australian Ngari Capes Marine Park, covering an extensive offshore area that is closest to Western Australia state waters ~48 km west of Esperance, 73 km west of Albany, and 68 km west of Bunbury, and extends to the edge of Australia's exclusive economic zone. The Marine Park covers an area of 271 833 km² and a water depth range from <15 m to 6400 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed South-	Natural values The Marine Park includes examples of ecosystems representative of: • Southern Province—includes the deepest ocean areas of the Australian EEZ, reaching depths of ~5900 m, and is characterised by a long continental slope incised by numerous, well-developed submarine canyons, and the Diamantina Fracture Zone, a rugged area of deep sea floor comprising seamounts and many ridges and troughs • South-west Transition—the main features of this area are the Naturaliste Plateau, the deepest submarine plateau along Australia's continental margins. The Plateau supports rich and diverse biological communities. Deep-water mixing results from the dynamics of major ocean currents when these meet the sea floor • South-west Shelf Province—marine life in this area is diverse and influenced by the warm waters of the Leeuwin Current. A small upwelling of nutrient-rich water off Cape Mentelle during summer increases productivity locally, attracting aggregations of marine life. Key ecological features of the Marine Park are: • Albany Canyon group and adjacent shelf break—a feature consisting of 32 canyons cut deeply into the steep continental slope. The canyons are

AMP	Zones, IUCN categories and zone area	Description	Values^
		west Corner Marine Park on 9 October 2017.	believed to be associated with small periodic upwellings that enhance productivity and attract aggregations of marine life • Cape Mentelle upwelling—draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope, and onto the inner continental shelf, where it results in phytoplankton blooms at the surface • Diamantina Fracture Zone—a unique sea floor feature consisting of a rugged, deep-water environment of seamounts and many closely spaced troughs and ridges. The ridges and seamounts can affect water dynamics and flow, enhancing productivity, and may act as 'stepping stones' for species dispersal and migration across the region and the wider abyssal plain • Naturaliste Plateau—the combination of this unique sea floor feature's structural complexity, mixed water dynamics, and relative isolation indicate that it supports deep-water communities with high species diversity and endemism • Western Rock Lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western Rock Lobsters are an important part of the food web on the inner shelf, particularly as juveniles • Ancient coastline between 90 m and 120 m depth—high benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for seabirds, Australian Sea Lions, White Sharks, and Sperm Whales; a migratory pathway for Antarctic Blue, Pygmy Blue, and Humpback Whales; and a calving buffer area for Southern Right Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Nyungar/Noongar people have responsibilities for sea country in the Marine Park. Traditional owners have maintained cultural responsibilities for sea country as passed down from elders, to keep the oceans healthy, to support

AMP	Zones, IUCN categories and zone area	Description	Values^
			spiritual wellbeing and to uphold and protect obligatory cultural responsibilities for future generations. The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. Historic shipwrecks The Marine Park contains 10 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Tourism, commercial fishing, commercial shipping, and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Two Rocks	National Park Zone (II) 15 km² Multiple Use Zone (VI) 867 km²	The Two Rocks Marine Park is located 25 km north-west of Perth, to the north-west of the Western Australian Marmion Marine Park. The Marine Park covers an area of 882 km², extending from the Western Australian state water boundary, and a water depth range from 15 m to 120 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Two Rocks Marine Park on 9 October 2017.	Natural values The Marine Park includes examples of ecosystems representative of the South-west Shelf Transition—an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. The inshore lagoons are thought to be important areas for benthic productivity and recruitment for a range of marine species. Key ecological features of the Marine Park are: • Commonwealth marine environment within and adjacent to the west coast inshore lagoons—an area that is regionally important for enhanced benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species • Western Rock Lobster—plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western Rock Lobsters are an important part of the food web on the inner shelf, particularly as juveniles

AMP	Zones, IUCN categories and zone area	Description	Values^
			• Ancient coastline between 90 m and 120 m depth—high benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for seabirds and Australian Sea Lions, a migratory pathway for Humpback and Pygmy Blue Whales, and a calving buffer area for Southern Right Whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Swan River traditional owners have responsibilities for sea country in the Marine Park. Traditional owners have maintained cultural responsibilities for sea country as passed down from elders, to keep the oceans healthy, to support spiritual wellbeing and to uphold and protect obligatory cultural responsibilities for future generations. The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. **Social and economic values** Tourism, commercial fishing, recreation, including fishing, and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

^ *Source: Ref. 68.*

Table 2-21: Summary of AMPs (North Marine Parks)

AMP Name	Zones, IUCN categories and zone area	Description	Values^
Oceanic Shoals	National Park Zone (II) 406 km²	The Oceanic Shoals Marine Park is located west of the Tiwi Islands, ~155 km north-	**Natural Values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Transition— a dynamic environment influenced by strong tidal

AMP Name	Zones, IUCN categories and zone area	Description	Values^
	Habitat Protection Zone (IV) 6929 km² Multiple Use Zone (VI) 39 964 km² Special Purpose Zone (Trawl) (VI) 24 444 km²	west of Darwin, Northern Territory and 305 km north of Wyndham, Western Australia. It extends to the limit of Australia's exclusive economic zone. The Marine Park covers an area of 71 743 km² and water depths from <15 m to 500 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Oceanic Shoals Marine Park on 9 October 2017.	currents, upwellings of nutrient-rich waters, and a range of prominent sea floor features. The pinnacles, carbonate banks, and shoals are sites of enhanced biological productivity. Key ecological features of the Marine Park are: • Carbonate bank and terrace systems of the Van Diemen Rise—an area characterised by terraces, banks, channels, and valleys supporting sponges, soft coral, polychaetes, ascidians, turtles, snakes, and sharks • Carbonate bank and terrace system of the Sahul Shelf—an area characterised by terraces, banks, channels, and valleys, supporting sponges, soft corals, sessile filter feeders, polychaetes, and ascidians • Pinnacles of the Bonaparte Basin—an area that contains the largest concentration of pinnacles along the Australian margin, where local upwellings of nutrient-rich water attract aggregations of fish, seabirds, and turtles • Shelf break and slope of the Arafura Shelf—an area characterised by continental slope, patch reefs, and hard substrate pinnacles that support >280 demersal fish species. The Marine Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging and internesting habitat for marine turtles. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. The Northern Land Council and the Kimberley Land Council are the Native Title Representative Bodies for the Northern Territory's northern region, and the Kimberley region. The Tiwi Land Council collectively represents traditional owners of the Tiwi Islands. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan.

AMP Name	Zones, IUCN categories and zone area	Description	Values^
			Social and economic values Commercial fishing and mining are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.
Joseph Bonaparte Gulf	Multiple Use Zone (VI) 6346 km² Special Purpose Zone (VI) 2251 km²	The Joseph Bonaparte Gulf Marine Park is located ~15 km west of Wadeye, Northern Territory, and ~90 km north of Wyndham, Western Australia, in the Joseph Bonaparte Gulf. It is adjacent to the Western Australian North Kimberley Marine Park. The Marine Park covers an area of 8597 km² and water depth ranges between <15 m and 100 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Joseph Bonaparte Gulf Marine Park on 9 October 2017.	**Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Transition— a dynamic environment influenced by strong tidal currents, monsoonal winds, cyclones, and wind-generated waves. The large tidal ranges and wide intertidal zones near the Marine Park create a physically dynamic and turbid marine environment. The key ecological feature in the Marine Park is the carbonate bank and terrace system of the Sahul Shelf—characterised by terraces, banks, channels, and valleys supporting sponges, soft corals, sessile filter feeders, polychaetes, and ascidians. The Marine Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging habitat for marine turtles and the Australian Snubfin Dolphin. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people have responsibilities for sea country in the Marine Park. They are represented by the following Prescribed Body Corporates: Miriuwung and Gajerrong Aboriginal Corporation, and Balanggarra Aboriginal Corporation. These corporations are the points of contact for their respective areas of sea country in the Marine Park. The Northern Land Council and the Kimberley Land Council are the Native Title Representative Bodies for the Northern Territory's northern region, and the Kimberley region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the West Kimberley National Heritage Place.

AMP Name	Zones, IUCN categories and zone area	Description	Values^
			Social and economic values Tourism, commercial fishing, mining, and recreation including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

^ *Source: Ref. 69.*

Table 2-22: Summary of AMPs (IOT)

AMP	Zones, IUCN categories, and zone area	Description	Values^
Cocos (Keeling) Islands	Habitat Protection Zone (IV) National Park Zone (II)	Cocos (Keeling) Islands Marine Park covers an area of 467,054 km^2 and extends from most of the islands' shoreline to the limit of Australia's EEZ, approximately 200 nm from shore. In 2022, the Cocos (Keeling) Islands Marine Park was established by the Australian Government under the EPBC Act.	**Natural Values** The Cocos (Keeling) Islands are a group of 27 stunning tropical low-lying coral islands surrounded by the clear turquoise waters of the Indian Ocean. The marine environment includes coral, lagoon and deep-sea habitats and species, with several habitats and species of international conservation significance including green turtles and hybrid varieties of reef fish. The location of the Cocos (Keeling) Islands, around 2,750 km north-west of Perth, makes it home to one of Australia's most remote communities. Cocos (Keeling) Islands Marine Park is of international conservation significance, protecting 467,054 km^2 of ocean and seafloor features. It provides habitats for a range of unique, migratory and threatened species in a region of the world where the ocean is facing increased environmental pressures. The marine park also adjoins PKNP, connecting and increasing protections across land and sea for species like seabirds which require both environments for their survival. **Cultural Values** Most of the islands' community members are Cocos Malay, who maintain vibrant and unique cultural traditions including strong cultural connections to the surrounding marine environment. The lagoon and ocean are an important part of life for all community members living on this remote atoll. **Heritage values** The Commonwealth listed heritage areas within the Cocos (Keeling) Islands Marine Park cover both historic and natural sites.

AMP	Zones, IUCN categories, and zone area	Description	Values^
			Historic shipwrecks The Marine Park contains one known shipwreck listed under the *Underwater Cultural Heritage Act 2018*; *SMS Emden*, an Imperial German Navy ship which ran aground in 1914. **Social and economic values** Cocos (Keeling) Islands Marine Park was co-designed with the community as the marine environment is locally important for many social, cultural and economic reasons. The marine park's warm tropical waters are valued by the community for recreational and subsistence fishing and other activities like boating, diving, snorkelling, kite surfing and kayaking. It is also a major attraction for visitors which helps to support and promote the local tourism industry. Additionally, the unique marine environment of Cocos (Keeling) Islands means there is potential for increasing scientific study and educational activities in the area..
Christmas Island	Habitat Protection Zone (IV) National Park Zone (II)	Christmas Island Marine Park covers an area of 277,016 km^2 and extends from the island's shoreline to the limit of Australia's EEZ, approximately 200 nm from shore. In 2022, the Christmas Island Marine Park was established by the Australian Government under the EPBC Act.	**Natural Values** Christmas Island rises sharply from the deep surrounding tropical waters of the Indian Ocean to a height of 361 m. It is often referred to as a natural wonder due to its stunning and significant natural environment, which includes rainforests, surrounding clear azure waters and marine and terrestrial habitats and species of international conservation significance. The location of Christmas Island, around 2,600 km north-west of Perth makes Christmas Island one of Australia's most remote communities. Christmas Island Marine Park is of international conservation significance, protecting 277,016 km^2 of ocean and seafloor features. It provides habitats for a range of unique, migratory and threatened species in a region of the world where the ocean is facing increased environmental pressures. The marine park adjoins Christmas Island National Park, connecting and increasing protections across land and sea for species like seabirds which require both environments for their survival. **Cultural Values** The ocean is a centrepiece of life for many community members, including those of Malay and Chinese heritage who maintain strong cultural traditions and connections to the surrounding marine environment.

AMP	Zones, IUCN categories, and zone area	Description	Values^
			Heritage values There are commonwealth heritage listed sites within the Christmas Island marine park. **Historic shipwrecks** There are no listed underwater cultural heritage shipwrecks within the Christmas Island marine park. **Social and economic values** Christmas Island Marine Park was co-designed with the local community as the marine environment is important for many social, cultural and economic reasons. The park's clear and warm topical waters are valued by the community for commercial, recreational and subsistence fishing and other activities like boating, diving and snorkelling. It is also an attraction for many visitors which helps to support and promote the local tourism industry. Additionally, the unique marine environment of Christmas Island means there is potential for increasing scientific study and educational activities in the area.

^ Source: Ref. 103; Ref. 104.

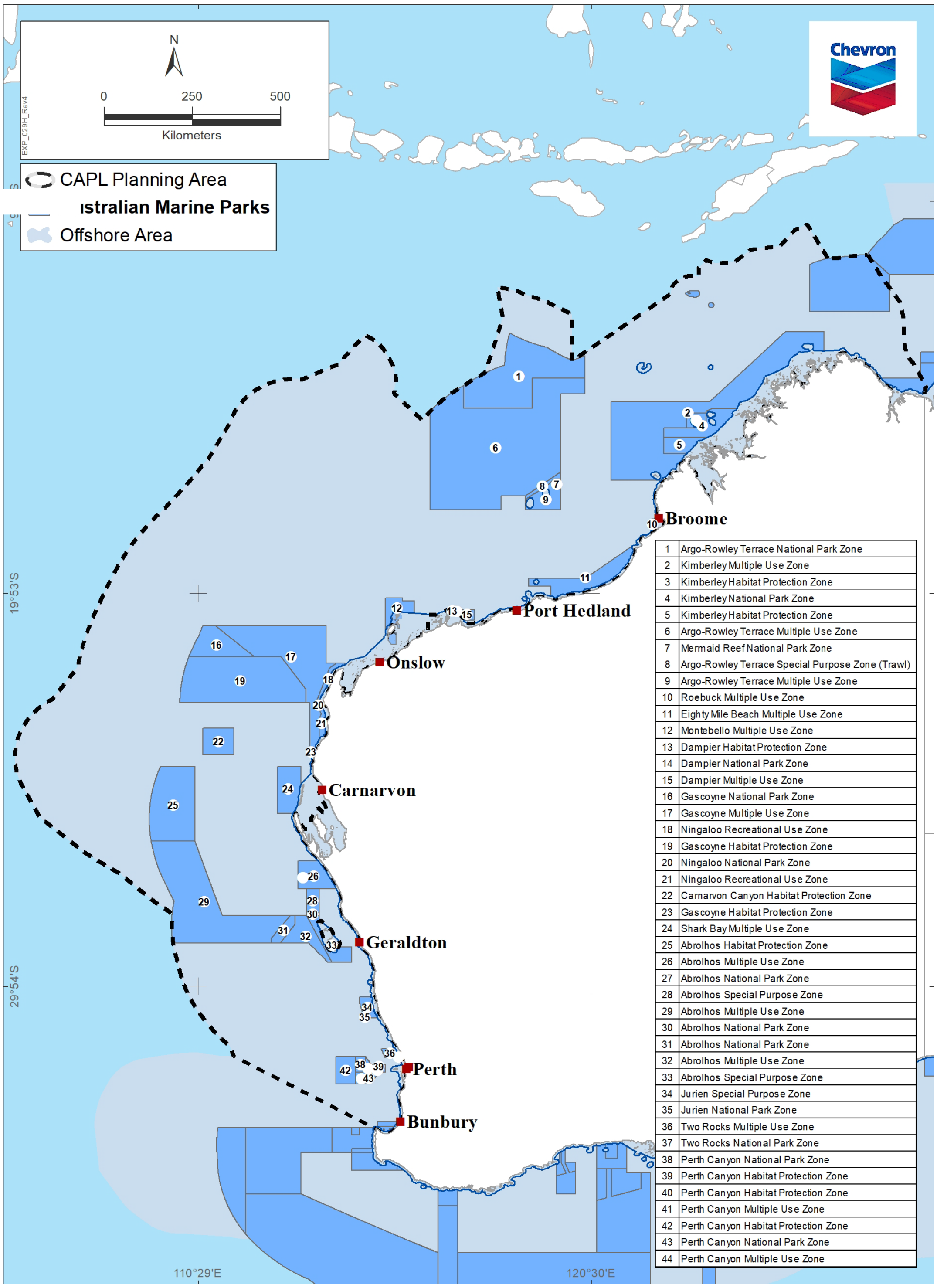
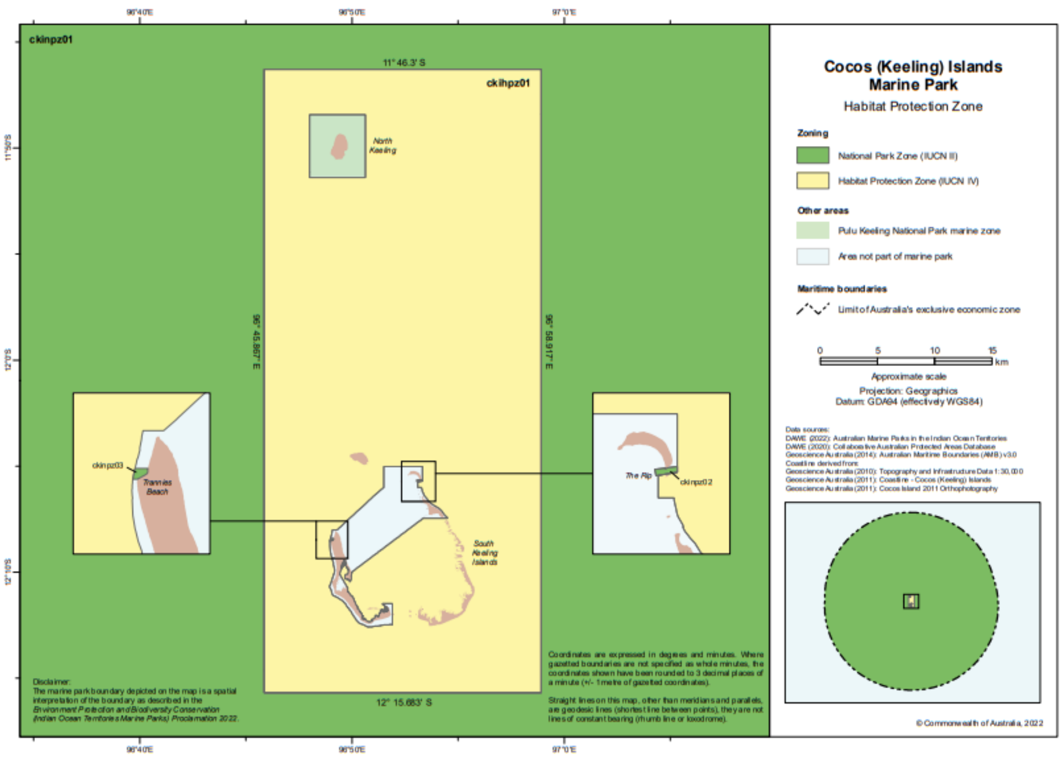
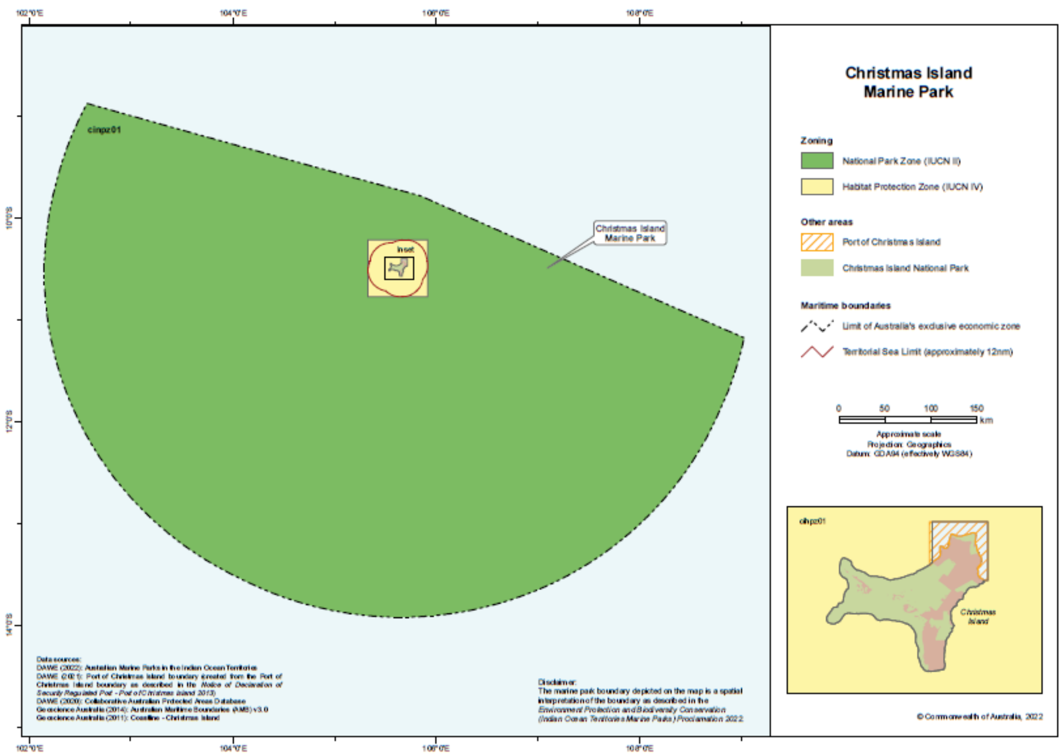


Figure 2-8: Australian Marine Parks



Source: Ref. 104

Figure 2-9: Cocos (Keeling) Islands Marine Park (and zoning)



Source: Ref. 103

Figure 2-10: Christmas Island Marine Park (and zoning)

2.6.2 Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for a region's biodiversity or its ecosystem function and integrity (Ref. 70). KEFs meet one or more of these criteria:

- a species, group of species, or a community with a regionally important ecological role (e.g. a predator, or prey that affects a large biomass or number of other marine species)
- a species, group of species, or a community that is nationally or regionally important for biodiversity
- an area or habitat that is nationally or regionally important for:
  - enhanced or high productivity (such as predictable upwellings—an upwelling occurs when cold nutrient-rich waters from the bottom of the ocean rise to the surface)
  - aggregations of marine life (such as feeding, resting, breeding or nursery areas)
  - biodiversity and endemism (species that only occur in a specific area)
- a unique sea floor feature, with known or presumed ecological properties of regional significance.

KEFs have been identified by the Australian Government on the basis of advice from scientists about the ecological processes and characteristics of the area.

Table 2-23, Table 2-24, and Table 2-25 summarises the values of the KEFs within the north-west, south-west, and north marine bioregions present within the PA.

To assist with planning and future management of new marine parks in Australia's IOT, Parks Australia and Museums Victoria are currently identifying potential BIAs and KEFs (Ref. 96). Where these potential KEFs intersect with the PA, a summary has been provided in Table 2-26.

Table 2-23: Key ecological features of the North-west Marine Bioregion

KEF	Value	Description^
Ancient coastline at 125 m depth contour	Unique sea floor feature with ecological properties of regional significance	Parts of the ancient coastline, particularly where it exists as a rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column, providing relatively nutrient-rich local environments.
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	High productivity and aggregations of marine life	Ashmore Reef is the largest of only three emergent oceanic reefs present in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of birds and other marine life; they are areas of enhanced primary productivity in an otherwise low-nutrient environment. Ashmore Reef supports the highest number of coral species of any reef off the west Australian coast.

KEF	Value	Description^
Canyons linking the Argo Abyssal Plain with the Scott Plateau	High productivity and aggregations of marine life	The canyons linking the Argo Abyssal Plain and Scott Plateau are important features likely to be associated with aggregations of marine life.
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Unique sea floor features with ecological properties of regional significance	The canyons are associated with upwelling as they channel deep water from the Cuvier Abyssal Plain up onto the slope. This nutrient-rich water interacts with the Leeuwin Current at the canyon heads. Aggregations of Whale Sharks, manta rays, sea snakes, sharks, large predatory fish, and seabirds are known to occur in this area.
Carbonate bank and terrace system of the Sahul Shelf	Unique sea floor feature with ecological properties of regional significance	Little is known about the bank and terrace system of the Sahul Shelf, but it is regionally important because of its likely ecological role in enhancing biodiversity and local productivity relative to its surrounds. The banks are thought to support a high diversity of organisms (including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians, and other sessile filter feeders). The banks are known to be foraging areas for Loggerhead, Olive Ridley, and Flatback Turtles. Cetaceans and Green and Freshwater Sawfish are likely to occur in the area.
Commonwealth waters adjacent to Ningaloo Reef	High productivity and aggregations of marine life	The Leeuwin and Ningaloo currents interact, leading to areas of enhanced productivity in the Commonwealth waters adjacent to Ningaloo Reef. Aggregations of Whale Sharks, manta rays, Humpback Whales, sea snakes, sharks, large predatory fish, and seabirds are known to occur in this area.
Continental Slope Demersal Fish Communities	High levels of endemism	The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition, and the Northwest Province is high compared to elsewhere along the continental slope.
Exmouth Plateau	Unique sea floor feature with ecological properties of regional significance	The Exmouth Plateau is a regionally and nationally unique deep-sea plateau in tropical waters. The plateau is a very large topographic obstacle that may modify the flow of deep waters, generating internal tides and may contribute to upwelling of deeper water nutrients closer to the surface, thus serving an important ecological role.
Glomar Shoals	High productivity and aggregations of marine life	The Glomar Shoals are regionally important for their high biological diversity and high localised productivity. Biological data specific to Glomar Shoals is limited; however, the fish of Glomar Shoals are probably a subset of reef-dependent species and anecdotal and fishing industry evidence suggests they are particularly abundant.
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	High productivity and aggregations of marine life	The reefs of the Rowley Shoals (including Mermaid Reef) are areas of enhanced productivity and high species richness. Enhanced productivity that contributes to this species richness is thought to be facilitated by the breaking of internal waves in the waters surrounding the reefs, causing mixing and resuspension of nutrients from water depths of 500–700 m into the photic zone. The steep changes in slope around the reef also attract a

KEF	Value	Description^
		range of migratory pelagic species such as dolphins, tuna, billfish, and sharks.
Pinnacles of the Bonaparte Basin	Unique sea floor feature with ecological properties of regional significance	As they provide areas of hard substrate in an otherwise relatively featureless environment, the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required. Covering >520 km^2 within the Bonaparte Basin, this feature contains the largest concentration of pinnacles along the Australian margin. The pinnacles of the Bonaparte Basin are thought to be the eroded remnants of underlying strata; it is likely that the vertical walls generate local upwelling of nutrient-rich water, leading to phytoplankton productivity that attracts aggregations of planktivorous and predatory fish, seabirds, and foraging turtles.
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	High productivity and aggregations of marine life	Seringapatam Reef and the Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity, and high species richness associated with the reefs themselves. As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.
Wallaby Saddle	High productivity and aggregations of marine life	The Wallaby Saddle may be an area of enhanced productivity. Historical whaling records provide evidence of Sperm Whale aggregations in the area of the Wallaby Saddle, possibly due to the enhanced productivity of the area and aggregations of baitfish.

^ Source: Ref. 71.

Table 2-24: Key ecological features of the North Marine Bioregion

KEF	Value	Description^
Carbonate bank and terrace system of the Van Diemen Rise	Unique sea floor feature with ecological properties of regional significance	The bank and terrace system of the Van Diemen Rise is part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east; it is characterised by terrace, banks, channels, and valleys. The variability in water depth and substrate composition may contribute to the presence of unique ecosystems in the channels. Species present include sponges, soft corals, and other sessile filter feeders associated with hard substrate sediments of the deep channels; epifauna and infauna include polychaetes and ascidians. Olive Ridley Turtles, sea snakes, and sharks are also found associated with this feature.
Pinnacles of the Bonaparte Basin	Unique sea floor feature with ecological properties of regional significance	As they provide areas of hard substrate in an otherwise relatively featureless environment, the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required. Covering >520 km^2 within the Bonaparte Basin, this feature contains the largest concentration of pinnacles along the Australian margin. The pinnacles of the Bonaparte Basin are thought to be the eroded remnants of underlying strata; it is likely that the vertical walls

KEF	Value	Description^
		generate local upwelling of nutrient-rich water, leading to phytoplankton productivity that attracts aggregations of planktivorous and predatory fish, seabirds, and foraging turtles.

^ *Source: Ref. 72.*

Table 2-25: Key ecological features of the South-west Marine Bioregion

KEF	Value	Description^
Ancient coastline at 90–120 m depth	Relatively high productivity and aggregations of marine life, and high levels of biodiversity and endemism	Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment, such as in the western Great Australian Bight, where the sea floor is dominated by sponge communities of significant biodiversity and structural complexity.
Cape Mentelle upwelling	High productivity and aggregations of marine life	The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope, and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins, and sharks.
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	High levels of biodiversity and endemism	The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean. They support more than one million pairs of breeding seabirds.
Commonwealth marine environment within and adjacent to Geographe Bay	High productivity and aggregations of marine life, and high levels of biodiversity and endemism	Geographe Bay is known for its extensive beds of tropical and temperate seagrass that support a diversity of species, many of them not found anywhere else. The bay provides important nursery habitat for many species. It is also an important migratory area for Humpback Whales.
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	High productivity and aggregations of marine life	These lagoons are important for benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fishery species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor, and Australian Salmon.
Naturaliste Plateau	Unique sea floor feature with ecological properties of regional significance	The Naturaliste Plateau is Australia's deepest temperate marginal plateau. The combination of its structural complexity, mixed water dynamics, and relative isolation indicate that it supports deep-water communities with high species diversity and endemism.
Meso-scale eddies (several locations)	High productivity and aggregations of marine life	Driven by interactions between currents and bathymetry, persistent meso-scale eddies form in predictable locations within the meanders of the Leeuwin Current. They are important transporters

KEF	Value	Description^
		of nutrients and plankton communities and are likely to attract a range of organisms from the higher trophic levels, such as marine mammals, seabirds, tuna and billfish. The eddies play a critical role in determining species distribution, as they influence the southerly range boundaries of tropical and subtropical species, the transport of coastal phytoplankton communities offshore and recruitment to fisheries.
Perth Canyon and adjacent shelf break, and other west coast canyons	High biological productivity and aggregations of marine life, and unique sea floor features with ecological properties of regional significance	The Perth Canyon is the largest known undersea canyon in Australian waters. Deep ocean currents rise to the surface, creating a nutrient-rich cold-water habitat attracting feeding aggregations of deep-diving mammals, such as Pygmy Blue Whales and large predatory fish that feed on aggregations of small fish, krill, and squid.
Western demersal slope and associated fish communities	Species groups that are nationally or regionally important to biodiversity	The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish, and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits.
Western Rock Lobster	A species that plays a regionally important ecological role	This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles.

^ *Source: Ref. 73.*

Table 2-26: Proposed key ecological features of the IOT

KEF	Value	Description^
Cocos (Keeling) Seamount	Unique seamount and depth zones, faunal composition unique to Australian marine domain, IOT and EEZ.	The Cocos (Keeling) Islands is of national importance for biodiversity and endemism. The Islands sits on top of a large seamount with a base diameter of ~70 km. Upper seamount is biologically important to pelagic fish, seabirds, marine mammals' species and some deep water fish species detected in shallow water. Differences in proximity to landmasses, net primary productivity of seawater, environment history and migration history will likely result in unique biological assemblage on this feature. Very rare mesophotic and upper bathyal depth zones within IOT and EEZ, mid bathyal layer is also very rare (< 2,041 km^2).
Christmas Hadal (Christmas Island)	The Hadal (below 6,000 m) plains and seafloor are some	The Christmas Hadal is of national importance for biodiversity and endemism of the region, with specialist fauna known to occur. Fauna within this

KEF	Value	Description^
	of the deepest seafloors in the Australian EEZ and forms 93.2% of this habitat in the EEZ.	zone have adapted through time to survive the extreme pressures, cold and lack of organic matter in this zone. The Christmas Hadal is one of deepest points across the entire Australian marine domain and likely shares species that inhabit the deep Sunda Trench in Indonesia's EEZ.
Christmas Hard Plains (Christmas Island)	Manganese nodules are scare rocky substrates on the mostly sedimentary abyssal plain and support distinctive specialised fauna.	Christmas Island hard plains is of regional importance for biodiversity and endemism. Manganese nodules occur between seamounts in siliceous sediments that form from beneath lysocline (3,800 m deep) in water that dissolves particles of calcareous origin. They provide a variety of geochemical processes and influence the composition on the benthos. Density of these nodules will affect the community composition and biomass. The Ulrike seamount is also within this region rising at 5,800 m between 200-2600 m deep.
Christmas Island Seamount	Unique seamount and depth zones. Faunal composition unique in Australian marine domain, IOT and EEZ.	Christmas Island sits above a massive volcanic seamount covered in shallow water and bathyal communities that evolved over time. Differences in proximity to landmasses, net primary productivity of seawater, environment history and migration history will likely result in unique biological assemblage on this feature. The sublittoral habitat (30-200 m depth) is likely to be biologically important for pelagic fish, seabirds and marine mammal species. Very rare mesophotic and upper bathyal depth zones within IOT and EEZ, mid bathyal layer is also very rare
Golden Bo'sunbird Seamount (Christmas Island)	Mid-bathyal (1,000–2,000 m) benthic / demersal habitats occurring on seamount summits contain rare benthic habitats at these depths within Indian Ocean. Biologically unique community	The Golden Bo'sunbird seamount is a cluster of national importance for biodiversity and endemism. The cluster of seamounts is in a relatively productive region, and influenced by currents and flows, which assist in the mixing and vertical transport of nutrients. Potential unique biogeographic mix of tropical and subtropical Indian ocean species with distinct communities dependent on migration and environmental history. The seamounts also play an important role in pelagic ecosystems.
Investigator Ridge (Cocos (Keeling) Islands)	The ridge is lined with flanks and summits that are expected to support large areas of rocky substrata in IOT between 2,500–4,000 m deep.	The Central Investigator Ridge of regional importance for biodiversity and endemism and occurs along the north to south fault zone in the ocean crust of the Wharton Basin. This habitat would support a specialised epifauna that has adapted to living on bare rock surfaces.
Muirfield Seamount (Cocos (Keeling) Islands)	Unique Seamount within IOT and EEZ. Ecologically significant habitats. National importance for biodiversity and endemism.	Muirfield is the shallowest seamount in Australia's IOT, with its summit lying ~16 m below sea-level. It is one of three features within the IOT with seafloor habitat between 30–1,000 m deep and is the tallest seamount in Australian waters rising ~4,000 m from the abyssal plain. Due to its height and location the biological community of the seamount is expected to be of international significance.

KEF	Value	Description^
Raitt Rise Seamounts (Cocos (Keeling) Islands)	Mid-Bathyal seamount (1,000–2,000 m) with benthic demersal habitat on seamount summit. Distinct biological community.	The Raitt Rise Seamount is a chain and is of regional importance for biodiversity and endemism. The summit is between 1000-2000 m deep which is influenced by currents and circulation flows, and in theory should have a unique biogeographic mix of tropical and subtropical Indian Ocean species. Science deficient on demersal fish dynamics on the Raitt Rise.

^ *Source: Ref. 96.*

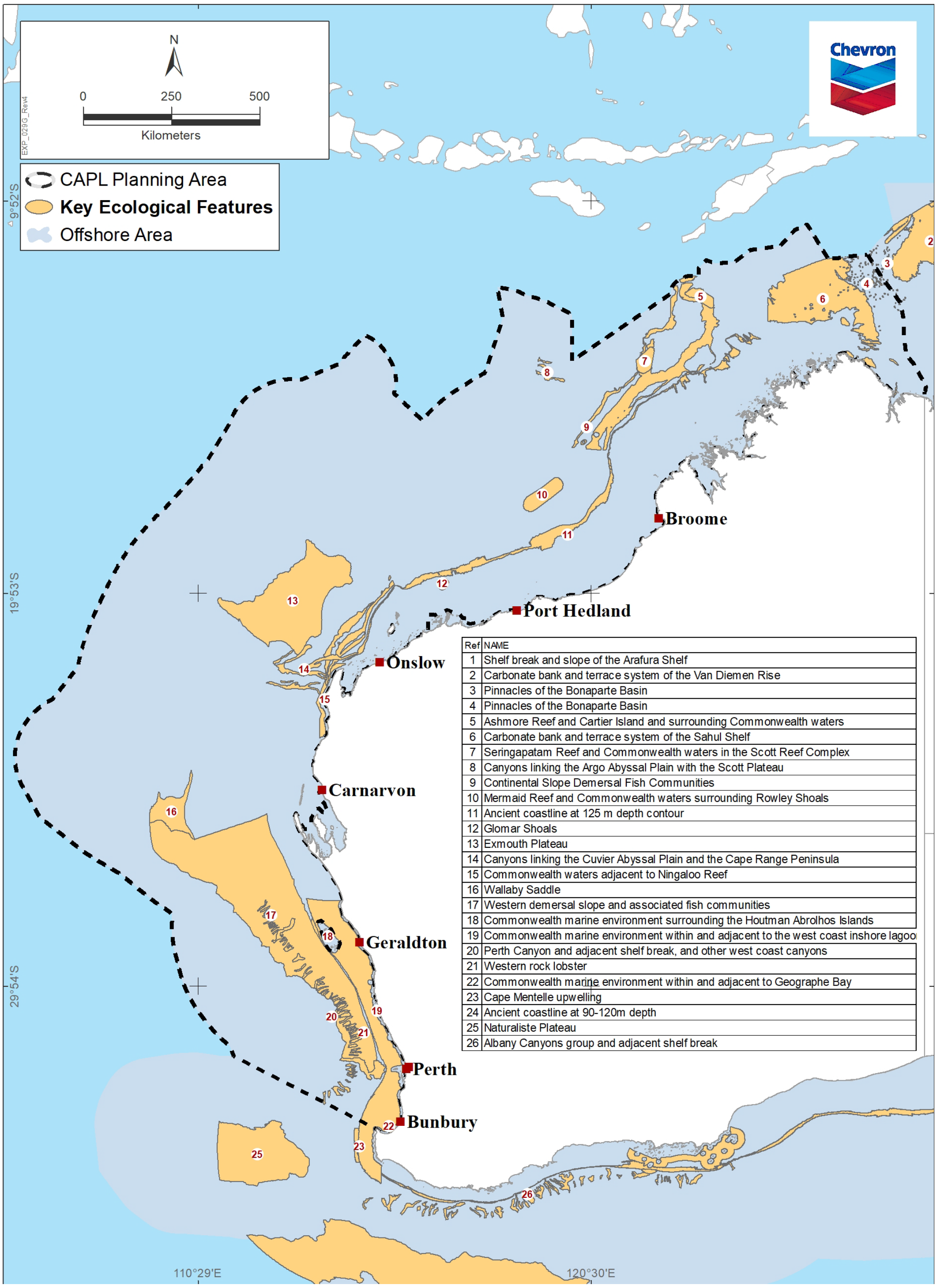
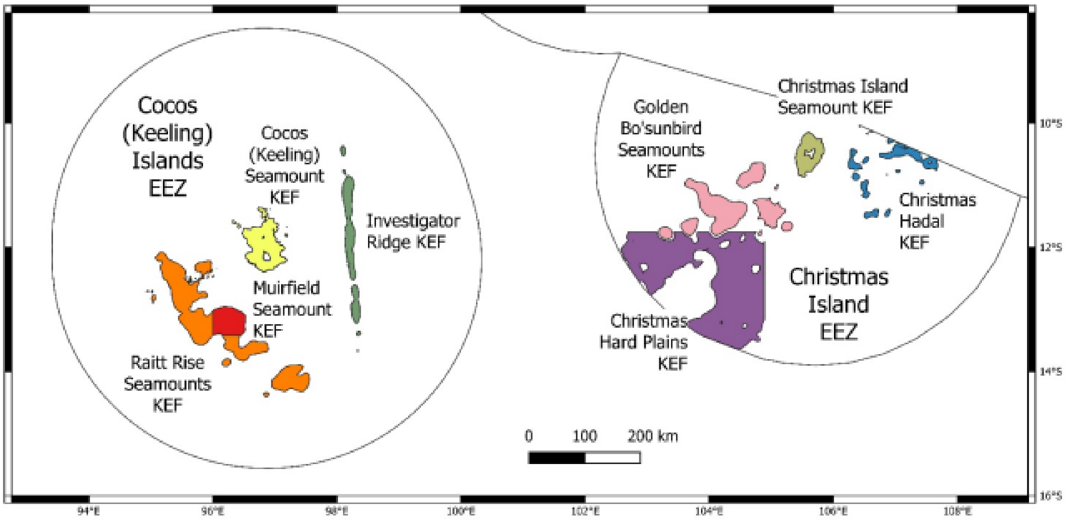


Figure 2-11: Key ecological features



Source: Ref. 96

Figure 2-12: Proposed key ecological features in Australia's Indian Ocean Territories

2.7 Commonwealth land area

While not an MNES, Commonwealth land is also protected under the EPBC Act, and is a particular value and sensitivity under the OPGGS(E)R. Commonwealth land includes land owned or leased by the Commonwealth or a Commonwealth agency, land in the Jervis Bay Territory, land in the Christmas Island, Ashmore and Cartier Islands, Coral Sea Islands, Cocos (Keeling) Islands, Australian Antarctic territory and Heard and McDonald Islands external territories, and any other area of land that is included in a Commonwealth reserve.

Based on searches of the online PMST (Ref. 109, appendix a), the named Commonwealth land areas within the PA are listed in Table 2-27. The full list of Commonwealth land areas identified from the PMST is provided in appendix a.

Maritime military firing practice and exercise areas have been identified extending into waters around:

- Dampier Peninsula (Derby)
- North West Cape (Learmonth)
- South-western Australia (Perth and Lancelin) (Ref. 126).

Table 2-27: Commonwealth land areas

Commonwealth Land Name	Land ID
Environment and Heritage	
Commonwealth Land - Christmas Island National Park	94101 94102 94103 94104 94105
Commonwealth Land - Pulu Keeling National Park	95001 95002

Commonwealth Land Name	Land ID
Defence	
Artillery Barracks – Fremantle^	50155
Broome Training Depot^	50141
Bunbury Training Depot^	50142
Campbell Barracks – Swanbourne	50181 50182 50183 50184 50185 50186 50187
Exmouth Admin & HF Transmitting^	50124 50125 50126 50127 50128 50129
Exmouth Naval HF Receiving Station (H/F Receiving Station, Learmonth, WA)^	50130
Exmouth VLF Transmitter Station	50122 50123
Geraldton Training Depot "A" Company 16th Battalion^	50195 50196 50197
Greenough Rifle Range^	50234
HMAS Stirling-Rockingham; *HMAS Stirling* - Garden Island	50117 50131 50132 50133 50134
Lancelin Training Area	50120 50121
Learmonth - Air Weapons Range	50193
Learmonth RAAF Base	50096 50097 50098 50099 50100 50101 50102 50103 50104 50105 50106 50107 50108

Commonwealth Land Name	Land ID
	50109
Learmonth Radar Site - Twin Tanks Exmouth^	50002
Learmonth Radar Site – Vlaming Head Exmouth^	50001
Learmonth Transmitting Station^	50239
Norforce Depot – Derby^	50144
RAAF Base Curtin	50113
Rockingham - Navy CPSO^	50135
Swanbourne Rifle Range^	50188 50191
Yampi Sound Training Area	50145

^ Commonwealth land identified in the Protected Matters Search Report but not expected to be exposed to CAPL's activities (as located inland).

3 physical environment

3.1 Meteorology

Northwest WA is characterised by an arid, subtropical climate. In summer (between September and March), average daily temperatures range from 21 °C to 36 °C. During winter (May to July), mean daily temperatures range from 14 °C to 29 °C (Ref. 74; Ref. 75). April and August are considered transitional months during which either the summer or winter weather regime may dominate, or conditions may vary between the two (Ref. 75). The area receives relatively low rainfall, although heavy downpours can occur during tropical cyclones and depressions.

Wind patterns in north-west WA are dictated by the seasonal movement of atmospheric pressure systems. During summer, high-pressure cells produce prevailing winds from the north-west and south-west, which vary between 10 and 13 ms-1. During winter, high-pressure cells over central Australia produce north-easterly to south-easterly winds with average speeds of between 6 and 8 ms-1.

The cyclone season in north-west WA runs from November to April, with an average of five tropical cyclones per year (Ref. 76). Summer thunderstorms can have associated winds with gusts exceeding 20 ms^{-1}, but these winds are usually of short duration.

The air quality in the North-west Marine Region is largely unpolluted due to the Region’s relative remoteness.

The Cocos (Keeling) Islands and Christmas Island are part of Australia’s IOT and are located at the southern edge of the equatorial low-pressure belt (between 0 to 5o north or south of equator) (Ref. 100) resulting in intense heat in a humid tropical zone. Monsoons occur between January to May but are controlled by oceanic conditions, most of the year consists of south-east trade winds with annual rainfall varying between ~800 and ~3000 mm with average of ~2000 pa, the average maximum temperature is 28.9 °C and average minimum being 22.2 °C (Ref. 101; Ref. 102).

3.2 Oceanography

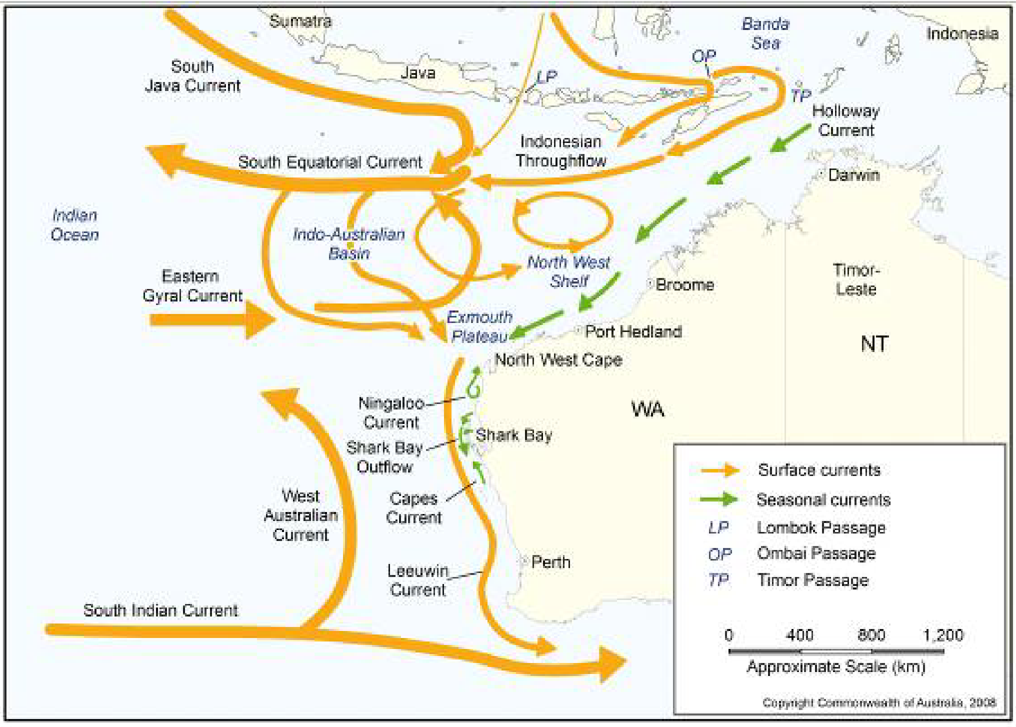
3.2.1 Water temperature

Waters in north-west WA are tropical year-round, with sea surface temperature in open shelf waters reaching ~26 °C in summer, and dropping to ~22 °C in winter. Nearshore temperatures of north-west WA fluctuate through a higher temperature range from ~17 °C in winter to ~31 °C in summer (Ref. 77).

3.2.2 Circulation and currents

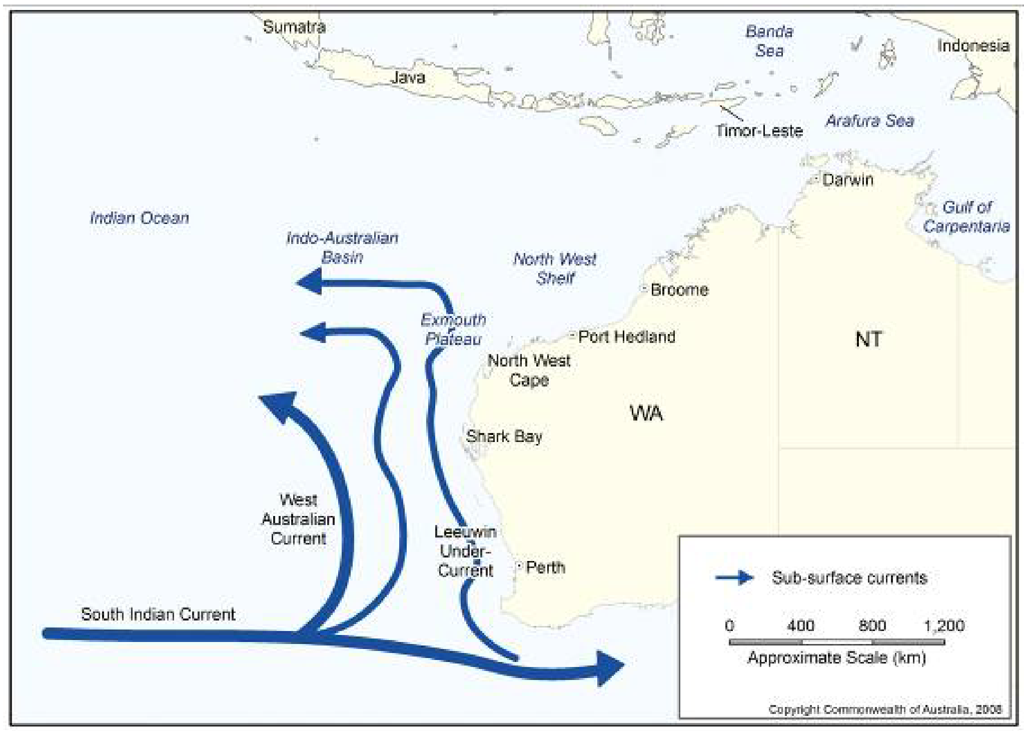
The major surface currents influencing north-west WA flow towards the poles and include the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current, and the Eastern Gyral Current. The Ningaloo Current, the Holloway Current, the Shark Bay Outflow, and the Capes Current are seasonal surface currents in the region. Below these surface currents are several subsurface currents, the most important of which are the Leeuwin Undercurrent and the West Australian Current. These subsurface currents flow towards the equator in the opposite direction to surface currents (Ref. 71). Figure 3-1 and Figure 3-2 show the main surface and subsurface currents in north-west WA.

Water circulation in north-west WA is strongly influenced by the southward-flowing Indonesian Throughflow. The strength of the Throughflow, and its influence in north-west WA, varies seasonally in association with the north-west monsoon (Ref. 71).



(Source: Ref. 71)

Figure 3-1: Surface and seasonal currents in the region



(Source: Ref. 71)

Figure 3-2: Subsurface currents in the region

3.2.3 Waves

The prevailing oceanic conditions in north-west WA are governed by a combination of sea and swell waves. Local wind-generated seas have variable wave heights, typically ranging from 0 to 4 m under non-tropical cyclone conditions. North-west WA typically experiences a persistent winter swell of ~2 m, generated by low-pressure systems in southern latitudes.

3.2.4 Tides

North-west WA has some of the largest tides along a coastline adjoining an open ocean in the world. Tides increase in amplitude from south to north, corresponding with the increasing width of the continental shelf (Ref. 71). Tidal movements are larger and stronger in the nearshore waters compared to the offshore waters. Tides in the region are broadly categorised as semidiurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle (Ref. 71).

3.3 Marine water quality

3.3.1 Nutrients

North-west WA's surface waters are nutrient-poor due to the Indonesian Throughflow dominating the surface waters of the entire region.

Sporadic and variable nutrient loadings may occur within coastal waters due to changes in river run-off (e.g. Ashburton River), blooms of nitrogen-fixing microbes, tidal mixing, low-frequency circulation, and habitat influences (i.e. mangroves) (Ref. 78).

3.3.2 Turbidity

Water clarity in north-west WA varies according to water movement, depth, and seabed sediment type. Nearshore waters in the region may be relatively turbid as a result of local current-induced resuspension of fine sediments and episodic run-off from adjacent rivers, although there is high spatial and temporal variation. However, some protected coastal areas, such as the lagoon system of the fringing Ningaloo Reef, can be characterised by relatively clear water with low turbidity.

3.3.3 Water chemistry

Salinity varies spatially and temporally in the waters across north-west WA. Water salinity varies between 34.4 and 36.3 g/L in offshore waters around the North West Shelf (Ref. 79).

Wenziker et al. (Ref. 79) estimated natural background concentrations for a range of potential contaminants in the waters around the Dampier Archipelago, thus providing baseline information as to the water quality within nearshore waters of the North West Shelf. The contaminants investigated encompassed a range of heavy metals (e.g. cadmium, chromium, copper, lead, mercury, and zinc) and organic chemicals (e.g. polycyclic aromatic hydrocarbons, total petroleum hydrocarbons). The survey identified low background concentrations of metals and organic chemicals, with localised elevations of some contaminants (metals) near the coastal industrial centres and ports (e.g. Dampier). Except for a few select constituents, such as relatively high natural levels of cadmium, the concentrations of metals were low by world standards. Wenziker et al. (Ref. 79) recommended that guideline water quality trigger values from the Australian and

New Zealand Guidelines for Fresh and Marine Water Quality (Ref. 80) are suitable for use in the North West Shelf.

3.3.4 Marine geomorphology

The sea floor of north-west WA comprises four general feature types: continental shelf, continental slope, continental rise, and abyssal plain. Most of the region is either continental slope or continental shelf.

3.4 Seabed features

The geomorphology of Australia's continental margin is varied, with several geomorphic features present, including basins, canyons, terraces, seamounts, ridges, and plateaus. The key geomorphic features (Ref. 81; Ref. 96) that were mapped as potentially occurring within the PA, are:

- abyssal plain/deep ocean floor
- apron/fan
- bank/shoals
- basin
- canyon
- hadal plain.

3.5 Marine habitat

The Seamap Australia spatial data layer is a nationally synthesised data product of sea floor marine habitat data (Ref. 82). Australian continental shelf benthic habitat layers in GIS format were collected from various stakeholders around the country, compiled and reviewed by Australian National Data Service and external independent assessors, to produce a national classification of marine habitats.

Seamap Australia spatial data were used to indicate the types of marine habitat present within the PA. Table 3-1 summarises the areas of marine habitat associated with the MNES identified in this document.

Table 3-1: Marine habitat and key sensitivities

Matter of national environmental significance	Key sensitivities							Habitat type				
	AMP	KEF	Ramsar wetland	National Heritage	Commonwealth Heritage	World Heritage	TEC	Seagrass	Mangrove	Coral	Saltmarsh	Macroalgae
Ashmore Reef	✓							✓		✓		
Ashmore Reef and Cartier Island and surrounding Commonwealth waters		✓								✓		
Ashmore reef National Nature Reserve			✓							✓		

Matter of national environmental significance	Key sensitivities							Habitat type				
	AMP	KEF	Ramsar wetland	National Heritage	Commonwealth Heritage	World Heritage	TEC	Seagrass	Mangrove	Coral	Saltmarsh	Macroalgae
Ashmore Reef National Nature Reserve					✓					✓		
Carbonate bank and terrace system of the Sahul Shelf		✓								✓		
Carbonate bank and terrace system of the Van Diemen Rise		✓								✓		
Cartier Island	✓							✓		✓		
Cocos (Keeling) Islands	✓		✓		✓			✓	✓	✓		
Commonwealth marine environment in and adjacent to Geographe Bay		✓						✓				
Commonwealth marine environment in and adjacent to the west coast inshore lagoons		✓						✓				✓
Christmas Island	✓		✓		✓			✓	✓	✓		
Eighty-mile Beach			✓						✓		✓	
Geographe	✓							✓				
Joseph Bonaparte Gulf	✓									✓		
Mermaid Reef – Rowley Shoals					✓					✓		
Ningaloo Coast				✓						✓		
Ningaloo Coast						✓			✓	✓		
Ningaloo Marine Area – Commonwealth Waters					✓					✓		
Oceanic Shoals	✓									✓		
Ord River Floodplain			✓						✓		✓	
Roebuck Bay			✓					✓	✓			
Scott Reef and Surrounds – Commonwealth Area					✓			✓		✓		
Shark Bay						✓		✓				
Shark Bay (Wooramel Seagrass Bank)				✓				✓				

Matter of national environmental significance	Key sensitivities							Habitat type				
	AMP	KEF	Ramsar wetland	National Heritage	Commonwealth Heritage	World Heritage	TEC	Seagrass	Mangrove	Coral	Saltmarsh	Macroalgae
Subtropical and Temperate Coastal Saltmarsh							✓				✓	
The West Kimberley				✓					✓	✓		
Thrombolite (microbial) community of coastal freshwater lakes of the Swan Coastal Plain (Lake Richmond)							✓					✓
Two Rocks	✓							✓				✓

3.6 Shoreline type

The Smartline Coastal Geomorphic Map of Australia (Ref. 83) is a detailed map of the coastal landform types—or geomorphology—of continental Australia and most of its adjacent islands. Using the intertidal classifications provided by the Smartline database, the types of shoreline that are present within the PA, their overall length, and percentage present in the PA is listed in Table 3-2. Note, this dataset does not include the IOT shorelines.

Table 3-2: Shoreline type and length within PA

Shoreline type	Length (100 kms)
Unclassified	4608.46
Muddy tidal flats	2162.74
Hard bedrock shore	2151.61
Tidal flats (sediment undifferentiated)	1811.23
Sandy beach undifferentiated	966.09
Fine-medium sand beach	400.78
Hard rock cliff (>5 m)	248.45
Tidal sediment flats (inferred from mangroves)	192.49
Beach (sediment type undifferentiated)	161.49
Fine-medium sandy tidal flats	137.94
Sandy shore undifferentiated	102.32
Sandy tidal flats	68.28
Mixed sandy shore undifferentiated	37.96
Hard rocky shore platform	21.59
Artificial shoreline undifferentiated	13.87

Shoreline type	Length (100 kms)
Rocky shore (undifferentiated)	8.84
Boulder revetment	6.98
Sandy tidal flats with coarse stony debris	3.87
Perched sandy beach (undifferentiated)	2.81
Soft ‘bedrock’ shore	0.39
Concrete dock structures	0.23
Coral shingle beach	0.21

4 socioeconomic environment

4.1 Commercial shipping

The Australian Maritime Safety Authority (AMSA) uses a satellite automatic identification system (AIS) service that provides AIS data across the Indo-Pacific and Indonesian region. The AIS can send and receive ship information (such as identity, position, course, speed, ship particulars, and cargo information) to and from other ships, suitably equipped aircraft, and shore. It can handle >2,000 reports per minute and updates information as often as every two seconds. Although the AIS is conventionally a line-of-sight radio broadcast system for communication between ships, and between ships and shore stations, recent technological developments have seen satellites adapted for receiving AIS messages from low Earth orbit.

Given the size of the PA, CAPL has reviewed this AIS shipping density information to understand areas within the PA that comprise high activity and are important for the WA economy. Based on this data, the key shipping channels are those between:

- Fremantle, Dampier, and Port Hedland ports to Indonesia
- Fremantle, Dampier, and Port Hedland ports to Timor
- Port of Dampier to various offshore oil and gas developments.

The AIS data also reflects the vessel density in and around known oil and gas facilities and developments within the PA.

4.2 Commercial fishing and aquaculture

Fishing and aquaculture activities are managed under various State and Commonwealth agencies. Table 4-1 and Table 4-2 list and summarise the State and Commonwealth managed fisheries that overlap the PA (Ref. 84; Ref. 85)

Table 4-1: State managed fisheries

Fishery	2021–2022 season summary^
Abalone	The 2021–2022 fishing season reported a commercial catch of 29.7 t. Catch was below TACC due to economic impacts of COVID-19 on overseas markets..
Abrolhos Islands and Mid-West Trawl	The 2021–2022 fishing season reported a commercial catch of 616 t. Catch within acceptable range but below predicted range.
Broome Prawn	The 2021–2022 fishing season reported a negligible commercial catch. Minimal fishing occurred in 2021.
Cockburn Sound (Crab)	The fishery has been closed since April 2014. In 2021 recruitment indices showed a slight decline while egg production improved marginally. However, both metrics remain below limit reference levels Decline is consistent with an environmentally limited stock.
Cockburn Sound (Fish Net)	The 2021–2022 fishing season reported a commercial catch of 318.8 t (nearshore fisheries, total finfish). Metro Zone Garfish fishery closed in 2017. Southern garfish and whitebait consistent with an environmentally limited stock
Cockburn Sound (Line and Pot)	The Cockburn Sound Line and Pot Managed Fishery record a catch of 0.5 t during 2020/20.

Fishery	2021–2022 season summary^
Exmouth Gulf Prawn	The 2021–2022 fishing season reported a commercial catch of 777 t. Most species were within their acceptable catch ranges. Brown tiger prawns were just below their acceptable catch range.
Inner Shark Bay Demersal	The 2021–2022 fishing season reported a commercial catch of <1 t. Catch in Freycinet above acceptable range.
Gascoyne Demersal Scalefish	The 2021–2022 fishing season reported a commercial catch of 38.9 t of Snapper, and 125 t of other demersal species. Snapper spawning biomass was around the limit level. Additional management action undertaken in 2018 including TACC reduction. Management for other demersals adequate.
Kimberley Crab	The 2021 fishing season reported a commercial catch of 0.8 t (Mud Crab).
Kimberley Gillnet and Barramundi	The 2021–2022 fishing season reported a commercial catch of 67 t (barramundi), and 100 t (total). Catch is above the acceptable range but is considered acceptable as the catch rate remains high.
Kimberley Prawn	The 2021–2022 fishing season reported a commercial catch of 204 t. Banana prawn catch at an acceptable level.
Mackerel Fishery	The 2021–2022 fishing season reported a commercial catch of 238 t. Catch just below range due to changes in fishery.
Marine Aquarium	The 2021 fishing season reported a commercial catch of 13,362 fish.
Nickol Bay Prawn	The 2021–2022 fishing season reported a commercial catch of 123 t. Catch within acceptable range.
Northern Demersal Scalefish	The 2021–2022 fishing season reported a commercial catch of 1,544 t (total), 592 t (Goldband Snapper), 167 t (Red Emperor). Catches were at an acceptable level.
Octopus	The 2021–2022 fishing season reported a commercial catch of 487 t. Catch within acceptable range. Catch recovered in 2021 after COVID-19 issues.
Onslow Prawn	The 2021–2022 fishing season reported a commercial catch <60 t. Low effort in 2021.
Pearl Oyster Wildstock	The 2021–2022 fishing season reported a commercial catch of 590,064 oysters (8,175 dive hours). Catch below quota as COVID-19 issues reduced fishing. Catch rates increased from 2018 to 2021.
Pilbara Crab	The 2021 fishing season reported a commercial catch of 8.9 t (Blue Swimmer Crab). Due to the COVID-19 pandemic and associated changes in market demands, fishing only occurred for three months of the year.
Pilbara Fish Trawl	The Pilbara Demersal Scalefish fishery (PDSF) includes the Pilbara Trap fishery The 2021-2022 fishing season for the trawl sectorreported a commercial catch of 1,928 t.
Pilbara Trap	The PDSF includes the Pilbara Trap fishery. The 2021 fishing season for the PDSF reported a commercial catch of 2,714 t. Of this, 24% (662 t) was taken by the trap sector. The total catch of the trap fishery exceeded the acceptable catch range in 2021 (i.e. 241-537 t).
Pilbara Line	The PDSF includes the Pilbara Trap fishery. The 2020 fishing season for the PDSF reported a commercial catch of 2,714 t. Of this, 5% (124 t) was taken by the line sector. The total catch of the line fishery was within the acceptable catch range (36-127 t).
Shark Bay Beach Seine and Mesh Net	The 2021–2022 fishing season reported a commercial catch of 135 t. Catch below the acceptable range due to ongoing low levels of effort, further impacted by COVID.
Shark Bay Crab	The 2021–2022 fishing season reported a commercial catch of 549 t. Catch within acceptable range. Spawning and recruitment levels have

Fishery	2021–2022 season summary^
	slightly declined under the current environmental conditions and harvest levels.
Shark Bay Prawn	The 2021–2022 fishing season reported a commercial catch of 1,303 t. Western king prawn catches below the acceptable range due to lower recruitment levels. Additional management measures were implemented within the season to protect breeding stocks.
Shark Bay Scallop	The 2021–2022 fishing season reported a commercial catch of 613 t. At least 98% of quota achieved.
Southern Demersal Gillnet & Demersal Longline West Coast Demersal Gillnet & Demersal Longline	The Temperate Demersal Gillnet and Demersal Longline Fishery (TDGDLF) comprises the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF), which operates between 26° and 33°S, and the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), which operates from 33°S to the WA/SA border. The 2021-2022 fishing season reported a commercial catch of 718 t (key species only) 835 t (total sharks and rays).
South West Coast Salmon / South Coast Salmon	South West Coast Salmon fishery is part of the West Coast Estuarine and Nearshore Scalefish and Invertebrates fishery. In 2020, the total commercial catch within the West Coast Nearshore and Estuarine Finfish resource was 246.8 t. This catch is much lower (~150 t) than the catch reported in 2019 (406.5 t), mostly due to an approximately 130 t reduction in the catch of Western Australian Salmon. This reduction was a result of reduced demand related to COVID and large reductions in rock lobster fishing, which uses salmon as bait. In 2020, a total catch of 16.6 t of Western Australian salmon was recorded. The South Coast Estuarine and Nearshore Scalefish and Invertebrates Resource (SCENSIR) covers three commercial fisheries, including the South Coast Salmon fishery. In 2021, this fishery recorded a total catch of 318 t. In 2020, a total catch of 78.1 t of Western Australian salmon was recorded. Low Salmon catch due to low effort from limited market demand.
South West Trawl	Only one boat fished in the SWTMF in 2021 for a total of 5 boat days.
Specimen Shell	The 2021 fishing season reported a commercial catch of 5,443 shells.
West Coast Deep Sea Crustacean	The 2021–2022 fishing season reported a commercial catch of 154 t. TAC achieved but effort is above acceptable range. The stock status is currently being reviewed.
West Coast Demersal Scalefish	The 2021–2022 fishing season reported a commercial catch of 259 t. Demersal suite catch within range.
West Coast Estuarine	The 2021–2022 fishing season reported a commercial catch of 55 t (Peel Harvey crab), 73 t (sea mullet Peel Harvey), and 10 t (yellowfin whiting Peel Harvey). Other West Coast Estuarine crab fisheries not reported due to confidentiality requirements. Catch and catch rates within acceptable ranges.
West Coast Purse Seine	The 2021–2022 fishing season reported a commercial catch of 504 t (all species). Catch was acceptable.
West Coast Rock Lobster	The 2021–2022 fishing season reported a commercial catch of 6,333 t. Catch within TACC plus 1.5% water loss i.e. 6400 t.
Western Australian Sea Cucumber	The 2021–2022 fishing season reported a commercial catch of 31.5 t (Sandfish), and 0 t (Redfish). Rotational harvest schedule by industry. Kimberley fished for first time in 3 years. Shark Bay stock fished 2 years running.

^ *Source: Ref. 86.*

Table 4-2: Commonwealth managed fisheries

Fishery	2022 fishery status summary^
North-West Slope Trawl Fishery	The 2020–2021 fishing season reported a commercial catch of 86.9 t.. Scampi made up approximately 72 % of the total catch in 2020–21, with the rest made up of various finfish and other crustaceans The fishery recorded 233 active days comprising 4,420 trawl-hours. Six permits were in place with four vessels active for the season.
Small Pelagic Fishery	The 2021–2022 fishing season reported a commercial catch of 18,878 t. The fishery recorded 401 search-hours with 400 midwater trawl shots. In 2021-2022, 33 entities held quota statutory fishing right (SFRs), with four vessels actively using purse seine methods and two using trawl methods.
Southern Bluefin Tuna Fishery	The 2020–2021 fishing season reported a commercial catch of 5,646 t. The fishery recorded 1,101 search-hours with 152 shots. In 2020-2021, 85 entities held quota SFRs, with seven vessels actively using purse seine methods and 20 using longline methods.
Western Deepwater Trawl Fishery	The 2020–2021 fishing season reported a commercial catch of 5 t with economic value withheld. The fishery recorded 4 active days comprising 30 trawl-hours. Eleven permits were in place with one vessel active for the season.
Western Skipjack Fishery	There has been no fishing effort in the Skipjack Tuna Fishery (STF) since the 2008–2009 fishing season. Variability in the availability of skipjack tuna in the Australian Fishing Zone and the prices received for product influence participation levels in the fishery.
Western Tuna and Billfish Fishery	The 2021 fishing season reported a commercial catch of 252 t with the economic value withheld. The fishery recorded 304,561 hooks for the season. 94 entities held quota SFRs, with two vessels actively using pelagic longline and no vessels using minor line methods.

^ *Source: Ref. 87.*

4.3 Recreational fisheries

The WA Department of Primary Industries and Regional Development (DPIRD) conducts state-wide recreational fishing surveys every two years, with the first survey completed in 2011. The survey collects information from more than 3,000 recreational fishers who record their catches in logbooks over a 12-month period with DPIRD also conducting interviews throughout the State and monitoring the number of boat launches and retrievals using cameras at various boat ramps.

Key findings of the 2017–2018 survey report (Ref. 88) are included in Table 4-3.

Table 4-3: Recreational fishing survey outcomes

Component	Number
Number of participants	~6,000
Number of recreational fishing boat licences issued	~135 000
Most popular species	
Blue Swimmer Crab	Number caught ~667 000
School Whiting	Number caught ~259 000
Fishing effort by bioregion	
West Coast	76%
Gascoyne Coast	11%
North Coast	8%

Component	Number
South Coast	5%

Source: Ref. 88

4.4 Traditional fisheries

Customary fishing applies to a person who has a traditional connection with the area being fished, and is fishing for personal, domestic, ceremonial, educational or non-commercial needs (Ref. 124). A Customary Fishing Policy has been incorporated into the *Fish Resources Management Act 1994* (WA), which allows for customary fishing by applicable persons to occur within a sustainable fisheries management framework. Customary fishing does not apply to other species of marine fauna (e.g. crocodile, turtle, or dugong).

Under amendments made in 2012 to the *Conservation and Land Management Act 1984* (WA) Aboriginal people can undertake customary activities which includes hunting (except in marine sanctuary zones or marine nature reserves) for dugong, turtle, or crocodiles in WA.

As described in further in Section 4.5.3, ongoing use of marine and coastal resources, including customary fishing, is expected to occur in NWMR and SWMR and adjacent coastal waters. However, it is expected that much of this activity will occur within shallow coastal waters around the mainland coast.

The PA intersects with the MoU Box that allows for traditional Indonesian fishers within Australian waters. The MoU Box is managed via a bilateral agreement between Australian and Indonesian governments (Ref. 125).

4.5 Heritage value of places

Listed World Heritage properties, and National Heritage places, are MNES under the EPBC Act, and a particular value and sensitivity under the OPGGS(E)R. Table 4-4 identifies the presence of these, and other marine or coastal heritage protected places, within the PA.

Table 4-4: Presence of heritage value

Feature	PA	Description
World Heritage property	✓	Section 2.1
National Heritage place	✓	Section 2.2
Commonwealth Heritage place	✓	Section 4.5.1
Indigenous Protected Areas		Section 4.5.3.1
Sites or artefacts protected under the *Underwater Cultural Heritage Act 2018* (Cth)	✓	Section 4.5.2
Sites or artefacts protected under the *Aboriginal Cultural Heritage Act 2021* (WA)	✓	Section 4.5.3.3
Determined areas under the *Native Title Act 1993* (Cth)	✓	Section 4.5.3.2
Claim areas under the *Native Title Act 1993* (Cth)	✓	Section 4.5.3.2

^ *Where ✓ = present, ✗ = not present.*

4.5.1 Commonwealth heritage places

The Commonwealth Heritage List is a list of Indigenous, historic, and natural heritage places owned or controlled by the Australian Government. The

Commonwealth Heritage List spatial database (Ref. 6) describes the place name, class (Indigenous, natural, historic), and status.

A search of the Commonwealth Heritage List spatial database (Ref. 6) and searches of the online PMST (appendix a) identified that Commonwealth Heritage Places occur in the PA[6] (Table 4-5). The information presented in Table 4-5 outlines the nominator's Summary Statement of Significance sourced from the Australian Heritage Database (Ref. 5).

Table 4-5: Commonwealth Heritage places

Commonwealth Heritage place	Class	Summary of significance^
Ashmore Reef National Nature Reserve (External territories list)	Natural	Ashmore Reef (which is an atoll that includes four low-lying uninhabited sand islands) has major significance as a staging point for wading birds migrating between Australia and the northern hemisphere, including 43 species listed on the China–Australia Migratory Bird Agreement (CAMBA) and/or the Japan–Australia Migratory Bird Agreement (JAMBA). The place provides habitat for three species of sea snake; *Aipysurus apraefrontalis*, *A. foliosquama*, and *A. fuscus* with very restricted distributions. *Aipysurus fuscus* is endemic to Ashmore Reef. Ashmore Reef supports extremely high concentrations of breeding seabirds, many of which are nomadic and typically breed on small isolated islands. Breeding colonies of 17 species of seabirds have been recorded. The islands are regarded as supporting some of the most important seabird rookeries on the Sahul Shelf, including large (1,000 to 50,000 breeding pairs) breeding colonies of Sooty Tern (*Sterna fuscata*), Crested Tern (*S. bergii*), Bridled Tern (*S. anaethetus*) and Common Noddy (*Anous stolidus*), and smaller breeding colonies of Little Egret (*Egretta alba*), Eastern Reef Egret (*E. sacra*), Black Noddy (*Anous minutus*), White-tailed Tropic Bird (*Phaethon lepturus*), and Red-tailed Tropic Bird (*P. rubricauda*). The place is also important for providing breeding habitat for Green (*Chelonia mydas*) and Hawksbill Turtles (*Eretmochelys imbricata*). Ashmore Reef exhibits a higher diversity of marine habitats compared with other North West Shelf reefs. The place supports an exceptionally diverse marine fauna, particularly corals (255 species in 56 genera) and molluscs (433 species), and is regarded as having the highest diversity of sea snakes (12 species) in the world. Other highly diverse fauna include birds (78 species), decapod crustaceans (99 species), echinoderms (178 species), and fish (569 species). Species of conservation significance recorded at Ashmore Reef include: the nationally endangered Little Tern (*Sterna albifrons*) and Loggerhead Turtle (*Caretta caretta*), and the nationally vulnerable Green Turtle (*Chelonia mydas*) and Hawksbill Turtle (*Eretmochelys imbricata*). The place also includes species not previously recorded or only rarely recorded in Australia including: three bird species (Brown Hawk Owl [*Ninox scutulata*], White-tailed Tropic Bird [*Phaethon lepturus*], and Black Noddy [*Anous minutus*]); five hermatypic coral species; and 13 fish species. Ashmore Reef is an important scientific reference area for migratory seabirds, sea snakes, and marine invertebrates. It has been the site of several major scientific expeditions and is

[6] Only Commonwealth Heritage places with a coastal and/or marine interface have been identified and described.

Commonwealth Heritage place	Class	Summary of significance^
		the subject of ongoing scientific monitoring of biological diversity, fauna populations, and breeding activity. Ashmore Reef is the type locality for two species of sea snake—*Aipysurus apraefrontalis* and *A. foliosquama*. Ashmore Reef is significant for its history of human occupation and use. Although the reef may have been known to the Rottinese people (Rote is an island in modern-day Indonesia) for many centuries, the first description is probably that contained in Eredia (1600) if accepted, this may be the first description of Ashmore Reef, which is now part of Australia. Ashmore Reef is believed to have been visited by fisherman from Rote Island since the early 18th century, as well as by Makassans and Bajau ('Sea Gypsies') and people from the island of Seram. The Ashmore Reef islands were used both for fishing and as a staging point for voyages to the southern reefs off Australia's coast. Occupation by these seafarers, particularly from the area east of Madura (Indonesia), on the islands occurred intermittently during the 1930s. Visits recommenced in 1947 following World War II and have continued. The islands are also significant for phosphate mining, which lead to their annexation by Great Britain and ultimate transfer to the Australian Government in 1934. Physical evidence of these former occupations exists and would be particularly significant in archaeological terms. Such evidence may include original wells and grave sites and would include evidence of disturbance from early phosphate mining.
Christmas Island Natural Areas (External territories list)	Natural	Christmas Island is a classic example of a tectonically uplifted coral atoll with its characteristic steep series of rainforest-covered terraces and sheer limestone cliffs. The island's geological formations are significant in illustrating the evolution of the Christmas Rise due to tectonic and volcanic action and the collision of the Asian and Australian plates. The evolutionary significance of Christmas Island is demonstrated both by its high level of endemism and by its unique assemblage of plant and animal species. The dominance of the land crabs is a striking feature of the island's fauna. The island has 13 of the 20 species known worldwide and one of the highest land crab densities known in the Indian Ocean. The land crabs of Christmas Island are remarkable for their variety and numbers and for the role they play in the ecology of the rainforest. The endemic Red Crab (*Gecarcoidea natalis*) is numerically the most notable of this crab assemblage with an estimated population of approximately 120 million crabs. The threatened Robber or Coconut Crab (*Birgus latro*), with a population estimated at one million individuals is one of the largest remaining in the world. Christmas Island is famous for its spectacular annual Red Crab migrations from the plateau rainforest to the sea during the wet season. The migrating population has been estimated at numbering 30-45 million adult crabs. The rainforests of Christmas Island are biogeographically significant; species have evolved from being either shoreline forest or early rainforest succession species to those that fill a tall climax rainforest role. The Island contains unique plant communities of high conservation and scientific interest including a variety of elevated and relict cycad and back-mangrove communities of international significance.

Commonwealth Heritage place	Class	Summary of significance^
		The presence of 17 endemic plant species in the climax rainforest community contributes to the place's significance for understanding evolutionary relationships. Notable examples include a rare fern *Asplenium listeri*, a tall tree-like *Pandanus elatus* and a palm *Arenga listeri*. The island's rich endemic fauna includes three mammal species, 10 bird species, five reptile species, one crab species, two insects, three marine fish species and several marine sponges species. The island is recognised as an internationally significant Endemic Bird Area. The well-developed karst landscape of Christmas Island contains an internationally significant cave fauna with twelve endemic invertebrate species. The island is also one of the world's most significant seabird islands, both for the variety and numbers of sea-birds, with over 100 species of bird having been recorded, including eight species which breed on the island. The island rainforest provides significant habitat for two endemics the nationally endangered Abbott's Booby (*Papsula abbotti*) and the nationally vulnerable Christmas Island Frigatebird (*Fregeta andrewsi*). The island's relatively simple fringing reefs and adjacent waters support a rich diversity of marine species typical of Indian Ocean tropical reefs. The island also provides habitat for two nationally vulnerable species of turtle, the Green (*Chelonia mydas*) and Hawksbill (*Eretochelys imbricata*), which nest on two of the Island's beaches, and two nationally vulnerable shark species. Christmas Island is one of the most scientifically documented oceanic islands in the world. Island ecosystems have been historically critical in the development of evolutionary theory as they highlight natural selection, speciation and niche filling. Christmas Island correspondingly is a significant location for scientific research. The unique ecosystems of the Island present special opportunities for the study of evolution of species in relative isolation and the adaptation of migrant species to new environments. These species have often evolved to fit different ecological niches to which they are usually associated and the rainforests on the island exhibit species with many of these characteristics. Christmas Island provides habitat for four nationally endangered and six nationally vulnerable fauna species, and one nationally vulnerable plant species. There are a number of places of cultural heritage value included within or adjacent to this area that are included in the Register of the National Estate. It is possible that additional cultural heritage values exist within the area that are yet to be identified.
Cliff Point Historic Site (WA list)	Historic	The Cliff Point Historic Site, individually significant within the area of Garden Island, is important as it was the first site inhabited by Governor Stirling's party in 1829 when founding the colony of WA, and as WA's first official non-convict settlement. The site was initially occupied by Captain Charles Fremantle before the arrival of Captain Stirling. The party occupied the site for two months before a move was made to the Swan River settlement on the mainland. The Cliff Point Historic Site is important as the site of first settlement in WA and is highly valued by the community for its cultural associations.

Commonwealth Heritage place	Class	Summary of significance^
		The Cliff Point Historic Site, also known as Sulphur Town, after HMS Sulphur was chosen in 1828 by Governor Stirling to transport settlers to the new colony and is important for its association with Governor Stirling and Captain Charles Fremantle.
Garden Island (WA list)	Natural	Garden Island was the first site occupied by Governor Stirling's party in 1829 when founding the colony of WA; it was also the site of the first official non-convict settlement in WA. The Cliff Point Historic Site on Garden Island, also known as Sulphur Town, was initially occupied by Captain Charles Fremantle before the arrival of Captain Stirling, and is listed separately in the Register (Reg. No. 10657). The party occupied the site for two months before they moved to the Swan River settlement on the mainland. Garden Island, and in particular the Cliff Point Historic Site, is highly valued for its cultural associations as the site of first settlement in WA and is important for its association with Governor Stirling and Captain Charles Fremantle. In 1911, the Commonwealth resumed Garden Island from WA for use as a naval base. The strategic role of Garden Island and Cockburn Sound, which was secured for coastal defence in World War II, is illustrated by defence installations including Challenger or J Gun Battery, and the Scriven, Beacon, and Collie Battery complexes, supported by a range of service structures. Challenger Battery is listed separately in the Register at Reg. No. 18968. The absence of feral predators means that Garden Island provides a significant refuge for animals vulnerable to predation on the mainland. Due to its isolation from the WA mainland, the island is relatively free of disturbance from humans or introduced animals. Species of particular interest include the Tammar Wallaby (*Macropus eugenii*), Carpet Python (*Morelia spilota*), and the Lined Skink (*Lerista lineata*). Populations of the 14 species of reptile and the Tammar Wallaby have been isolated from mainland populations for 6,000–7,000 years. In particular, the population of the Tammar Wallaby on Garden Island is morphologically distinct from all other populations. The vegetation on Garden Island differs in structure and composition from vegetation on nearby Rottnest Island and the adjacent mainland (e.g. eucalypts and banksia, which are common on the mainland, are absent from the island). Due to a low fire frequency, the vegetation on Garden Island is older and denser than that on the mainland. The northern end of the island supports some of the oldest stands of the rare Rottnest Island Pine (*Callitris preissii*), with most trees dating from the 1920s. Other species that are now rare in the region include the Cheesewood (*Pittosporum phylliraeoides var. phylliraeoides*) and Rottnest Teatree (*Melaleuca lanceolata*). The parabolic sand dunes on the western side of Garden Island are among the best-preserved dunes of the Quindalup soil unit, which is widespread in coastal WA. It is likely that Indigenous values exist at this place. The Australian Heritage Commission (AHC) has not yet identified, documented, or assessed these values for National Estate significance.
HMAS Sydney II and *HSK*	Historic	The naval battle fought between the Australian warship *HMAS Sydney II* and the German commerce raider *HSK Kormoran* off the WA coast during World War II was a defining event in Australia's cultural history. *HMAS Sydney II*

Commonwealth Heritage place	Class	Summary of significance^
Kormoran Shipwreck Sites (External territories list)		was Australia's most famous warship of the time and this battle has forever linked the stories of these warships to each other. The tragic loss of *HMAS Sydney II* and its entire crew of 645 following the battle with *HSK Kormoran*, remains Australia's worst naval disaster and sent shockwaves throughout the Australian community in November 1941. The battle between *HMAS Sydney II* and *HSK Kormoran* had far-reaching consequences for developing Australia's defences. The loss of *HMAS Sydney II* was the first and most significant in a succession of Australian naval losses that directly threatened the security of Australia and its surrounding seas, having occurred only 17 days before the Japanese launched their attacks in Southeast Asia and the Northern Pacific. The aftermath of the sinking of *HMAS Sydney II* and subsequent warship losses saw a major shift in Australian military and political doctrine away from defending Australia by defending the British Empire to that of direct defence of the Australian mainland and the development of a defence alliance with the United States. The discovery and inspection of *HMAS Sydney II* and *HSK Kormoran* in 2008 has enabled reconciliation of theory and known historical fact concerning the battle with the archaeological evidence present in the remains. This physical evidence was pivotal to the findings of the 2009 *HMAS Sydney II* Commission of Inquiry (Cole Inquiry), and allowed some circumstances of the loss of *HMAS Sydney II* to be better understood. It has also enabled the study of unique technological features that allowed *HSK Kormoran* to avoid identification as a warship when approaching *HMAS Sydney II* until reaching point blank range for the weapons of the time. The surprise achieved by using these technologies was a major factor in the destruction of *HMAS Sydney II*. During the relatively short but conspicuous career of *HMAS Sydney II*, it was commanded by two of the most highly regarded and respected officers serving in the Royal Australian Navy at that time (Captain J.A. Collins and Captain J. Burnett). Their association with *HMAS Sydney II* is significant in both their naval careers and of the ship itself. The 2008 discovery of *HMAS Sydney II* and *HSK Kormoran* has highlighted the ongoing importance of these shipwrecks and their stories to the wider Australian community. The stories of these two ships are not only valued by the family and friends of the servicemen who died but also by veterans, defence personnel, and the Australian community in general. The location, interpretation, and memorialisation of these shipwrecks also provides some closure for the families.
Lancelin Defence Training Area (WA list)	Natural	The Lancelin Defence Training Area (DTA) is at the northern end of the Swan Coastal Plain, an area of exceptionally diverse flora and fauna. Much of Lancelin is dominated by species-rich Banksia woodlands and Myrtaceous/Proteaceous heaths. The floristic mosaic of *Banksia attenuata – B. menziessi* low woodlands, wet heaths, and low-heath communities represent significant vegetation remnants that are poorly conserved and under-represented in the conservation reserve system. The Lancelin DTA contains wetlands that are important in the hydrogeological system of the region. The Namming freshwater wetland suite contains a high diversity of habitats, is an important breeding site for waterfowl, and acts as a drought refuge for both waterfowl and other fauna.

Commonwealth Heritage place	Class	Summary of significance^
		The Lancelin DTA is close to the boundary of two major zoogeographic regions, the semi-arid Eyrean zone, and the Bassean, or south-western zone of WA. This accounts in part for the high vertebrate fauna richness, particularly for reptiles and frogs, with eight frog species recorded in the large, seasonal Walyengarra Lake. Several species occur at the edge of their distribution range within the place. Reptile species that are at, or near, the southern limit of their distribution in the Lancelin DTA include the skink *Lerista planiventralis* and the snake *Simoselaps littoralis*. Many bird species are at or near their northern limit of distribution here, including the Southern Emu Wren (*Stipiturus malachurus*), and the Spotted Pardalote (*Pardalotus punctata*), while several are at their southern limits, including the Pied Butcherbird (*Cracticus nigrogularis*), and the Pied Honeyeater (*Certhionyx variegatus*). The vegetation community known as Tall Heath—comprising *Calothamnus quadrifidus*, *Dryandra sessilis*, and *Hakea trifurcata*—is near the southern limit of its distribution within the Lancelin DTA. Stands of Tuart (*Eucalyptus gomphocephala*) are significant as this area is close to this restricted species' northern limit. Several flora species found in the place are listed as poorly known or rare (Priority species) in WA, including species that are known from only a few populations that are under threat. The Lancelin DTA occurs within a narrow strip along the central and south WA coast where a number of reptile species have restricted distributions. Species with restricted distributions that occur here include the legless lizards *Aclys concinna*, *Pletholax gracilis*, and *Delma grayii* and the skinks *Ctenotus australis* and *Lerista praepedita*.
Learmonth Air Weapons Range Facility (WA list)	Natural	The geomorphology of Cape Range, of which the Learmonth Air Weapons Range (AWR) Facility is a part, is of considerable importance in documenting sea level and landform changes since the late Cenozoic Era (~1.8 million years ago). A series of emergent reef complexes, which represent several periods of coral reef development, are striking elements of the geomorphology of the western side of the Learmonth AWR Facility and Cape Range. The ages of these reef terraces are key to understanding of the timing of uplift events. The coastal plain of Cape Range contains a network of subterranean waterways, comprising caverns and fissures in the limestone beneath the coastal plain. Of these, Bundera Sinkhole, found within the Learmonth AWR Facility, is the only deep anchialine system known in Australia, and is the only continental anchialine system known in the southern hemisphere. Anchialine systems are cave systems with restricted exposure to open air, with subterranean connections to the sea, and showing marine and terrestrial influences. Anchialine systems are noted both for their relict fauna and their high species richness. The physicochemical environment in Bundera Sinkhole is very complex, and is associated with biogeochemical processes that are likely to be important for maintaining the unique community contained in this system. The cave fauna of Cape Range, including that within the Learmonth AWR Facility at Bundera Sinkhole, is of exceptional biogeographical importance. Much of the fauna developed a long time ago, with a number of species of the

Commonwealth Heritage place	Class	Summary of significance^
		aquatic cave fauna (stygofauna) originating in the Tethys Sea ~170 million years ago. Bundera Sinkhole supports several species of aquatic stygofauna, many of which are endemic to the sinkhole or to Cape Range. Many of the stygofauna species have their closest known affinities with the fauna of anchialine caves on either side of the North Atlantic. This narrow cave is also the only known southern hemisphere site for a crustacean from the class Remipedia (*Lasionectes exleyi*). *L. exleyi* is listed as endangered at both State and Commonwealth levels. This species is widely separated from related species found in the North Atlantic. Bundera Sinkhole is also the only known locality in the southern hemisphere for another crustacean species: *Danielopolina sp. Nov*. Several other crustacean species found in Bundera Sinkhole are likely to have originated from the Tethys Sea, including: *Stygiocaris lancifera* (the Lance-beaked Cave Shrimp); two copepods from the Calanoida order (*Bunderia sp. and Stygocyclopia sp.*); and another copepod, *Halicyclops spinifer*. Many of these species also have widely separated distributions (e.g. Halicyclops is confined in Australia to Cape Range, but is also found in Iran, Brazil, and India). The Lance-beaked Cave Shrimp is listed as rare or likely to become extinct at the State level. The gastropod *Iravadia sp*. is found in brackish water in Bundera Sinkhole, and represents the first marine/estuarine stygophile recorded from the region. A fish species, the Blind or Cave Gudgeon *Milyeringa veritas*, also occurs here—it is one of only two vertebrate species known in Australasia that is confined to caves. This species is listed as vulnerable at the national level. *Prionospio thalanji sp. nov*., a worm from the Spionidae family, has been described from Bundera Sinkhole. Other species from this genus are predominantly marine, and this is the first global record of a spionid occurring in a cave environment. The ecosystems represented in the caves of the Cape Range and subterranean waterways under the coastal plains of the peninsula, including in the Learmonth AWR Facility at Bundera Sinkhole, are rare in WA. Only a small number of cave ecosystems exist in WA, and Bundera Sinkhole, along with other caves at Cape Range, are the only example in Australia of an orogenic (formed during a mountain building phase) limestone from the Tertiary Period (between 65 million and 1.8 million years ago). Stygofauna throughout the world is of considerable scientific interest, yielding important information concerning the evolution of life on earth. The stygofauna at Cape Range, including species found within the Learmonth AWR Facility at Bundera Sinkhole, give insights into the origin of Australian fauna, changes in climate since the Miocene Epoch, and the biogeographical history of the continent Several species of vertebrate terrestrial fauna at Cape Range, including within the Learmonth AWR Facility, are of biogeographical importance because they form isolated populations, or populations at the limit of their range. The reptile fauna is of particular biogeographical significance, with a number of species or subspecies occurring here with highly restricted distributions.

Commonwealth Heritage place	Class	Summary of significance^
		The Learmonth AWR Facility supports six southern reptile species that are at, or close to, their northern geographic limit: *Diplodactylus ornatus*, *Ctenotus fallens*, *Lerista lineopunctulata*, *L. praepedita*, *Morethia lineoocellata*, and *Vermicella littoralis*. All these species are found on the western coastal dunes, and are largely restricted to the coastal corridor. All are endemic to southern WA and restricted to sandy coastal habitats along the western coast. The Learmonth AWR Facility supports several plant species that are either endemic, or mainly limited to the Cape Range peninsula, with at least ten endemic flora species occurring here.
Mermaid Reef – Rowley Shoals (WA list)	Natural	Mermaid Reef is characterised by environmental conditions that are rare for shelf-edge reefs and are known only in the Rowley Shoals in WA; these conditions include clear, deep oceanic water and large tidal ranges. Species of conservation significance recorded at the place include the nationally vulnerable Green Turtle (Chelonia mydas). The Rowley Shoals provide habitat for species not previously been recorded in WA, including 216 fish species, 39 mollusc species, and seven echinoderm species. The Rowley Shoals are regionally important for their fauna diversity, which includes: corals (184 species in 52 genera); molluscs (260 species); echinoderms (90 species); and fish (485 species). Mermaid Reef, together with Clerke and Imperieuse Reefs, has biogeographical significance due to the presence of species that are at, or close to, the limits of their geographic ranges, including fish known previously only from Indonesian waters (e.g. the apogonid *Cheilodipterus singapurensis*, the pomacentrid *Chrysiptera hemicyanea*, the blenniid *Escenius schroederi*, and several gobiids). The monotypic labrid *Conniella apterygia* is endemic to the region of Rowley Shoals and Seringapatam and Scott Reefs. Mermaid Reef is particularly significant as a stepping-stone in the spread of genetic material from the Indonesian archipelago to the reefs to the south. The Rowley Shoals are important for benchmark studies as they are one of the few places off the north-west coast of WA that have been the site of major biological collection trips by the WA Museum. The Rowley Shoals includes the type locality of several fish, including the genus and species of the wrasse *Conniella apterygia* and the serranid species *Pseudanthias sheni*. The place is one of the best morphological examples of shelf-edge reefs in Australian waters and is important for demonstrating their principal structural and developmental characteristics. A shipwreck off the western edge of Mermaid Reef is believed to be that of the British whaling vessel Lively, which was lost in the early 1800s.
Ningaloo Marine Area – Commonwealth Waters (WA list)	Natural	Whale Sharks (*Rhincodon typus*) congregate in the Ningaloo Marine Area after the mass coral spawning each autumn in the adjacent Ningaloo Reef (State waters). The place is an important feeding area for the Whale Shark and one of the few places in the world where they are known to congregate regularly in significant numbers. The place is part of the annual migration route for the endangered (Commonwealth) Humpback Whale. They migrate north to Kimberley (WA) breeding grounds in winter (June–August) and south to Antarctic feeding grounds in summer (August–November). Other Commonwealth listed threatened species found in the place are the endangered Blue Whale, Southern Right Whale (*Eubalaena australis*),

Commonwealth Heritage place	Class	Summary of significance^
		Loggerhead Turtle, and Southern Giant Petrel (*Macronectes giganteus*); the vulnerable Fin Whale (*Balaenoptera physalis*), Sei Whale (*B. borealis*), Green Turtle, Hawksbill Turtle, Flatback Turtle, Soft-plumaged Petrel (*Pterodroma mollis*), Great White Shark (*Carcharodon carcharias*), and Grey Nurse Shark (*Carcharias taurus*). Other significant species include the Dugong, Spinner Dolphin (*Stenella longirostris*), Yellow-nosed Albatross (*Diomedea chlororhynchos*) and Osprey (*Pandion haliaetus*). Marine turtle density is exceptionally high in the place; Green Turtles are the most abundant, exceeding the highest densities recorded in the Great Barrier Reef Marine Park (Queensland). The place is on the migratory route of many trans-equatorial wader bird species, and provides valuable feeding grounds for many migratory seabirds, including 11 species protected under JAMBA and/or CAMBA including the Wedge-tailed Shearwater (*Puffinus pacificus*), Wilson's Storm Petrel (*Oceanites oceanicus*), Lesser Frigatebird (*Fregata ariel*), Crested Tern (*Sterna bergii*), and White-winged Tern (*Chlidonias leucoptera*). The place is an important breeding area for billfish, and is one of the few areas in the world where aggregations of several species (Black Marlin, Blue Marlin, Striped Marlin, and sailfish) occur. The place is an important feeding area for manta rays in autumn and winter and significant for tuna migration and potentially important for juvenile Southern Bluefin Tuna (*Thunnus maccoyii*). The Ningaloo Marine Area provides opportunities for scientific research in many different fields related to aspects of the place's unique and interesting features. Past, current, and ongoing research is being undertaken by academic and research institutions, including: the Department of Biodiversity, Conservation and Attractions (WA), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Institute of Marine Science (AIMS), Murdoch University (WA), University of WA, Edith Cowan University (WA), and James Cook University (Queensland). Areas of research include tourism, marine ecology, whales, marine turtles, Whale Sharks, fish, and oceanography. The Ningaloo Marine Area has many historic associations for European exploration and development of the North West Cape and northern WA, including pearling and whaling activities. To date eight shipwrecks dating from 1811 to 1923 have been discovered in the area. Other Indigenous and non-Indigenous cultural values of National Estate significance may exist in this place, but the AHC has not yet identified, documented, or assessed these values.
North Keeling Island (External territories list)	Natural	North Keeling Island is significant as one of the few remaining pristine tropical islands in the Indian Ocean region. The Island has rare ecosystems and a high significance for Indian Ocean Sea birds, playing a vital part in the stability of the Indian Ocean sea bird biota. The Island is significant to studies of island biogeography because of its evolution in isolation. It contains rare ecosystems now absent from other islands of the Cocos and Keeling Group. Closed canopy forests on the Island are unusual as they are comprised of species generally found as

Commonwealth Heritage place	Class	Summary of significance^
		stunted shrubs in successional forests on the shoreline of tropical islands elsewhere in the region. The Island is of very high importance to Indian Island sea bird populations, supporting the most diverse populations in this ocean. Nineteen species are found on the Island, 12 of which breed here. This is significant as the Island is the only rookery within 900 km. The Island also supports a diverse land crab population with six species occurring here. The Island is the habitat of several rare species including: the Robber Crab which is listed as vulnerable to extinction in the IUCN red data book. The Buff-banded Rail, listed as endangered by IUCN, is restricted to this island. Two species of turtle listed as endangered by IUCN, the Green and Hawksbill turtles, nest on the Island's beaches. The Island is also significant as one of the four remaining Red-footed Booby nesting areas in the world. The Cocos Islands were the only coral atolls visited by Charles Darwin in the 1830s. The flora and fauna observed by Darwin on Cocos Island at that time is now found only on North Keeling. The Island is of particular significance in the history of Australia in World War One, due to the sinking of the SMS Emden by the *HMAS Sydney* in 1914. The wreck of the Emden is also significant as a wrecksite of a World War One cruiser, having research potential in marine archaeology.
Scott Reef and Surrounds – Commonwealth Area (External territories list)	Natural	Scott Reef is a significant component of a disjointed chain of shelf-edge reefs separated from Indonesia by the Timor Trough. It is regionally significant both because of its high representation of species not found in coastal waters off WA and for the unusual nature of its fauna, which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region. Scott Reef is important for its contribution to understanding long-term geomorphological and reef formation processes and past environments—its sedimentary sequence extends back to include sediments from the Triassic Period. The place has biogeographical significance due to the presence of species that are at, or close to, the limits of their geographic ranges, including fish known previously only from Indonesian waters (e.g. *Cheilodipterus singapurensis*, *Chrysoptera hemicyanea*, *Ecsenius schroederi*, and several gobiids). In addition, some coral species may be endemic to Scott Reef. The reef's isolation and large size may predispose it for the evolution of genetically distinct subspecies or endemic species. Several species are currently only known from Scott Reef, including 51 fish species, 14 mollusc species, six echinoderm species, and the seagrass *Thalassia hemprichii*. Scott Reef is of biogeographical significance due to its connectivity in terms of gene flow and coral spore movement to surrounding reefs such as Ashmore Reef and Rowley Shoals. Scott Reef has enormous habitat diversity and is considered a hot spot of fish diversity. Scott Reef is characterised by environmental conditions that are rare for shelf atolls; these conditions include clear, deep oceanic water and large tidal ranges. Scott Reef has nationally vulnerable Green Turtles (*Chelonia mydas*), which are genetically distinct from those on near-coastal sites in WA, from the Lacepede Islands to North West Cape. The sand cays of the place are important habitat for migrating animals in the largely landless expanse of the Timor Sea.

Commonwealth Heritage place	Class	Summary of significance^
		They are an important staging area for birds, particularly migrants to and from Australia. Seventeen of the 25 bird species identified on Scott Reef are on CAMBA and/or JAMBA lists. Scott and Seringapatam Reefs together are regionally important for the diversity of their fauna, which includes corals (224 species in 56 genera); molluscs (279 species); decapod crustacea (56 species); echinoderms (117 species); and fish (558 species). Scott Reef is important for scientific research and benchmark studies due to its great age, the exceptional documentation of its geophysical and physical environmental characteristics, and its use as a site of major biological collection trips and surveys by the WA Museum and AIMS.
Yampi Defence Area (WA list)	Natural	The Yampi Defence Area displays a complex mosaic of landforms in the transition from the sandstone plateaus of the north-west Kimberley, to the broad plains and pindan scrub of the south-west Kimberley. The occurrence of such diverse landscapes within a relatively limited area is unusual. The strong relationship that exists between past orogenic events and the diverse landscape pattern of ridges and valleys is emphasised in the shape of the Yampi Fold Belt, and distinguished by the pronounced ria embayments that characterise the coastline. Landforms originating from rocks within the Yampi Fold Belt and the terrain associated with the Late Devonian Lillybooraroo Conglomerate are of considerable scientific importance. The erosion of the Lillybooraroo Conglomerate, which covers the Yampi Fold Belt, has partially exposed a pre-Devonian land surface, the attributes of which have enormous potential to aid our understanding of long-term geomorphological processes and evolution. Suggestions that the Lillybooraroo Conglomerate remains an original valley fill deposit would attest to very low rates of erosion and long-term landscape stability, reinforcing the scientific importance of the place. The Yampi Defence Area, which is at the crossroads of the Dampierland, Central, and Northern Kimberley biogeographical regions, has a diverse range of ecosystems, displaying an unusual richness of faunal associations and vegetation communities, with >800 plant species (approximately one-third of the described Kimberley flora) being recorded. Previous surveys of the Dampier Peninsula and Walcott Inlet, and the Kimberley Rainforest Survey enable the changing floristic composition to be compared between adjacent areas. On the basis of species richness, indications are that the Yampi Defence Area supports >1,000 species, including undescribed, rare, and fire-sensitive species that are declining elsewhere in the Kimberley. Similarly, the known distributions of vertebrates from the Yampi Peninsula, and locations to the north and south, indicate that a far richer fauna is likely to occur in the place. Fire-protected sandstone communities, typified by healthy mixed-age stands of cypress pine (*Callitris intratropica*) once common throughout the Kimberley are now very rare in northern Australia, and the occurrence of such stands around Secure Bay are important reference sites for similar Kimberley plant communities that are subject to more frequent fire regimes. The extensive sandstone landforms support small isolated patches of rainforest (the south-west

Commonwealth Heritage place	Class	Summary of significance^
		limit in the Kimberley of the distribution of rainforest over sandstone), creating important nodes of diversity and refugia that contain many regionally endemic plants, animals, and invertebrates. Granite landforms are of restricted distribution in the Kimberley and mostly occur in drier areas. The high concentration of granite outcrop sequences at Yampi occurs in a higher rainfall zone resulting in formation of diverse and specialised vegetation communities. Aquatic plants inhabit the ephemeral pools that form in granite depressions, while rock-colonisers populate the granite fissures and scree slopes where run-off water is high. Six plant taxa occur within the place that are endemic to the Yampi Peninsula. Yampi Defence Area is the type locality for the insectivorous plant *Byblis filifolia*, first collected in 1838 during the voyage of HMS Beagle. The close juxtaposition of three botanical regions within the place is highlighted by the presence of numerous tropical plant species and several animal taxa that are at the southern edge of their distribution. Merging with these are many arid zone plants at the northern and western edge of their distribution, recognisable as the pindan grades into the taller woodland structure of the north-western Kimberley. The sandstone mesa south of Kimbolton is the southernmost locality for several plant taxa restricted to the fire-protected sandstone ranges of the Kimberley. The diversity of landforms in the place and the resultant high concentration of small refugial habitats support a regionally rich vertebrate fauna and represent the most southerly known extant population of the nationally vulnerable Golden-backed Tree-rat (*Mesembriomys macrurus*) and the most southerly record in the Kimberley of the Sugar Glider (*Petaurus breviceps*). The bird fauna is significant as it represents a suite of species that are at, or near, the southern edge of their range in the semi-humid zone of the Kimberley including the Green-winged Pigeon (*Chalcophaps indica*); the Torres Strait Pigeon (*Ducula bicolor*); and the Little Shrike-thrush (*Colluricincla megarhyncha parvula*). The place is also an important zone of overlap between many northern and southern species and subspecies. The vertebrate fauna shows its closest similarity to those recorded from the wetter areas of the west Kimberley that lie further to the north. The place supports several fauna and flora species that are listed as specially protected, threatened, or having priority status in WA, as well as four fauna species that are nationally vulnerable and one species that is nationally endangered. Other Indigenous and non-Indigenous cultural values of National Estate significance may exist in this place, but the AHC has not yet identified, documented, or assessed these values.

^ Source: Ref. 5.

4.5.2 Underwater cultural heritage

Australia's underwater cultural heritage is protected under the *Underwater Cultural Heritage Act 2018* (Cth) (UCH Act); this legislation protects shipwrecks, sunken aircraft and other types of underwater heritage, including First Nations underwater cultural heritage in Australian waters[7].

Under section 15 of the UCH Act, underwater cultural heritage is defined as “any trace of human existence that has a cultural, historical, or archaeological character, and is located under water”. The UCH Act protects physical sites and artefacts; intangible heritage values with no physical component are not protected under the Act (Ref. 121).

A desktop analysis was undertaken to determine the presence of underwater cultural heritage within the PA using searches of the online *Australasian Underwater Cultural Heritage Database* (Ref. 89) for known underwater cultural heritage (shipwrecks, aircraft, relics, and other underwater cultural heritage) in Australian waters.

Over 700 shipwrecks are present within the PA. Given this number, no additional detail is provided in this document. If shipwrecks are present within an EMBA described in a project-specific EP, CAPL will identify and detail the significance of these shipwrecks in that EP.

Similarly, records for sunken aircraft, artefacts, and other underwater cultural heritage are present within the PA. Where these are present within an EMBA described in a project-specific EP, CAPL will identify and detail the significance of these shipwrecks in that EP.

4.5.3 First Nations cultural activities, connections, and obligations

The land adjacent to the NWMR and SWMR has been inhabited by First Nations people for at least 50,000 years, and they continue to use the NWMR and SWMR and adjacent coastal resources with an ongoing connection to these areas (Ref. 71, Ref. 73).

The term ‘country’ refers to more than just a geographical area, and includes values, places, resources, stories, and cultural obligations associated with that geographical area (Ref. 110, Ref. 111). For First Nations peoples, the term ‘country’ includes both land and sea and the coastal areas that are connected with the traditional country of a group or clan.

First Nations people in both the northwest and southwest of WA continue to rely on coastal and marine environments and resources of the region for their cultural identity, health and wellbeing, and their domestic and commercial economies (Ref. 110, Ref. 111). Their commitment to their sea country is demonstrated through their native title claims and their many initiatives to regain their role as managers of the cultural and natural values of northwest WA (Ref. 110, Ref. 111).

First Nations peoples of northwest and southwest WA engage in a diverse range of marine resource use activities, including hunting, egg collecting, fishing and gathering shellfish. Activities also continue on lands and waters where they have ceremonial and spiritual connections (Ref. 110, Ref. 111).

4.5.3.1 Indigenous Protected Areas

Indigenous Protected Areas (IPAs) are protected areas of land and sea country that are managed by First Nations groups (Ref. 112). Table 4-5 summarises the IPAs present within the PA.

[7] The UCH Act applies to all Australian waters, including both State waters (coastal waters) and Commonwealth waters (extending from coastal waters to the edge of continental shelf).

Table 4-6: IPAs within the PA

IPA Name	IUCN categories	Description
Balanggarra	VI	The Balanggarra IPA is located in the Kimberley region near the WA border, and covers over one million ha of land and sea country. The northern part of the Balanggarra country is 'blue water' country and includes Cape Londonderry, several rivers such as the lower Drysdale and King George, saltwater, reefs, and offshore islands, like Sir Graham Moore and the Governor Islands. The southern part is 'brown water' country and includes land drained by the Forrest River system, the muddy waters of the Cambridge Gulf and Adolphus Island (Ref. 113).
Bardi Jawi	IV, VI	The Bardi Jawi IPA was dedicated in 2013, and is located 160 km north of Broome. Surrounded by sea on three sides, it covers 126,990 ha of land and sea country. Its Traditional Owners are saltwater people from six coastal clan groups who are based in three communities: Djarindjin, Lombadina, and Ardyaloon (One Arm Point) (Ref. 114).
Dambimangari	VI	Dedicated in 2013, Dambimangari IPA is located on the Kimberley coast between Broome and Darwin. Situated north of Derby, it stretches east to the Prince Regent area and covers 642,294 ha of contrasting landscapes — open grasslands merge into eucalyptus woodlands which extend to intertidal flats, rocky reefs and shoals — all abundant with plants and animals. Dambimangari, which means 'belonging to homeland', is the traditional home of the Worrarra people. Dambimangari peoples' identity is interwoven with the sea and its reefs and islands. Reefs are important hunting grounds for *Jaya* (saltwater fish) and *Warliny* (dugong) and a good catch means their ancestors are happy and looking after them (Ref. 115).
Karajarri	II, VI	The Karajarri IPA was dedicated in 2014, and covers nearly 2.5 million ha of land in the southern Kimberley. The Karajarri IPA lies south of Broome and includes 130 km of coastline stretching from Gordon Bay to Cape Missiessy. It comprises extensive coastlines, tidal creeks and wetlands as well as arid country that stretches into the Great Sandy Desert (Ref. 116)
Nyangumarta Warrarn	VI	Dedicated in 2015, Nyangumarta Warrarn IPA covers 2.8 million ha. The Nyangumarta Warrarn IPA overlaps with several conservation reserves which are jointly vested or managed with the Western Australian Department of Parks and Wildlife, such as Eighty Mile Beach Marine Park, Walyarta Conservation Park and Kujungurru Nature Reserve. The majority of the IPA though is desert country which harbours many culturally significant places and several threatened species such as the greater bilby, the marsupial mole and a number of endangered plant species. Nyangumarta Native Title holders have a holistic approach to land management; the landscape, plants and animals with Nyangumarta country have been inseparable from Nyangumarta law, culture, language and traditional knowledge since Creation time and are integral to Indigenous conservation and land management (Ref. 117).
Uunguu	VI	In 2011 the Wunambal Gaambera people dedicated Stage One of the Uunguu IPA in the north Kimberley. Stage Two was declared in 2015 and the IPA now covers over 759,806 ha. Uunguu has been home to the Wunambal Gaambera people for many thousands of years and is part of the Wanjina Wunggurr

IPA Name	IUCN categories	Description
		culture. Like their ancestors, Wunambal Gaambera people call their country Uunguu – 'our living home' (Ref. 118).
Yawuru	IV, VI	The Yawuru IPA covers 127,914 ha and is multi-tenured - covering the Yawuru Joint-Managed Conservation Estate and multiple other protected areas. It also covers significant cultural and environmental areas of the Roebuck Plains cattle station. The Yawuru people are the Native Title holders of their land and sea - their ancestors have lived along the foreshores of Roebuck Bay, across the Pindan Plains and inland along the fringes of the Great Sandy Desert for thousands of years. Yawuru country was created and given form by *Bugarrigarra* and is the source of Yawuru spirit, culture and language. Yawuru relationship to country is guided by *mabu buru* (healthy country), *mabu ngarrungunil* (healthy community) and *mabu liyan* (good feelings). Yawuru people live on their country as an interconnected landscape by the cycle of the seasons (Ref. 119).

Source: Ref: 122

4.5.3.2 Native Title

Native Title recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs, and is administered under the *Native Title Act 1993* (Cth).

The PA overlaps with multiple native title claims and determinants, as detailed in Table 4-6.

Table 4-7: Native Title

Tribunal ID	Name	Native Title holders
WCD2015/005	Balanggarra #4	Members of the Balanggarra community as referred to in Schedule Six of the Orders
WCD2013/005	Balanggarra (Combined)	Members of the Balanggarra community
WCD2005/003	Bardi and Jawi Native Title Determination	Bardi and Jawi People
WCD2018/005	Bindunbur	The Jabirr Jabirr/Ngumbarl, Nyul Nyul and Nimanburr people
WCD2020/008	Boorroola Moorrool Moorrool Part A	Nyikina People
WCD2011/002	Dambimangari	Wanjina Wunggurr Community
WCD2019/016	Gnulli, Gnulli #2 and Gnulli #3 - Yinggarda, Baiyungu and Thalanyji People	Baiyungu, Thalanyji, Yinggarda People
WCD2018/004	Jabirr Jabirr/Ngumbarl	Jabirr Jabirr/Ngumbarl people
WCD2020/002^	Jabirr Jabirr/Ngumbarl Part B	Jabirr Jabirr/Ngumbarl People
WCD2018/015	Kariyarra	Kariyarra community
WCD2002/001^	Karajarri People (Area A)	Karajarri People
WCD2004/002^	Karajarri People (Area B)	Karajarri People
WCD2018/012	Malgana Part A	Malgana People
WCD2019/007	Mayala #2	(Not defined in database)

Tribunal ID	Name	Native Title holders
WCD2018/009	Mayala People	(Not defined in database)
WCD2006/002	Miriuwung Gajerrong #4	The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija groups and other Aboriginal people who are acknowledged by these groups as having rights in the determination area.
WCD2003/001	Miriuwung-Gajerrong (Western Australia)	Miriuwung (including Yirralalem, Ngamoowalem, Wiram, Yardanggarlm, Nganalam and Mandangala), Gajerrong, Doolboong, Wardenybeng and Gija and, in respect to Boorroongoong (Lacrosse Island), also Balangarra.
WCD2019/014^	Nanda People Part B, Malgana 2 and Malgana 3	Malgana and Nanda People
WCD2018/011^	Nanda People and Nanda #2	Nanda People
WCD2007/003	Ngarla and Ngarla #2 (Determination Area A)	Members of the Ngarla language group
WCD2005/001	Ngarluma/Yindjibarndi	'Ngarluma People' in relation to the Ngarluma Native Title Area; and 'Yindjibarndi People' in relation to the Yindjibarndi Native Title Area
WCD2012/001^	Nyangumarta-Karajarri Overlap Proceeding (Yawinya)	The Nyangumarta People and the Karajarri People
WCD2014/003^	Nyikina Mangala	The Nyikina Mangala People
WCD2006/001	Rubibi Community	Yawuru Community
WCD2001/003^	Rubibi Community	Yawuru Community
WCD2008/003^	Thalanyji	Thalanyji people
WCD2011/001	Uunguu Part A	Members of the Wanjina Wunggurr Community
WCD2012/003^	Uunguu - Area B	Wanjina-Wunggurr Community
WCD2004/001^	Wanjina - Wunggurr Wilinggin Native Title Determination No 1	Members of the Wanjina-Wunggurr Community
WCD2020/010	Warrwa Combined Part A	Warrwa People
WCD2020/009	Warrwa Mawadjala Gadjidgar	Warrwa Mawadjala Gadjidgar
WCD2018/006	Yaburara & Mardudhunera People	The Mardudhunera People
WCD2020/001	Yamatji Nation	(Not defined in database)

^ Native Title identified in database review but not expected to be exposed to CAPL's activities (as located inland, and due to Native Title existing in parts of the determination area).

Source: Ref. 123

4.5.3.3 Aboriginal Heritage Sites

The *Aboriginal Cultural Heritage Act 2021* (WA) protects and manages Aboriginal heritage sites within WA. Only Aboriginal Heritage places, which has been assessed as meeting section 5 of the *Aboriginal Cultural Heritage Act 2021* (WA)[8], with a potential coastal and/or marine interface that intersects with the geographic extent of the PA have been included. This is considered a conservative approach, as the heritage sites within the Department of Planning, Lands and Heritage (DPLH) spatial dataset (Ref. 120) include a buffer around sites to protect privacy regarding the location. As such, the identified heritage sites may not be present within the PA.

4.6 GIS analysis of the DPLH spatial dataset (Ref. 120) indicates that over 1,200 Aboriginal Heritage sites have the potential to be within the PA. Given this number, no additional detail is provided in this document. If heritage places are present within an EMBA described in a project-specific EP, CAPL will identify and detail the significance of these sites in that EP.Defence

Table 4-7 lists the Australian Department of Defence's prohibited and training areas that are within the PA (Ref. 90).

Table 4-8: Department of Defence Prohibited and Training Areas

Area Type	Area Name
Practice Areas	Darwin AWR Central
	Learmonth AWR
	North-West Australian Exercise Area
Training Areas	North Australian Exercise Area
	Yampi Field Training Area
	Learmonth AWR
	West Australian Exercise Area

4.7 Tourism

Tourism is an important industry for WA, directly employing 56 300 people and indirectly employing a further 22,100 (Ref. 91). The value of the WA tourism industry is AU$7.2 billion by Gross State Product (Ref. 91).

Tourism is already a vital economic driver of the Northern Territory and is forecast to continue its strong growth in future years. Marine-based tourism in northern Australia is mainly associated with recreational fishing, but also includes cruise shipping, SCUBA diving and bird watching (Ref. 105). The majority of recreational fishing effort in northern Australia is restricted to coastal waters, during the dry season (Ref. 105).

Charter fishing, diving, snorkelling, whale, marine turtle and dolphin watching and cruising are the main commercial tourism activities in and adjacent to the North-west Marine Region. With the exception of offshore charter fishing, most marine tourism activities occur in State waters (Ref. 106).

Within the South-west Marine Bioregion, whale, seal and dolphin watching, together with charter fishing are the main commercial tourism activities (Ref. 107). Charter fishing activities may occur in both State and Commonwealth waters,

[8] In August 2023, the WA Government announced that the *Aboriginal Cultural Heritage Act 2021* (WA) will be repealed. However, this Act remains in force until the *Aboriginal Heritage Legislation Amendment and Repeal Bill 2023* (WA) is enacted, which will reinstate the previous *Aboriginal Heritage Act 1972* (WA) with amendments.

while marine mammal watching activities tend to occur in coastal waters (Ref. 107).

Within the IOT, tourism activities associated with the Christmas Island Marine Park and Cocos (Keeling) Islands Marine Park include scuba diving, snorkelling, kite surfing, kayaking, free diving and fishing (Ref. 108).

5 acronyms and abbreviations

Table 5-1 defines the acronyms and abbreviations used in this document.

Table 5-1: Term, acronyms and abbreviations

Acronym or abbreviation	Definition
~	Approximately
<	Less/fewer than
>	Greater/more than
AHC	Australian Heritage Commission
AIMS	Australian Institute of Marine Science
AIS	Automatic identification System
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
AU$	Australian dollar
AWR	Air Weapons Range
BIA	Biologically Important Area; a spatially defined area where aggregations of individuals of a species are known to display biologically important behaviours such as breeding, foraging, resting, or migration
BP	Before Present
CAMBA	China–Australia Migratory Bird Agreement
CAPL	Chevron Australia Pty Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Doline	A shallow depression, either funnel- or saucer-shaped, with a floor covered by cultivated soil, formed by solution in limestone country
DPIRD	Western Australian Department of Primary Industries and Regional Development
DTA	Defence Training Area
EEA	Environmental Exposure Area (now referred to as the Planning Area for Scientific Monitoring)
EEZ	Exclusive Economic Zone
EMBA	Environment that May Be Affected
Endangered Species	A species that is not critically endangered, but is facing a very high risk of extinction in the wild in the near future.
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
g/L	Grams per litre
GIS	Geographic Information System
ha	Hectare
HMAS	His Majesty's Australian Ship (during World War II)
HMS	His (or Her) Majesty's Ship (British)
HSK	Ship of the German Navy (during World War II)

Acronym or abbreviation	Definition
IBRA	Interim Biogeographic Regionalisation for Australia
IOT	Indian Ocean Territories (Australia)
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
Karst	An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns.
KEF	Key Ecological Feature
km	Kilometre
km^2	Square kilometre
m	Metre
mm	Millimetre
MNES	Matters of National Environmental Significance, as defined in Part 3, Division 1 of the EPBC Act.
MoU	Memorandum of Understanding
ms^{-1}	Metres per second
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NWMR	North West Marine Region
OPGGS(E)R	Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSMP	Operational and Scientific Monitoring Plan
PA	Planning Area
PDSF	Pilbara Demersal Scalefish Fisheries
Photic zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be greatly affected by turbidity.
PKNP	Pulu Keeling National Park
PMST	Protected Matters Search Tool
Priority Species	A species that does not meet the criteria for listing as Threatened Fauna or Declared Rare Flora, but which either may be suspected to be threatened; or is not threatened, but is rare and in need of ongoing monitoring; or is dependent on ongoing management intervention to prevent it from becoming threatened.
Sessile	Permanently attached directly to the substratum by its base (i.e. immobile), without a stalk or stem
SFR	Statutory fishing right
SNES	Species of National Environmental Significance
Stochastic	Random probability distribution or pattern
Swale	A low place in a tract of land, usually moister than the adjacent higher land
SWMR	South-West Marine Region
t	Tonne
TDGDLF	Temperate Demersal Gillnet and Demersal Longline Fishery

Acronym or abbreviation	Definition
TEC	Threatened Ecological Community
Trophic	Relating to food or nutrition / nutritive processes
Vulnerable Species	A species is listed as vulnerable under the EPBC Act if it is not critically endangered or endangered and it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
WA	Western Australia
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery

6 references

The following documentation is either directly referenced in this document or is a recommended source of background information.

Where references and citations have been copied from Government Database sources, the database has been referenced but the references as cited by the databases have not been specified here. For source material, please refer to the governmental databases for specific source references.

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appendix a protected matters search report

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 07-Aug-2023

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	3
National Heritage Places:	9
Wetlands of International Importance (Ramsar	10
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	9
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	189
Listed Migratory Species:	108

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	629
Commonwealth Heritage Places:	45
Listed Marine Species:	211
Whales and Other Cetaceans:	41
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	2
Australian Marine Parks:	63
Habitat Critical to the Survival of Marine Turtles:	5

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	200
Regional Forest Agreements:	1
Nationally Important Wetlands:	29
EPBC Act Referrals:	710
Key Ecological Features (Marine):	23
Biologically Important Areas:	130
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Legal Status
Australian Convict Sites (Fremantle Prison)	WA	Declared property
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
Fremantle Prison (former)	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Natural		
Lesueur National Park	WA	Listed place
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Becher point wetlands	Within Ramsar site
Eighty-mile beach	Within Ramsar site
Forrestdale and thomsons lakes	Within 10km of Ramsar site
Hosnies spring	Within Ramsar site

Ramsar Site Name	Proximity
Ord river floodplain	Within Ramsar site
Peel-yalgorup system	Within Ramsar site
Pulu keeling national park	Within Ramsar site
Roebuck bay	Within Ramsar site
The dales	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea
EEZ and Territorial Sea
EEZ and Territorial Sea
Extended Continental Shelf
Extended Continental Shelf
Extended Continental Shelf
Extended Continental Shelf
Extended Continental Shelf
Extended Continental Shelf

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Aquatic Root Mat Community in Caves of the Swan Coastal Plain	Endangered	Community known to occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area

Community Name	Threatened Category	Presence Text
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbial) community of coastal freshwater lakes of the Swan Coastal Plain (Lake Richmond)	Endangered	Community known to occur within area
Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	Critically Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Accipiter hiogaster natalis Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Chalcophaps indica natalis Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hypotaenidia philippensis andrewsi Buff-banded Rail (Cocos (Keeling) Islands), Ayam Hutan [88994]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Endangered	Species or species habitat known to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Zanda baudinii listed as Calyptorhynchus baudinii Baudin's Cockatoo, Baudin's Black-Cockatoo, Long-billed Black-cockatoo [87736]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Breeding known to occur within area
CRUSTACEAN		
Kumonga exleyi		
Cape Range Remipede [86875]	Vulnerable	Species or species habitat known to occur within area
FISH		
Galaxiella nigrostriata		
Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat likely to occur within area
Hoplostethus atlanticus		
Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Milyeringa veritas		
Cape Range Cave Gudgeon, Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Nannatherina balstoni		
Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat likely to occur within area
Ophisternon candidum		
Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Breeding known to occur within area
INSECT		
Hesperocolletes douglasi		
Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Parantechinus apicalis		
Dibbler [313]	Endangered	Species or species habitat known to occur within area
Perameles bougainville listed as Perameles bougainville bougainville		
Shark Bay Bandicoot [278]	Endangered	Species or species habitat known to occur within area
Petrogale concinna monastria		
Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis lateralis		
Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis		
Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis		
Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat known to occur within area
Pseudomys fieldi		
Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Pteropus natalis		
Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Saccolaimus saccolaimus nudicluniatus		
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Trichosurus vulpecula arnhemensis Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur within area
OTHER		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Acacia forrestiana Forest's Wattle [17235]	Vulnerable	Species or species habitat likely to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Austrostipa bronweniae listed as Austrostipa bronwenae [92773]	Endangered	Species or species habitat likely to occur within area
Austrostipa jacobsiana [87809]	Critically Endangered	Species or species habitat may occur within area
Banksia mimica Summer Honeypot [82765]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Beyeria lepidopetala		
Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella		
Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens		
Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia caesarea subsp. maritima		
Cape Spider-orchid [64856]	Endangered	Species or species habitat likely to occur within area
Caladenia elegans		
Elegant Spider-orchid [56775]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii		
Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Caladenia procera		
Carbunup King Spider Orchid [68679]	Critically Endangered	Species or species habitat may occur within area
Caladenia viridescens		
Dunsborough Spider-orchid [56776]	Endangered	Species or species habitat known to occur within area
Caleana dixonii listed as Paracaleana dixonii		
Sandplain Duck Orchid [87944]	Endangered	Species or species habitat likely to occur within area
Chamelaucium lullfitzii listed as Chamelaucium sp. Gingin (N.G.Marchant 6)		
Gingin Wax [92777]	Endangered (listed as Chamelaucium sp. Gingin	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis dielsii subsp. teres Irwin's Conostylis [3614]	Endangered	Species or species habitat may occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
Drakaea concolor Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat known to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus beardiana Beard's Mallee [18933]	Vulnerable	Species or species habitat may occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat may occur within area
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat likely to occur within area
Eucalyptus suberea Cork Mallee, Mount Lesueur Mallee [5529]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus x phylacis Meelup Mallee [87817]	Endangered	Species or species habitat known to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea batrachioides Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat likely to occur within area
Grevillea humifusa Spreading Grevillea [61182]	Endangered	Species or species habitat may occur within area
Hakea megalosperma Lesueur Hakea [10505]	Vulnerable	Species or species habitat likely to occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Leucopogon marginatus Thick-margined Leucopogon [12527]	Endangered	Species or species habitat likely to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat may occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Melaleuca sp. Wanneroo (G.J. Keighery 16705) [89456]	Endangered	Species or species habitat known to occur within area
Minuria tridens Minnie Daisy [13753]	Vulnerable	Species or species habitat known to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Pterostylis sinuata Northampton Midget Greenhood, Western Swan Greenhood [84991]	Endangered	Species or species habitat likely to occur within area
Seringia exastia Fringed Fire-bush [88920]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Stachystemon nematophorus		
Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D.Papenfus 696)		
Selena's Synaphea [82881]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Pinjarra Plain (A.S.George 17182)		
[86878]	Endangered	Species or species habitat may occur within area
Synaphea sp. Serpentine (G.R.Brand 103)		
[86879]	Critically Endangered	Species or species habitat may occur within area
Synaphea stenoloba		
Dwellingup Synaphea [66311]	Endangered	Species or species habitat known to occur within area
Tectaria devexa		
Cave Fern [14767]	Endangered	Species or species habitat likely to occur within area
Tetratheca nephelioides		
[83217]	Critically Endangered	Species or species habitat likely to occur within area
Thelymitra stellata		
Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area
Wurmbea calcicola		
Naturaliste Nancy [64691]	Endangered	Species or species habitat known to occur within area
Wurmbea tubulosa		
Long-flowered Nancy [12739]	Endangered	Species or species habitat known to occur within area
REPTILE		
Acanthophis hawkei		
Plains Death Adder [83821]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Ctenotus lancelini Lancelin Island Skink [1482]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area
Liopholis pulchra longicauda Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely to occur within area
SHARK		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato listed as Centrophorus zeehaani Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area
SPIDER		
Idiosoma nigrum		
Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Breeding known to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - ARTILLERY BARRACKS - FREMANTLE [50155]	WA
Defence - BROOME TRAINING DEPOT [50141]	WA
Defence - BUNBURY TRAINING DEPOT [50142]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50181]	WA

Commonwealth Land Name	State
Defence - CAMPBELL BARRACKS - SWANBOURNE [50183]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50182]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50187]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50186]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50185]	WA
Defence - CAMPBELL BARRACKS - SWANBOURNE [50184]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50124]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50127]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50126]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50129]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50128]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50125]	WA
Defence - EXMOUTH NAVAL HF RECEIVING STATION (H/F Receiving Station, Learmonth, WA) [50130]	WA
Defence - EXMOUTH VLF TRANSMITTER STATION [50123]	WA
Defence - EXMOUTH VLF TRANSMITTER STATION [50122]	WA
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50195]	WA
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50197]	WA
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50196]	WA
Defence - GREENOUGH RIFLE RANGE [50234]	WA
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND [50133]	WA
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND [50134]	WA
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND [50117]	WA
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND [50131]	WA
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND [50132]	WA

Commonwealth Land Name	State
Defence - LANCELIN TRAINING AREA [50120]	WA
Defence - LANCELIN TRAINING AREA [50121]	WA
Defence - LEARMONTH - AIR WEAPONS RANGE [50193]	WA
Defence - LEARMONTH - RAAF BASE [50101]	WA
Defence - LEARMONTH - RAAF BASE [50107]	WA
Defence - LEARMONTH - RAAF BASE [50100]	WA
Defence - LEARMONTH - RAAF BASE [50102]	WA
Defence - LEARMONTH - RAAF BASE [50108]	WA
Defence - LEARMONTH - RAAF BASE [50109]	WA
Defence - LEARMONTH - RAAF BASE [50106]	WA
Defence - LEARMONTH - RAAF BASE [50104]	WA
Defence - LEARMONTH - RAAF BASE [50105]	WA
Defence - LEARMONTH - RAAF BASE [50103]	WA
Defence - LEARMONTH - RAAF BASE [50096]	WA
Defence - LEARMONTH - RAAF BASE [50099]	WA
Defence - LEARMONTH - RAAF BASE [50098]	WA
Defence - LEARMONTH - RAAF BASE [50097]	WA
Defence - LEARMONTH RADAR SITE - TWIN TANKS EXMOUTH [50002]	WA
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH [50001]	WA
Defence - LEARMONTH TRANSMITTING STATION [50239]	WA
Defence - NORFORCE DEPOT - DERBY [50144]	WA
Defence - RAAF BASE CURTIN [50113]	WA
Defence - ROCKINGHAM - NAVY CPSO [50135]	WA
Defence - SWANBOURNE RIFLE RANGE [50191]	WA
Defence - SWANBOURNE RIFLE RANGE [50188]	WA
Defence - YAMPI SOUND TRAINING AREA [50145]	WA

Commonwealth Land Name	State
Environment and Heritage	
Commonwealth Land - Christmas Island National Park [94103]	CI
Commonwealth Land - Christmas Island National Park [94102]	CI
Commonwealth Land - Christmas Island National Park [94101]	CI
Commonwealth Land - Christmas Island National Park [94104]	CI
Commonwealth Land - Christmas Island National Park [94105]	CI
Commonwealth Land - Pulu Keeling National Park [95001]	CKI
Commonwealth Land - Pulu Keeling National Park [95002]	CKI
Unknown	
Commonwealth Land - [51080]	WA
Commonwealth Land - [51081]	WA
Commonwealth Land - [50628]	WA
Commonwealth Land - [51085]	WA
Commonwealth Land - [51404]	WA
Commonwealth Land - [51086]	WA
Commonwealth Land - [51084]	WA
Commonwealth Land - [51403]	WA
Commonwealth Land - [94211]	CI
Commonwealth Land - [94213]	CI
Commonwealth Land - [50612]	WA
Commonwealth Land - [50621]	WA
Commonwealth Land - [50620]	WA
Commonwealth Land - [51088]	WA
Commonwealth Land - [50622]	WA
Commonwealth Land - [50625]	WA
Commonwealth Land - [50626]	WA
Commonwealth Land - [50629]	WA
Commonwealth Land - [94210]	CI

Commonwealth Land Name	State
Commonwealth Land - [94215]	CI
Commonwealth Land - [94217]	CI
Commonwealth Land - [94219]	CI
Commonwealth Land - [94214]	CI
Commonwealth Land - [50498]	WA
Commonwealth Land - [94218]	CI
Commonwealth Land - [50424]	WA
Commonwealth Land - [50355]	WA
Commonwealth Land - [94212]	CI
Commonwealth Land - [96014]	CKI
Commonwealth Land - [51434]	WA
Commonwealth Land - [51436]	WA
Commonwealth Land - [51437]	WA
Commonwealth Land - [50408]	WA
Commonwealth Land - [94201]	CI
Commonwealth Land - [94202]	CI
Commonwealth Land - [94208]	CI
Commonwealth Land - [94209]	CI
Commonwealth Land - [50385]	WA
Commonwealth Land - [94204]	CI
Commonwealth Land - [94205]	CI
Commonwealth Land - [94206]	CI
Commonwealth Land - [94207]	CI
Commonwealth Land - [50437]	WA
Commonwealth Land - [50436]	WA
Commonwealth Land - [50439]	WA
Commonwealth Land - [50438]	WA

Commonwealth Land Name	State
Commonwealth Land - [94246]	CI
Commonwealth Land - [96002]	CKI
Commonwealth Land - [50432]	WA
Commonwealth Land - [50430]	WA
Commonwealth Land - [50434]	WA
Commonwealth Land - [50433]	WA
Commonwealth Land - [51807]	WA
Commonwealth Land - [94239]	CI
Commonwealth Land - [51715]	WA
Commonwealth Land - [51714]	WA
Commonwealth Land - [51716]	WA
Commonwealth Land - [51711]	WA
Commonwealth Land - [51710]	WA
Commonwealth Land - [51713]	WA
Commonwealth Land - [51712]	WA
Commonwealth Land - [51719]	WA
Commonwealth Land - [51718]	WA
Commonwealth Land - [51888]	WA
Commonwealth Land - [51667]	WA
Commonwealth Land - [51889]	WA
Commonwealth Land - [51887]	WA
Commonwealth Land - [51886]	WA
Commonwealth Land - [51666]	WA
Commonwealth Land - [51668]	WA
Commonwealth Land - [51671]	WA
Commonwealth Land - [51670]	WA
Commonwealth Land - [51092]	WA

Commonwealth Land Name	State
Commonwealth Land - [51411]	WA
Commonwealth Land - [51094]	WA
Commonwealth Land - [51091]	WA
Commonwealth Land - [51099]	WA
Commonwealth Land - [51098]	WA
Commonwealth Land - [51672]	WA
Commonwealth Land - [51890]	WA
Commonwealth Land - [51966]	WA
Commonwealth Land - [50611]	WA
Commonwealth Land - [50618]	WA
Commonwealth Land - [50619]	WA
Commonwealth Land - [50568]	WA
Commonwealth Land - [50569]	WA
Commonwealth Land - [50564]	WA
Commonwealth Land - [50565]	WA
Commonwealth Land - [51698]	WA
Commonwealth Land - [51696]	WA
Commonwealth Land - [50587]	WA
Commonwealth Land - [51699]	WA
Commonwealth Land - [51894]	WA
Commonwealth Land - [52200]	WA
Commonwealth Land - [51695]	WA
Commonwealth Land - [51987]	WA
Commonwealth Land - [50585]	WA
Commonwealth Land - [50586]	WA
Commonwealth Land - [50584]	WA
Commonwealth Land - [50616]	WA

Commonwealth Land Name	State
Commonwealth Land - [50617]	WA
Commonwealth Land - [50588]	WA
Commonwealth Land - [50589]	WA
Commonwealth Land - [50580]	WA
Commonwealth Land - [50581]	WA
Commonwealth Land - [50582]	WA
Commonwealth Land - [50583]	WA
Commonwealth Land - [50615]	WA
Commonwealth Land - [50614]	WA
Commonwealth Land - [50613]	WA
Commonwealth Land - [51708]	WA
Commonwealth Land - [50370]	WA
Commonwealth Land - [94273]	CI
Commonwealth Land - [94272]	CI
Commonwealth Land - [94275]	CI
Commonwealth Land - [94274]	CI
Commonwealth Land - [94277]	CI
Commonwealth Land - [94276]	CI
Commonwealth Land - [50636]	WA
Commonwealth Land - [50378]	WA
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Commonwealth Heritage Places

[Resource Information]

Name	State	Status
Historic		
Administration Building Forecourt	EXT	Listed place
Administrators House Precinct	EXT	Listed place
Artillery Barracks	WA	Listed place
Bungalow 702	EXT	Listed place
Captain Ballards Grave	EXT	Listed place
Cliff Point Historic Site	WA	Listed place
Direction Island (DI) Houses	EXT	Listed place
Drumsite Industrial Area	EXT	Listed place
Early Settlers Graves	EXT	Listed place
Geraldton Drill Hall Complex	WA	Listed place
Government House	EXT	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Home Island Cemetery	EXT	Listed place
Home Island Foreshore	EXT	Listed place
Home Island Industrial Precinct	EXT	Listed place

Name	State	Status
Industrial and Administrative Group	EXT	Listed place
J Gun Battery	WA	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Oceania House and Surrounds	EXT	Listed place
Old Co-op Shop (Canteen)	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Qantas Huts (former)	EXT	Listed place
RAAF Memorial	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
Six Inch Guns	EXT	Listed place
Slipway and Tank	EXT	Listed place
South Point Settlement Remains	EXT	Listed place
Type 2 Residences	EXT	Listed place
Type T Houses Precinct	EXT	Listed place
West Island Elevated Houses	EXT	Listed place
West Island Housing Precinct	EXT	Listed place
West Island Mosque	EXT	Listed place
Indigenous		
Oombalai Area	WA	Within listed place
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Christmas Island Natural Areas	EXT	Listed place
Garden Island	WA	Listed place
Lancelin Defence Training Area	WA	Listed place
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place

Name	State	Status
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
North Keeling Island	EXT	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Yampi Defence Area	WA	Listed place

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area overfly marine area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Cecropis daurica as Hirundo daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
[Phaethon lepturus] White-tailed Tropicbird [1014]		Breeding known to occur within area
[Phaethon lepturus fulvus] Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat known to occur within area
[Phaethon rubricauda] Red-tailed Tropicbird [994]		Breeding known to occur within area
[Phalacrocorax fuscescens] Black-faced Cormorant [59660]		Breeding likely to occur within area
[Phalaropus lobatus] Red-necked Phalarope [838]		Roosting known to occur within area
[Philomachus pugnax] Ruff (Reeve) [850]		Roosting known to occur within area overfly marine area
[Phoebetria fusca] Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
[Pluvialis fulva] Pacific Golden Plover [25545]		Roosting known to occur within area
[Pluvialis squatarola] Grey Plover [865]		Roosting known to occur within area overfly marine area
[Pterodroma macroptera] Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
[Pterodroma mollis] Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Puffinus assimilis] Little Shearwater [59363]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area overfly marine area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Choeroichthys sculptus Sculptured Pipefish [66197]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Reptile		

Scientific Name	Threatened Category	Presence Text
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Chitulia inornata as Hydrophis inornatus Plain Seasnake [87379]		Species or species habitat may occur within area
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		Species or species habitat may occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli Small-headed Seasnake [75601]		Species or species habitat may occur within area
Lapemis curtus as Lapemis hardwickii Spine-bellied Seasnake [83554]		Species or species habitat may occur within area
Leioselasma coggeri as Hydrophis coggeri Black-headed Sea Snake, Slender-necked Seasnake [87373]		Species or species habitat may occur within area
Leioselasma czeblukovi as Hydrophis czeblukovi Fine-spined Seasnake, Geometrical Seasnake [87374]		Species or species habitat may occur within area
Leioselasma pacifica as Hydrophis pacificus Large-headed Seasnake, Pacific Seasnake [87378]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Sousa sahulensis Australian Humpback Dolphin [87942]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Commonwealth Reserves Terrestrial [Resource Information]

Name	State	Type
Christmas Island	EXT	National Park (Commonwealth)
Pulu Keeling	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories

Park Name	Zone & IUCN Categories
Abrolhos	Habitat Protection Zone (IUCN IV)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Christmas Island	Habitat Protection Zone (IUCN IV)
Cocos (Keeling) Islands	Habitat Protection Zone (IUCN IV)
Dampier	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Habitat Protection Zone (IUCN IV)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Dampier	Multiple Use Zone (IUCN VI)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Multiple Use Zone (IUCN VI)
Geographe	Multiple Use Zone (IUCN VI)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)

Park Name	Zone & IUCN Categories
Kimberley	Multiple Use Zone (IUCN VI)
Montebello	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Perth Canyon	Multiple Use Zone (IUCN VI)
Perth Canyon	Multiple Use Zone (IUCN VI)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
South-west Corner	Multiple Use Zone (IUCN VI)
Two Rocks	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	National Park Zone (IUCN II)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Christmas Island	National Park Zone (IUCN II)
Cocos (Keeling) Islands	National Park Zone (IUCN II)
Cocos (Keeling) Islands	National Park Zone (IUCN II)
Cocos (Keeling) Islands	National Park Zone (IUCN II)
Dampier	National Park Zone (IUCN II)
Gascoyne	National Park Zone (IUCN II)
Jurien	National Park Zone (IUCN II)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Ningaloo	National Park Zone (IUCN II)
Perth Canyon	National Park Zone (IUCN II)
Perth Canyon	National Park Zone (IUCN II)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	National Park Zone (IUCN II)

Park Name	Zone & IUCN Categories
Two Rocks	National Park Zone (IUCN II)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ningaloo	Recreational Use Zone (IUCN IV)
Ningaloo	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Cartier Island	Sanctuary Zone (IUCN Ia)
Abrolhos	Special Purpose Zone (IUCN VI)
Abrolhos	Special Purpose Zone (IUCN VI)
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)
Jurien	Special Purpose Zone (IUCN VI)
Geographe	Special Purpose Zone (Mining Exclusion) (IUCN VI)
South-west Corner	Special Purpose Zone (Mining Exclusion) (IUCN VI)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles

Scientific Name	Behaviour	Presence
Aug - Sep		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
May - Jul		
Lepidochelys olivacea Olive Ridley Turtle [1767]	Nesting	Known to occur

Scientific Name	Behaviour	Presence
Nov-Feb		
Caretta caretta		
Loggerhead Turtle [1763]	Nesting	Known to occur
Nov - May		
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Nesting	Known to occur

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Abrolhos Islands	Fish Habitat Protection Area	WA
Adele Island	Nature Reserve	WA
Airlie Island	Nature Reserve	WA
Austin Bay	Nature Reserve	WA
Balanggarra	Indigenous Protected Area	WA
Bardi Jawi	Indigenous Protected Area	WA
Barrow Island	Nature Reserve	WA
Barrow Island	Marine Management Area	WA
Barrow Island	Marine Park	WA
Beagle Islands	Nature Reserve	WA
Bedout Island	Nature Reserve	WA
Beekeepers	Nature Reserve	WA
Bernier And Dorre Islands	Nature Reserve	WA
Bessieres Island	Nature Reserve	WA
Bold Park	Botanic Gardens	WA
Boodalan	Nature Reserve	WA
Boodie, Double Middle Islands	Nature Reserve	WA

Protected Area Name	Reserve Type	State
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	Nature Reserve	WA
Broome Bird Observatory	5(1)(h) Reserve	WA
Broome Wildlife Centre	5(1)(h) Reserve	WA
Browse Island	Nature Reserve	WA
Buller, Whittell And Green Islands	Nature Reserve	WA
Bundegi Coastal Park	5(1)(h) Reserve	WA
Burnside And Simpson Island	Nature Reserve	WA
Cape Range	National Park	WA
Cape Range	Conservation Park	WA
Cape Range (South)	National Park	WA
Carnac Island	Nature Reserve	WA
Cervantes Islands	Nature Reserve	WA
Cottesloe Reef	Fish Habitat Protection Area	WA
Coulomb Point	Nature Reserve	WA
Crampton	Nature Reserve	WA
Creery Island	Nature Reserve	WA
Dambimangari	Indigenous Protected Area	WA
Dirk Hartog Island	National Park	WA
Drovers Cave	National Park	WA
Eighty Mile Beach	Marine Park	WA
Escape Island	Nature Reserve	WA
Essex Rocks	Nature Reserve	WA
Fisherman Islands	Nature Reserve	WA
Freycinet, Double Islands etc	Nature Reserve	WA
Giralia	NRS Addition - Gazettal in Progress	WA

Protected Area Name	Reserve Type	State
Gnandaroo Island	Nature Reserve	WA
Great Sandy Island	Nature Reserve	WA
Houtman Abrolhos Islands	National Park	WA
Jarrkunpungu	Nature Reserve	WA
Jinmarnkur	Conservation Park	WA
Jinmarnkur Kulja	Nature Reserve	WA
Jurabi Coastal Park	5(1)(h) Reserve	WA
Jurien Bay	Marine Park	WA
Kalbarri	National Park	WA
Karajarri	Indigenous Protected Area	WA
Koks Island	Nature Reserve	WA
Kooljerrenup	Nature Reserve	WA
Kujungurru Warrarn	Nature Reserve	WA
Kujungurru Warrarn	Conservation Park	WA
Lacepede Islands	Nature Reserve	WA
Lake McLarty	Nature Reserve	WA
Lake Mealup	Nature Reserve	WA
Lalang-garram / Camden Sound	Marine Park	WA
Lalang-garram / Horizontal Falls	Marine Park	WA
Lancelin And Edwards Islands	Nature Reserve	WA
Lancelin Island Lagoon	Fish Habitat Protection Area	WA
Leeuwin-Naturaliste	National Park	WA
Len Howard	Conservation Park	WA
Leschenault Peninsula	Conservation Park	WA
Lesueur	National Park	WA
Lesueur Island	Nature Reserve	WA

Protected Area Name	Reserve Type	State
Lipfert, Milligan, Etc Islands	Nature Reserve	WA
Little Rocky Island	Nature Reserve	WA
Locker Island	Nature Reserve	WA
Lowendal Islands	Nature Reserve	WA
Low Rocks	Nature Reserve	WA
Marmion	Marine Park	WA
McLarty	Nature Reserve	WA
Mealup Point	Nature Reserve	WA
Miaboolya Beach	Fish Habitat Protection Area	WA
Mijing	5(1)(h) Reserve	WA
Mitchell River	National Park	WA
Montebello Islands	Conservation Park	WA
Montebello Islands	Conservation Park	WA
Montebello Islands	Marine Park	WA
Muiron Islands	Nature Reserve	WA
Muiron Islands	Marine Management Area	WA
Nambung	National Park	WA
Nanga Station	NRS Addition - Gazettal in Progress	WA
Neerabup	Nature Reserve	WA
Neerabup	National Park	WA
Ngari Capes	Marine Park	WA
Niiwalarra Islands	National Park	WA
Nilgen	Nature Reserve	WA
Ningaloo	Marine Park	WA
North Kimberley	Marine Park	WA

Protected Area Name	Reserve Type	State
North Lalang-garram	Marine Park	WA
North Sandy Island	Nature Reserve	WA
North Turtle Island	Nature Reserve	WA
NTWA Bushland covenant (0004)	Conservation Covenant	WA
NTWA Bushland covenant (0070)	Conservation Covenant	WA
NTWA Bushland covenant (0095)	Conservation Covenant	WA
Nyangumarta Warrarn	Indigenous Protected Area	WA
Nyangumarta Warrarn	Indigenous Protected Area	WA
Nyingguulu (Ningaloo) Coastal Reserve	5(1)(h) Reserve	WA
Ord River	Nature Reserve	WA
Outer Rocks	Nature Reserve	WA
Pelican Island	Nature Reserve	WA
Penguin Island	Conservation Park	WA
Point Quobba	Fish Habitat Protection Area	WA
Port Kennedy Scientific Park	Nature Reserve	WA
Prince Regent	National Park	WA
Rocky Island	Nature Reserve	WA
Ronsard Rocks	Nature Reserve	WA
Rottnest Island	State Reserve	WA
Round Island	Nature Reserve	WA
Rowley Shoals	Marine Park	WA
Sandland Island	Nature Reserve	WA
Scott Reef	Nature Reserve	WA
Serrurier Island	Nature Reserve	WA
Shark Bay	Marine Park	WA

Protected Area Name	Reserve Type	State
Shoalwater Bay Islands	Nature Reserve	WA
Shoalwater Islands	Marine Park	WA
Southern Beekeepers	Nature Reserve	WA
Sugar Loaf Rock	Nature Reserve	WA
Swan Island	Nature Reserve	WA
Swan River	Management Area	WA
Tamala Pastoral Lease (Part)	NRS Addition - Gazettal in Progress	WA
Tanner Island	Nature Reserve	WA
Tent Island	Nature Reserve	WA
Thevenard Island	Nature Reserve	WA
Unnamed WA01086	5(1)(h) Reserve	WA
Unnamed WA11883	5(1)(h) Reserve	WA
Unnamed WA26400	5(1)(h) Reserve	WA
Unnamed WA28968	5(1)(h) Reserve	WA
Unnamed WA33287	Nature Reserve	WA
Unnamed WA33799	Nature Reserve	WA
Unnamed WA34039	5(1)(h) Reserve	WA
Unnamed WA36915	Nature Reserve	WA
Unnamed WA37168	5(1)(h) Reserve	WA
Unnamed WA37338	5(1)(h) Reserve	WA
Unnamed WA37383	5(1)(h) Reserve	WA
Unnamed WA40322	5(1)(h) Reserve	WA
Unnamed WA40564	Nature Reserve	WA
Unnamed WA40828	5(1)(h) Reserve	WA
Unnamed WA40877	5(1)(h) Reserve	WA
Unnamed WA41080	5(1)(h) Reserve	WA

Protected Area Name	Reserve Type	State
Unnamed WA41102	5(1)(h) Reserve	WA
Unnamed WA41160	5(1)(g) Reserve	WA
Unnamed WA41775	5(1)(h) Reserve	WA
Unnamed WA42030	5(1)(g) Reserve	WA
Unnamed WA42469	Nature Reserve	WA
Unnamed WA43786	5(1)(h) Reserve	WA
Unnamed WA43903	Nature Reserve	WA
Unnamed WA44004	Nature Reserve	WA
Unnamed WA44665	5(1)(h) Reserve	WA
Unnamed WA44667	5(1)(h) Reserve	WA
Unnamed WA44669	5(1)(h) Reserve	WA
Unnamed WA44672	5(1)(h) Reserve	WA
Unnamed WA44673	5(1)(h) Reserve	WA
Unnamed WA44677	5(1)(h) Reserve	WA
Unnamed WA44682	5(1)(h) Reserve	WA
Unnamed WA44688	5(1)(h) Reserve	WA
Unnamed WA44977	Nature Reserve	WA
Unnamed WA44978	Nature Reserve	WA
Unnamed WA45089	Nature Reserve	WA
Unnamed WA46661	Nature Reserve	WA
Unnamed WA46982	5(1)(h) Reserve	WA
Unnamed WA46983	5(1)(h) Reserve	WA
Unnamed WA46984	5(1)(h) Reserve	WA
Unnamed WA48205	5(1)(h) Reserve	WA
Unnamed WA48717	Conservation Park	WA
Unnamed WA48858	Nature Reserve	WA
Unnamed WA48968	5(1)(h) Reserve	WA

Protected Area Name	Reserve Type	State
Unnamed WA49220	Conservation Park	WA
Unnamed WA49994	Conservation Park	WA
Unnamed WA51046	5(1)(h) Reserve	WA
Unnamed WA51105	5(1)(h) Reserve	WA
Unnamed WA51162	5(1)(h) Reserve	WA
Unnamed WA51497	5(1)(h) Reserve	WA
Unnamed WA51583	5(1)(h) Reserve	WA
Unnamed WA51617	5(1)(h) Reserve	WA
Unnamed WA51932	5(1)(h) Reserve	WA
Unnamed WA51943	5(1)(h) Reserve	WA
Unnamed WA51944	5(1)(h) Reserve	WA
Unnamed WA52354	5(1)(h) Reserve	WA
Unnamed WA52366	Nature Reserve	WA
Unnamed WA53015	Nature Reserve	WA
Utcha Well	Nature Reserve	WA
Uunguu	Indigenous Protected Area	WA
Victor Island	Nature Reserve	WA
Wanagarren	Nature Reserve	WA
Wedge Island	Nature Reserve	WA
Weld Island	Nature Reserve	WA
Whalebone Island	Nature Reserve	WA
Whitmore,Roberts,Doole Islands And Sandalwood Landing	Nature Reserve	WA
Wilinggin	Indigenous Protected Area	WA
Yalgorup	National Park	WA
Yanchep	National Park	WA

Protected Area Name	Reserve Type	State
Yawuru	Indigenous Protected Area	WA
Yawuru	Indigenous Protected Area	WA
Yawuru Nagulagun / Roebuck Bay	Marine Park	WA
Y Island	Nature Reserve	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
South West WA RFA	Western Australia

Nationally Important Wetlands [Resource Information]

Wetland Name	State
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Becher Point Wetlands	WA
Big Springs	WA
Bunda-Bunda Mound Springs	WA
Bundera Sinkhole	WA
Cape Range Subterranean Waterways	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Hosine's Spring, Christmas Island	EXT
Hutt Lagoon System	WA
Lake MacLeod	WA
Lake McLarty System	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA

Wetland Name	State
Loch McNess System	WA
Mermaid Reef	EXT
Ord Estuary System	WA
Peel-Harvey Estuary	WA
Prince Regent River System	WA
Pulu Keeling National Park	EXT
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Swan-Canning Estuary	WA
Willie Creek Wetlands	WA
Yalgorup Lakes System	WA
Yampi Sound Training Area	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Ashburton Infrastructure Project	2021/9064		Completed
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Cockatoo Island Multi-User Supply Base, WA	2017/7986		Assessment
Cocos West Island Seawater Desalination Plant	2022/09409		Completed
Fremantle District Police Complex Project	2022/09345		Completed
Gorgon Gas Development	2003/1294		Assessment
Jurien East Road Upgrade, 3 km NNE Jurien Bay, WA	2020/8740		Post-Approval
Koolan Island Operations	2022/09392		Assessment
Midwest Offshore Wind Farm	2022/09264		Assessment

Title of referral	Reference	Referral Outcome	Assessment Status
Northern Endeavour Phase 1 Decommissioning	2022/09327		Post-Approval
North West Shelf Project Extension, Carnarvon Basin, WA	2018/8335		Approval
Ocean Barramundi Expansion Project	2022/09272		Assessment
Optimised Mardie Solar Salt Project	2022/9169		Assessment
Production horticulture in Lot 6 and Lot 8 Old Coast Road, Myalup	2020/8827		Assessment
Project Crux Cable Lay and Operation	2022/09441		Completed
Project Highclere Cable Lay and Operation	2022/09203		Completed
Proposed Sand Extraction at Lot 601 Stanley Road, Wellesley, WA	2020/8635		Completed
Ridley Magnetite Project	2023/09477		Referral Decision
Runnymede Road Sand Quarry	2022/09262		Completed
Runnymede Road Sand Quarry	2022/09332		Assessment
Samphire Offshore Wind Farm	2022/09306		Assessment
Sand Extraction on 150 Runnymede Road Binningup	2022/09364		Assessment
Single Jetty Deep Water Port Renewable Hub, WA	2021/8942		Assessment
Yanchep Rail Extension, WA	2018/8262		Post-Approval
Yogi Magnetite Project, 225km east, northeast of Geraldton, WA	2017/8124		Assessment
Action clearly unacceptable			
Asian Renewable Energy Hub Revised Proposal, WA	2021/8891	Action Clearly Unacceptable	Completed
Highlands 3D Marine Seismic Survey	2012/6680	Action Clearly Unacceptable	Completed
Controlled action			
'Van Gogh' Petroleum Field Development	2007/3213	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
2-D seismic survey Scott Reef	2000/125	Controlled Action	Post-Approval
Airborne sonar trials	2001/540	Controlled Action	Completed
Albemarle Lithium hydroxide manufacturing plant, Kemerton, WA	2017/8099	Controlled Action	Post-Approval
Alkimos city centre and central development, WA	2015/7561	Controlled Action	Post-Approval
Alkimos Coastal Node	2020/8861	Controlled Action	Further Information Request
Alkimos Seawater Desalination	2019/8453	Controlled Action	Assessment Approach
Anketell Point Iron Ore Processing & Export Port	2009/5120	Controlled Action	Post-Approval
Asian Renewable Energy Hub, 220 km east of Port Hedland, Western Australia	2017/8112	Controlled Action	Post-Approval
Audacious Oil Field Standalone Development	2001/407	Controlled Action	Completed
Bagieau Road Limestone Quarry	2019/8533	Controlled Action	Further Information Request
Balmoral South Iron Ore Mine	2008/4236	Controlled Action	Post-Approval
Binningup Beach Residential Development, Lots 195, 304, 9003 Lakes Parade, Binningup WA	2009/5046	Controlled Action	Post-Approval
Binowee Iron Ore Project	2001/366	Controlled Action	Proposed Decision
Bluewaters Power Station Expansion Phases 3 & 4	2008/4113	Controlled Action	Proposed Decision
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Breeding, husbandry, slaughter and sale of goats	2004/1895	Controlled Action	Completed
Broome Boating Facility	2021/9098	Controlled Action	Referral Decision
Browse FLNG Development, Commonwealth Waters	2013/7079	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Bunbury Outer Ring Road Northern and Central Section Project, WA	2019/8471	Controlled Action	Post-Approval
Bunbury Port Berth 14A Expansion & Coal Storage & Loading Facility, WA	2014/7200	Controlled Action	Post-Approval
Butler North District Open Space playing fields development, Wanneroo, WA	2017/8053	Controlled Action	Post-Approval
Catalina Residential Development	2010/5785	Controlled Action	Post-Approval
Christmas Island Airport Expansion	2001/434	Controlled Action	Post-Approval
Christmas Island Port Facility	2001/435	Controlled Action	Post-Approval
Clear 2.86 ha of native vegetation for the purpose of horticulture	2010/5655	Controlled Action	Post-Approval
Coburn Mineral Sand Project	2003/1221	Controlled Action	Post-Approval
Conduct an exploration drilling campaign	2010/5718	Controlled Action	Completed
Construct and operate LNG & domestic gas plant including onshore and offshore facilities - Wheatston	2008/4469	Controlled Action	Post-Approval
Construction and operation of a Solar Salt Project, SW Onslow, WA	2016/7793	Controlled Action	Assessment Approach
construction and operation of a unmanned platform at the Cliff Head oil field, a	2003/1300	Controlled Action	Post-Approval
Construction of a Deepwater, General Container Port	2009/5178	Controlled Action	Proposed Decision
Construction of mobile phone tower	2002/694	Controlled Action	Completed
Construction of New Perth Bunbury Highway project	2005/2193	Controlled Action	Post-Approval
Construction of the Oakajee Port and Rail Project	2011/5797	Controlled Action	Post-Approval
Cultural Appearance Upgrade of the Chinese Literary Association Building	2007/3568	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Decommissioning of Buffalo Oil Field	2003/984	Controlled Action	Post-Approval
Decommissioning of Challis Oilfield	2003/942	Controlled Action	Post-Approval
Derby Tidal Power Project	2010/5544	Controlled Action	Final PER Or EIS
Derby Tidal Power Proposal	2001/398	Controlled Action	Completed
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Develop Jansz-Io deepwater gas field in Permit Areas WA-18-R, WA-25-R and WA-26-	2005/2184	Controlled Action	Post-Approval
Development of Angel gas and condensate field, North West Shelf	2004/1805	Controlled Action	Post-Approval
Development of Blacktip Gas Field	2003/1180	Controlled Action	Post-Approval
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Development of Coniston/Novara fields within the Exmouth Sub-basin	2011/5995	Controlled Action	Post-Approval
Development of Kwinana Quay port facility	2008/4387	Controlled Action	Completed
development of land based tourist facilities on Long Island	2006/2792	Controlled Action	Post-Approval
Development of Stybarrow petroleum field incl drilling and facility installation	2004/1469	Controlled Action	Post-Approval
Duchess Paradise Project	2011/6033	Controlled Action	Completed
East Christmas Island Phosphate Mines (9 sites)	2001/487	Controlled Action	Completed
Echo-Yodel Production Wells	2000/11	Controlled Action	Post-Approval
Eco quad tours for West Island visitors and tourists	2010/5749	Controlled Action	Completed
Eglinton/South Yanchep Residential Development	2011/6021	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Eglinton Estates - Clearing of native vegetation from Lot 1007 & part Lot 1008	2010/5777	Controlled Action	Post-Approval
Enfield full field development	2001/257	Controlled Action	Post-Approval
Equus Gas Fields Development Project, Carnarvon Basin	2012/6301	Controlled Action	Completed
Eramurra Industrial Salt Project	2021/9027	Controlled Action	Assessment Approach
Eramurra Industrial Salt Project, near Karratha, WA	2019/8448	Controlled Action	Completed
Excavate sand and limestone resources	2010/5621	Controlled Action	Completed
Exploration for Mineable Phosphate, Christmas Island	2000/43	Controlled Action	Completed
Extension of Lots 4 & 5 Ludlow Road Limestone Extraction, Myalup, WA	2019/8388	Controlled Action	Post-Approval
Gorgon Gas Development 4th Train Proposal	2011/5942	Controlled Action	Post-Approval
Gorgon Gas Revised Development	2008/4178	Controlled Action	Post-Approval
Greater Enfield (Vincent) Development	2005/2110	Controlled Action	Post-Approval
Greater Gorgon Development - Optical Fibre Cable, Mainland to Barrow Island	2005/2141	Controlled Action	Completed
Great Northern Pipeline - 630 km buried gas pipeline	2009/5257	Controlled Action	Completed
Halls Head Shopping Centre stages 2 & 3 expansion	2010/5636	Controlled Action	Post-Approval
Hematite (iron ore) Mine and Beneficiation Plant	2001/542	Controlled Action	Completed
Home Island slipway & access channel from Home Island Port Facility to Directio	2009/4969	Controlled Action	Completed
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Industry Zone	2010/5337	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Iron ore mine	2006/2522	Controlled Action	Post-Approval
Jindee Residential Development	2012/6631	Controlled Action	Post-Approval
Karara Magnetite Project	2006/3017	Controlled Action	Post-Approval
Learmonth Bundle Site and Launchway, WA	2017/8079	Controlled Action	Completed
Leeuwin Offshore Wind Farm	2022/9160	Controlled Action	Assessment Approach
Light Crude Oil Production	2001/365	Controlled Action	Post-Approval
Lily Beach Recreational Facilities	2001/395	Controlled Action	Post-Approval
Lily Beach Rock Pool Development	2001/400	Controlled Action	Completed
Lot 4 Runnymede Road, Wellesley - Proposed Sand Extraction	2020/8862	Controlled Action	Assessment Approach
Lot 505 Hungerford Avenue, Halls Head, WA Residential Development	2009/4789	Controlled Action	Post-Approval
Mandurah Junction Commercial and Residential Development	2010/5410	Controlled Action	Completed
Mangles Bay Marina Based Tourist Precinct	2010/5659	Controlled Action	Post-Approval
Mardie Project, 80 km south west of Karratha, WA	2018/8236	Controlled Action	Post-Approval
Mauds Landing Marina	2000/98	Controlled Action	Completed
Mitchell Freeway Extension and Wanneroo Road Upgrade, WA	2018/8367	Controlled Action	Post-Approval
Mitchell Freeway Extension between Burns Beach Rd and Hester Av, Neerabup, WA	2013/7091	Controlled Action	Post-Approval
Mixed Use Residential and Commercial Development	2009/4919	Controlled Action	Post-Approval
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Nava-1 Cable System	2001/510	Controlled Action	Completed
Neerabup Industrial Estate, Lot 701 Flynn Drive Neerabup WA	2012/6424	Controlled Action	Post-Approval
Neighbourhood Shopping Centre and Mixed Business Centre, Ocean Road, Dawesville	2006/3155	Controlled Action	Post-Approval
Ningaloo Lighthouse Development, 17km north west Exmouth, Western Australia	2020/8693	Controlled Action	Assessment Approach
Ocean Reef Marina Development	2009/4937	Controlled Action	Completed
open cut mine & assoc infrastructure	2005/2381	Controlled Action	Post-Approval
Parklands West Estate Development	2010/5693	Controlled Action	Post-Approval
Peel's Retreat Estate - Residential development	2006/3063	Controlled Action	Post-Approval
Phosphate Mining in South Point Christmas Island	2012/6653	Controlled Action	Post-Approval
Pluto Gas Project	2005/2258	Controlled Action	Completed
Pluto Gas Project Including Site B	2006/2968	Controlled Action	Post-Approval
Pluton Irvine Island Iron Ore Project	2011/6064	Controlled Action	Proposed Decision
Point Grey Marina Project	2010/5515	Controlled Action	Post-Approval
Point Grey Residential Development - Terrestrial Component	2011/5825	Controlled Action	Post-Approval
Port Enhancement Project	2001/266	Controlled Action	Post-Approval
Port Hedland Outer Harbour Development and associated marine and terrestrial in	2008/4159	Controlled Action	Post-Approval
Port Hedland Spoilbank Marina, WA	2019/8520	Controlled Action	Post-Approval
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Proposed excavation and earthworks at existing quarry, prior to subdivision	2008/4562	Controlled Action	Completed
Proposed exploration drilling programme for Christmas Island	2016/7779	Controlled Action	Completed
Proposed Urban Development	2008/3984	Controlled Action	Post-Approval
Proposed Urban Development of Lots 1005 & 1006	2008/4638	Controlled Action	Post-Approval
Proposed West Pilbara Iron Ore Project	2009/4706	Controlled Action	Post-Approval
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed
Public Ferry Hovercraft Operation	2003/1239	Controlled Action	Post-Approval
Pyrenees Oil Fields Development	2005/2034	Controlled Action	Post-Approval
Red-footed booby bird harvest	2002/844	Controlled Action	Referral Decision
Residential Development, Lot 522 Ditchingham Place Australind, WA	2019/8432	Controlled Action	Assessment Approach
Residential development,Lot 609, Yanchep Beach Road, Yanchep, WA	2014/7146	Controlled Action	Post-Approval
Residential development, Lots 21 and 100 Southern Estuary Road, Herron, WA	2017/8135	Controlled Action	Completed
Residential development Lot 1004 Alkimos WA	2011/5902	Controlled Action	Post-Approval
Road Upgrade/Construction between Lily Beach Road and Port Faci	2001/436	Controlled Action	Post-Approval
Rural Subdivision of a 975.2ha property	2004/1635	Controlled Action	Completed
Salvage, transport and processing of phosphate resource with extended airport si	2003/1217	Controlled Action	Post-Approval
Sand and Limestone Excavation Quarry	2008/4229	Controlled Action	Post-Approval
Sand Extraction Project Lot 5 Wellesley Road, Wellesley Shire of	2021/9034	Controlled Action	Assessment Approach

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Harvey			
Sand Mine, Lot 122 Old Coast Road, Parkfield, Binningup, WA	2014/7164	Controlled Action	Post-Approval
Sand Mining on Lot 7 Runnymede Road	2011/5996	Controlled Action	Post-Approval
Shark Hazard Mitigation Drum Line Program, WA	2014/7174	Controlled Action	Completed
Shenton Park Subdivision	2004/1479	Controlled Action	Completed
Simpson Development	2000/59	Controlled Action	Completed
Simpson Oil Field Development	2001/227	Controlled Action	Post-Approval
Southern Seawater Desalination Project	2008/4173	Controlled Action	Post-Approval
Subdivision Lot 1 Dawesville Rd	2005/2394	Controlled Action	Post-Approval
The Scarborough Project - FLNG & assoc subsea infrastructure, Carnarvon Basin	2013/6811	Controlled Action	Post-Approval
Torosa South Initial Appraisal Drilling	2007/3500	Controlled Action	Completed
Tourism Facility and Associated Infrastructure	2005/2038	Controlled Action	Post-Approval
Urban and Residential Development at Lot 9 Brighton	2011/6137	Controlled Action	Post-Approval
Urban development in accordance with the Local Structure Plan	2008/4601	Controlled Action	Post-Approval
Urban Development Ravendale Drive, Coodanup Drive & Wanjeep Street	2011/5928	Controlled Action	Post-Approval
Urban Residential Development at Lot 9049 Marmoin Avenue	2009/5155	Controlled Action	Post-Approval
Vegetation Clearing, Wannaroo Rd and Nowergup Rd	2011/5955	Controlled Action	Completed
Vincent Appraisal Well	2000/22	Controlled Action	Post-Approval
WA Offshore Windfarm	2021/8961	Controlled Action	Assessment Approach

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Warders Hotel, Block 1 Warders Cottages, Fremantle, WA	2018/8144	Controlled Action	Post-Approval
Wuudagu Bauxite Project	2019/8606	Controlled Action	Assessment Approach
Yannarie Solar Salt Project	2004/1679	Controlled Action	Completed
Yardie Creek Road Realignment Project	2021/8967	Controlled Action	Assessment Approach
Yarragadee Water Supply Development	2005/2073	Controlled Action	Completed
Yellow Crazy Ant Biological Control	2013/6836	Controlled Action	Post-Approval
Not controlled action			
'Goodwyn A' Low Pressure Train Project	2003/914	Not Controlled Action	Completed
'Looping 10' gas transmission pipeline from Kwinana to Hopelands	2005/2212	Not Controlled Action	Completed
'Van Gogh' Oil Appraisal Drilling Program, Exploration Permit Area WA-155-P(1)	2006/3148	Not Controlled Action	Completed
2D seismic survey, exploration permit NT/P67	2004/1587	Not Controlled Action	Completed
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
3D marine seismic survey in WA 314P and WA 315P	2004/1927	Not Controlled Action	Completed
96-108 Gaze Road - Residential upgrade	2006/2632	Not Controlled Action	Completed
Accommodation Units Sunday Island Bay, Dirk Hartog Island, WA	2015/7540	Not Controlled Action	Completed
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
AEC International Hydrocarbon Well Puffin 6	2000/36	Not Controlled Action	Completed
Aerial Baiting, Yellow Crazy Ant Supercolonies, Christmas Island, WA	2019/8492	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Airlie Island soil and groundwater investigations, Exmouth Gulf, offshore Pilbara coast	2014/7250	Not Controlled Action	Completed
Alkimos seawater desalination plant, offshore investigations, WA	2018/8224	Not Controlled Action	Completed
Amberton West urban development - Part lot 9005 Eglington WA	2013/7068	Not Controlled Action	Completed
APX-West Fibre-optic telecommunications cable system, WA to Singapore	2013/7102	Not Controlled Action	Completed
Aquaculture - Barramundi grow out, Yampi Sound	2005/2476	Not Controlled Action	Completed
archaeological surveys & excavation at historic sites, Cape Inscription	2006/3027	Not Controlled Action	Completed
Audacious-3 oil drilling well	2003/1042	Not Controlled Action	Completed
Backpacker-1 Offshore Hydrocarbon Exploration Well	2001/300	Not Controlled Action	Completed
Baniyas-1 Exploration Well, EP-424, near Onslow	2007/3282	Not Controlled Action	Completed
Barrow Island 2D Seismic survey	2006/2667	Not Controlled Action	Completed
Boat Ramp Construction	2001/237	Not Controlled Action	Completed
Bollinger 2D Seismic Survey 200km North of North West Cape WA	2004/1868	Not Controlled Action	Completed
Buffalo In-Fill Production Wells	2001/475	Not Controlled Action	Completed
Buffett Close Residential Development	2004/1887	Not Controlled Action	Completed
Building of a carport adjacent to residential house	2004/1538	Not Controlled Action	Completed
Bultaco-2, Laverda-2, Laverda-3 and Montesa-2 Appraisal Wells	2000/103	Not Controlled Action	Completed
Bushfire Mitigation Works - City of Mandurah	2020/8674	Not Controlled Action	Completed
Butler Railway Extension Project - Nowergup Depot Eastern	2011/5989	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Alignment			
Carnarvon 3D Marine Seismic Survey	2004/1890	Not Controlled Action	Completed
Cazadores 2D seismic survey	2004/1720	Not Controlled Action	Completed
Christmas Island/Construction of a double storey shed/carport at MQ387 Gaze Road	2004/1561	Not Controlled Action	Completed
Christmas Island Fuel Consolidation Project, Christmas Island	2012/6454	Not Controlled Action	Completed
Clear Lot 503, 54 Ocean Road Dawesville, WA	2014/7375	Not Controlled Action	Completed
Cliff Head 6 appraisal well	2004/1702	Not Controlled Action	Completed
Cliff Head Appraisal Wells	2003/938	Not Controlled Action	Completed
Cocos (Keeling) Islands Maintenance Dredging Home Island Slipway Redevelopment, Cocos (Keeling) Isla	2014/7140	Not Controlled Action	Completed
Community Recreation Centre	2003/1279	Not Controlled Action	Completed
Construct 110km buried natural gas pipeline from Onslow, connecting to Dampier/Bunbury natural gas p	2013/7039	Not Controlled Action	Completed
Construction and operation of an 8 turbine wind farm at Rous Head Harbour, Frema	2003/933	Not Controlled Action	Completed
Construction and operation of an unmanned sea platform and connecting pipeline to Varanus Island for	2004/1703	Not Controlled Action	Completed
Construction of a Commodities Berth, Wharf and Associated Infrastructure	2008/4129	Not Controlled Action	Completed
Construction of Secret Harbour High School	2004/1489	Not Controlled Action	Completed
Construction of several passing lanes between Lancelin and Jurien Bay, WA	2015/7509	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Container Deposit Scheme Project	2019/8517	Not Controlled Action	Completed
Controlled Source Electromagnetic 2D Survey	2009/4980	Not Controlled Action	Completed
Controlled Source Electromagnetic Survey	2007/3262	Not Controlled Action	Completed
Controlled Source Electromagnetic Survey	2010/5434	Not Controlled Action	Completed
Coot-1 hydrocarbon exploration well, Permit Area AC/L2 or AC/L3	2001/296	Not Controlled Action	Completed
courtyard shower & handbasin facilities	2006/2803	Not Controlled Action	Completed
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Demolish and replace Old Mandurah Traffic Bridge, Mandurah, WA	2015/7415	Not Controlled Action	Completed
Development of 5ha limestone quarry at Lot 2 Ludlow Rd	2006/2568	Not Controlled Action	Completed
Development of Halyard Field off the west coast of WA	2010/5611	Not Controlled Action	Completed
Development of iron ore facilities	2013/7013	Not Controlled Action	Completed
Development of Mutineer and Exeter petroleum fields for oil production, Permit	2003/1033	Not Controlled Action	Completed
Development of new Alkimos Wastwater Treatment Plant	2007/3259	Not Controlled Action	Completed
Differential Global Positioning System (DGPS)	2001/445	Not Controlled Action	Completed
Disposal of residential properties, Fremantle, WA	2019/8593	Not Controlled Action	Completed
Drilling between Kalbarri and Cliff Head	2005/2185	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Drilling of an exploration well Gats-1 in Permit Area WA-261-P	2004/1701	Not Controlled Action	Completed
Drilling of exploration well Audacious-1 in AC/P17	2000/5	Not Controlled Action	Completed
Drilling of exploration wells, Permit areas WA-301-P to WA-305-P	2002/769	Not Controlled Action	Completed
Drilling of Marina-1 Exploration Well	2007/3586	Not Controlled Action	Completed
Dwelling demolition, maintenance and carpark/carport/storage shed works	2004/1837	Not Controlled Action	Completed
Eagle-1 Exploration Drilling, North West Shelf, WA	2019/8578	Not Controlled Action	Completed
Earthworks and Excavation of Lots 2, 13 & 22 Old Coast Road	2009/5101	Not Controlled Action	Completed
Eastport canal estate development stage 5	2007/3737	Not Controlled Action	Completed
Echo A Development WA-23-L, WA-24-L	2005/2042	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Eradication of the European House Borer, Perth metropolitan area, WA	2009/5027	Not Controlled Action	Completed
Establishment of a 12.7 ha Gypsum Mine	2007/3398	Not Controlled Action	Completed
Establishment of a National Lifestyle Village	2011/6081	Not Controlled Action	Completed
Expansion of berthing facilities at Kwinana Bulk Terminal	2006/2509	Not Controlled Action	Completed
Expansion of existing Ammonium Nitrate Production Facility	2005/1941	Not Controlled Action	Completed
Expansion of the Sino Iron Ore Mine and export facilities, Cape Preston, WA	2017/7862	Not Controlled Action	Completed
Expansion Proposal, Mineralogy Cape Preston Iron Ore Project, Cape Preston, WA	2009/5010	Not Controlled Action	Completed
Expedition 369-Australian Cretaceous Climate and Tectonics, Australian EEZ waters	2017/7891	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Exploration Drilling in AC/P17, AC/P18 and AC/P24	2001/359	Not Controlled Action	Completed
Exploration drilling program located in exploration permits WA-286-P and TP/15	2002/676	Not Controlled Action	Completed
Exploration drilling well WA-155-P(1)	2003/971	Not Controlled Action	Completed
Exploration of appraisal wells	2006/3065	Not Controlled Action	Completed
Exploration Well (Taunton-2)	2002/731	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Exploration Well in Permit Area WA-155-P(1)	2002/759	Not Controlled Action	Completed
Exploratory drilling in permit area WA-225-P	2001/490	Not Controlled Action	Completed
Extension of 7.5km of the Joondalup Line electrified passenger railway from Cla	2010/5632	Not Controlled Action	Completed
Extension of a Masonary Brick Wall adjacent to the Poon Saan Club by 500 mm	2004/1564	Not Controlled Action	Completed
Extension of Brittain Road to connect with the South Western Hwy/Robertson Drive intersection	2007/3707	Not Controlled Action	Completed
Extension of Existing Limestone Quarry at Lot 5 Old Coast Road	2006/2831	Not Controlled Action	Completed
Extension of Simpson Oil Platforms & Wells	2002/685	Not Controlled Action	Completed
Extention to the existing Blind Strait Black Lip Pearl Oyster Farm	2004/1342	Not Controlled Action	Completed
External Upgrade of House	2010/5387	Not Controlled Action	Completed
Florida Estate Residential Subdivision Development Stage 13	2011/6045	Not Controlled Action	Completed
Florida North residential development, Lot 9008, Ocean Road, Dawesville, WA	2015/7462	Not Controlled Action	Completed
Flying Fish Cove Christmas Island Boat Ramp Maintenance	2021/8924	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Flying Fish Cove Landslide Mitigation Project	2020/8616	Not Controlled Action	Completed
Fremantle Ports Inner Harbour Capital Dredging Proposal	2005/2477	Not Controlled Action	Completed
Garage and Office Facilities	2004/1919	Not Controlled Action	Completed
Gas-fired Power Station	2005/2213	Not Controlled Action	Completed
Geo-science Investigations	2005/2069	Not Controlled Action	Completed
Gulf Fishing Lodge	2010/5499	Not Controlled Action	Completed
Hadda 1,Flying Foam 1,Magnat 1 exploration drill	2004/1697	Not Controlled Action	Completed
HCA05X Macedon Experimental Survey	2004/1926	Not Controlled Action	Completed
Hess Exploration Drilling Programme	2007/3566	Not Controlled Action	Completed
Housing and Garden Maintenance Works	2004/1487	Not Controlled Action	Completed
Huascaran-1 exploration well (WA-292-P)	2001/539	Not Controlled Action	Completed
Hydroponics Research Program	2007/3338	Not Controlled Action	Completed
Identification of unmarked grave, exhumation/identification of remains which may belong to a sailor	2006/2992	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
Indian Ocean Drive Passing Lane and Widening 52-258 SLK	2017/7884	Not Controlled Action	Completed
Indian Ocean Drive Widening, Gingin Shire, WA	2018/8346	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
INDIGO West Submarine Telecommunications Cable, WA	2017/8126	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Industrial development, Lot 561 Paris Road, Australind, WA	2016/7712	Not Controlled Action	Completed
Infill Production Well (Griffin-9)	2001/417	Not Controlled Action	Completed
Infrasound Monitoring Station	2007/3390	Not Controlled Action	Completed
Installation of a desalination plant and associated infrastructure	2013/6833	Not Controlled Action	Completed
Internal and external modifications Lot 1014 Gaze Road	2004/1807	Not Controlled Action	Completed
Jansz-2 and 3 Appraisal Wells	2002/754	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Kemerton Lateral Gas Pipeline Project	2005/2388	Not Controlled Action	Completed
Kennedy Bay urban development, Port Kennedy, WA	2014/7122	Not Controlled Action	Completed
Kennedy Park Estate Residential Development	2003/1044	Not Controlled Action	Completed
Kimberley Marine Offloading Facility	2020/8736	Not Controlled Action	Completed
Kimberley Multi-commodity Exploration Programme, WA	2013/6839	Not Controlled Action	Completed
Klammer 2D Seismic Survey	2002/868	Not Controlled Action	Completed
Koolan Island Mine - Reconstruction of seawall and capital dewatering of mine pit,130km northwest of	2016/7848	Not Controlled Action	Completed
Kwinana Gas-Fired Power Station	2005/2101	Not Controlled Action	Completed
Lancelin Caravan Park Project, Hopkins Dve & Casserley Way, Lancelin	2015/7546	Not Controlled Action	Completed
Learmonth Limestone Quarry	2001/392	Not Controlled Action	Completed
Light Industrial Subdivision Development	2004/1799	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Limestone quarry expansion	2005/2268	Not Controlled Action	Completed
Limestone Quarry Expansion, Lots 3618 and 1794, Finn Road	2005/2332	Not Controlled Action	Completed
Limestone quarry mining	2006/2942	Not Controlled Action	Completed
Lot 101 Mandurah Road, Madora Bay, WA	2012/6466	Not Controlled Action	Completed
Lot 1056 Extensions and Alterations	2004/1801	Not Controlled Action	Completed
Mahimahi Aquaculture Facility	2002/891	Not Controlled Action	Completed
Maia-Gaea Exploration wells	2000/17	Not Controlled Action	Completed
Maintenance Dredging in the Geraldton Port Outer Channel	2010/5488	Not Controlled Action	Completed
Maintenance of Tai Jin House, Smith Point	2009/4933	Not Controlled Action	Completed
Manaslu - 1 and Huascaran - 1 Offshore Exploration Wells	2001/235	Not Controlled Action	Completed
Mandurah Quay Residential Development	2010/5754	Not Controlled Action	Completed
Marine Seismic Survey in WA-239-P	2000/24	Not Controlled Action	Completed
Marine Survey for the Australia-ASEAN Power Link AAPL	2020/8714	Not Controlled Action	Completed
Mermaid Marine Australia Desalination Project	2011/5916	Not Controlled Action	Completed
Mobile Radio Communications System Upgrade	2002/718	Not Controlled Action	Completed
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed
Montesa-1 and Bultaco-1 Exploration Wells	2000/102	Not Controlled Action	Completed
Murujuga archaeological excavation, collection and sampling, Dampier Archipelago, WA	2014/7160	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Nexus Drilling Program NT-P66	2007/3745	Not Controlled Action	Completed
North Rankin B gas compression facility	2005/2500	Not Controlled Action	Completed
Nowergup Strawberry Farm McLennan Drive, Nowergup, WA	2017/8042	Not Controlled Action	Completed
Ocean Reef Marina Development, City of Joondalup, WA	2014/7237	Not Controlled Action	Completed
Oman Australia Cable Installation, WA	2021/8922	Not Controlled Action	Completed
Oman Australia Cable - Marine Route Survey	2020/8731	Not Controlled Action	Completed
Onslow Power Infrastructure Upgrade Project, Onslow, WA	2014/7314	Not Controlled Action	Completed
Onslow Water Supply Infrastructure Upgrade Project, Onslow, WA	2014/7329	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Palm Beach Caravan Park Redevelopment, Rockingham, WA	2013/6853	Not Controlled Action	Completed
Pipeline System Modifications Project	2000/3	Not Controlled Action	Completed
Placement of bitumen/ concrete on rail sections of heritage listed incline, Christmas Island	2013/7009	Not Controlled Action	Completed
Point Grey Entrance Road	2011/5807	Not Controlled Action	Completed
Port Hedland Channel Risk and Optimisation Project, WA	2017/7915	Not Controlled Action	Completed
Port of Broome Channel Optimisation Project, West Roebuck Bay, WA	2018/8162	Not Controlled Action	Completed
Power Station Diesel Generator Replacement	2009/4685	Not Controlled Action	Completed
Power Station Upgrade	2001/357	Not Controlled Action	Completed
Power Station Upgrade (South Port Site)	2001/414	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Proposed Community Centre	2010/5306	Not Controlled Action	Completed
Proposed sale or lease of Crown land, 11 lots, Christmas Island	2018/8220	Not Controlled Action	Completed
Puffin Oil wells 7, 8 & 9 development	2005/2336	Not Controlled Action	Completed
Quinns Main sewer extension, Clarkson - Neerabup, WA	2018/8215	Not Controlled Action	Completed
Rail and Port Facilities	2001/474	Not Controlled Action	Completed
Realignment of Gaze Road Service Road and Gaze Road Junction	2004/1735	Not Controlled Action	Completed
Refurbishment and Extension of Seaview Lodge	2012/6353	Not Controlled Action	Completed
renovate free-standing servant's quarters	2006/2811	Not Controlled Action	Completed
Replacement of deteriorating flat roof at rear of Mosque and extending side verandahs, Christmas Is	2013/6851	Not Controlled Action	Completed
Residential development, Lots 9010 and 9031, Yanchep Beach Rd, Yanchep	2016/7642	Not Controlled Action	Completed
Residential Development Eglinton West, Lot 5000 & part Lot 5001, Pipidinny Road, Eglinton	2014/7137	Not Controlled Action	Completed
residential subdivision	2005/1965	Not Controlled Action	Completed
Residential Subdivision, Lot 90 Leisure Way, Halls Head, WA	2018/8175	Not Controlled Action	Completed
Residential upgrade, 2 Coconut Grove	2007/3295	Not Controlled Action	Completed
Re-zoning of Land for Future Residential Development Purposes	2009/4908	Not Controlled Action	Completed
Rottnest Lodge Redevelopment	2019/8565	Not Controlled Action	Completed
Rural Residential Development Lot 7 Dunkeld Drive, Herron, WA	2014/7340	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Scientific Sonar Trial	2002/680	Not Controlled Action	Completed
Searipple gas and condensate field development	2000/89	Not Controlled Action	Completed
Secondary School Campus Development at Lot 150 Leisure Drive, Australind	2013/6744	Not Controlled Action	Completed
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin	2004/1700	Not Controlled Action	Completed
Sepia Depression Ocean Outlet Landline Duplication	2012/6248	Not Controlled Action	Completed
Skua and Swift Oilfields	2006/3195	Not Controlled Action	Completed
Spool Base Facility	2001/263	Not Controlled Action	Completed
Stanley Road waste management facility, Wellesley, WA	2014/7131	Not Controlled Action	Completed
Stormwater Remediation Project, Christmas Island	2019/8467	Not Controlled Action	Completed
Strumbo-1 Gas Exploration Well Permit Area WA-288-P	2002/884	Not Controlled Action	Completed
Subdivision of Lot 571 on DP 26701	2008/4230	Not Controlled Action	Completed
Subdivision of Part 7 of Lot 1014	2009/4851	Not Controlled Action	Completed
Subsea Gas Pipeline From Stybarrow Field to Griffin Venture Gas Export Pipeline	2005/2033	Not Controlled Action	Completed
sub-sea tieback of Perseus field wells	2004/1326	Not Controlled Action	Completed
Supermarket Extensions	2006/2515	Not Controlled Action	Completed
Telfer Gold Mine Project - Mine and Borefield Extensions and Upgrade of Storage	2002/787	Not Controlled Action	Completed
Telstra North Rankin Spur Fibre Optic Cable	2016/7836	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Thevenard Island Retirement Project	2015/7423	Not Controlled Action	Completed
Thresher-1 Well	2000/84	Not Controlled Action	Completed
To construct and operate an offshore submarine fibre optic cable, WA	2014/7373	Not Controlled Action	Completed
upgrade of House 11, William Keeling Crescent	2005/2447	Not Controlled Action	Completed
Upgrade of House 16 on William Keeling Crescent, a Cwlth owned house in Type T H	2006/2903	Not Controlled Action	Completed
Upgrade of Residence, Coconut Grove	2006/2728	Not Controlled Action	Completed
urban residential development	2006/2924	Not Controlled Action	Completed
Useless Loop Road Upgrade	2000/83	Not Controlled Action	Completed
Vegetation Clearance for Horticulture Operation Expansion, Lot 2, Springfield Rd, Parkfield, WA	2014/7196	Not Controlled Action	Completed
Verandah Extension to Existing Breezeway Unit, Gaze Road	2005/1970	Not Controlled Action	Completed
WA-286-P Exploration Drilling Programme	2007/3863	Not Controlled Action	Completed
WA-295-P Kerr-McGee Exploration Wells	2001/152	Not Controlled Action	Completed
Walkway Lighting Upgrade	2009/4965	Not Controlled Action	Completed
Wanda Offshore Research Project, 80 km north-east of Exmouth, WA	2018/8293	Not Controlled Action	Completed
Warders' Cottages Block 2 'W2'	2022/9148	Not Controlled Action	Completed
Warders' Cottages W2 minor works, Fremantle, WA	2018/8185	Not Controlled Action	Completed
Wastewater Treatment Plant	2008/4545	Not Controlled Action	Completed
Western Flank Gas Development	2005/2464	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Wheatstone 3D seismic survey, 70km north of Barrow Island	2004/1761	Not Controlled Action	Completed
Yellowfin Tuna Aquaculture Trial	2003/1115	Not Controlled Action	Completed
Yngling-1 exploration well for WA-368-P	2007/3523	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Kate' 3D marine seismic survey, exploration permits WA-320-P and WA-345-P, 60km	2005/2037	Not Controlled Action (Particular Manner)	Post-Approval
'Tourmaline' 2D marine seismic survey, permit areas WA-323-P, WA-330-P and WA-32	2005/2282	Not Controlled Action (Particular Manner)	Post-Approval
"Leanne" offshore 3D seismic exploration, WA-356-P	2005/1938	Not Controlled Action (Particular Manner)	Post-Approval
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D seismic surveys	2005/2151	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey	2012/6296	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
2D Marine Seismic Survey in Permit Area WA-337-P	2003/1158	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D or 3D Marine Seismic Survey in Petroleum Permit Area AC/P35	2009/4864	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey	2008/4493	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2005/2146	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey in WA Permit Area TP/22 and Commonwealth Permit Area WA-280-P	2005/2100	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey Permit Area WA-352-P	2008/4628	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D seismic survey within permit WA-291	2007/3265	Not Controlled Action (Particular Manner)	Post-Approval
2 geotechnical surveys - preliminary and final	2006/2886	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey	2008/4281	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2007/3800	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey (WA-482-P, WA-363-P), WA	2013/6761	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey in Permit Areas WA-15-R, WA-18-R, WA-205-P, WA-253-P, WA-267-P and WA-268-P	2003/1271	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey in WA 457-P & WA 458-P, North West Shelf, offshore WA	2013/6862	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic Survey - Maxima 3D MSS	2006/2945	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey over petroleum title WA-268-P	2007/3458	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Surveys - Contos CT-13 & Supertubes CT-13, offshore WA	2013/6901	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
3D Marine Seismic Survey Within WA-382-P	2007/3799	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic survey	2006/2715	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, Browse Basin, WA	2009/5048	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, near Scott Reef, Browse Basin	2005/2126	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, petroleum exploration permit AC/P33	2006/2918	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, WA	2008/4428	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey in the Carnarvon Bsin on the North West Shelf	2002/778	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic survey of AC/P4, AC/P17 and AC/P24	2006/2857	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey WA-406-P Bonaparte Basin	2007/3904	Not Controlled Action (Particular Manner)	Post-Approval
3D sesmic survey	2006/2781	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Acacia East Pit Cutback Mining Project,northern Kimberley, WA	2013/6752	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2009/4968	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2008/4565	Not Controlled Action (Particular Manner)	Post-Approval
Addition of Verandah to Block of Four Units	2005/2315	Not Controlled Action (Particular Manner)	Post-Approval
Aerial Baiting of Yellow Crazy Ants	2012/6438	Not Controlled Action (Particular Manner)	Post-Approval
Agrippina 3D Seismic Marine Survey	2009/5212	Not Controlled Action (Particular Manner)	Post-Approval
Apache Northwest Shelf Van Gogh Field Appraisal Drilling Program	2007/3495	Not Controlled Action (Particular Manner)	Post-Approval
Aperio 3D Marine Seismic Survey, WA	2012/6648	Not Controlled Action (Particular Manner)	Post-Approval
Artemis-1 Drilling Program (WA-360-P)	2010/5432	Not Controlled Action (Particular Manner)	Post-Approval
Asbestos Removal from Commonwealth Owned Assests including Commonwealth Heritage	2009/4873	Not Controlled Action (Particular Manner)	Post-Approval
Asbestos Removal from Various Buildings and Sites	2009/4887	Not Controlled Action (Particular Manner)	Post-Approval
Auralandia 3D marine seismic survey	2011/5961	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Australian Square Kilometre Array Pathfinder telescope & infrastructure	2009/4891	Not Controlled Action (Particular Manner)	Post-Approval
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
Australind Piggery expansion	2014/7117	Not Controlled Action (Particular Manner)	Post-Approval
Babylon 3D Marine Seismic Survey, Commonwealth Waters, nr Exmouth WA	2013/7081	Not Controlled Action (Particular Manner)	Post-Approval
Baiting Efficacy Trial of Feral Cat Bait and PAPP Toxicant	2008/4383	Not Controlled Action (Particular Manner)	Post-Approval
Balnaves Condensate Field Development	2011/6188	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Bonaventure 3D seismic survey	2006/2514	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval
Cable Seismic Exploration Permit areas WA-323-P and WA-330-P	2008/4227	Not Controlled Action (Particular Manner)	Post-Approval
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular Manner)	Post-Approval
Cape Preston East - Iron Ore Export Facilities, Pilbara, WA	2013/6844	Not Controlled Action (Particular Manner)	Post-Approval
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Cerberus exploration drilling campaign, Carnarvon Basin, WA	2016/7645	Not Controlled Action (Particular Manner)	Post-Approval
CETO 6 Garden Island Project, offshore WA	2016/7635	Not Controlled Action (Particular Manner)	Post-Approval
CETO 6 Geophysical and Geotechnical Surveys	2014/7408	Not Controlled Action (Particular Manner)	Post-Approval
CGGVERITAS 2010 2D Seismic Survey	2010/5714	Not Controlled Action (Particular Manner)	Post-Approval
Charon 3D Marine Seismic Survey	2007/3477	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
City of Cockburn Sporting Facilties	2005/2139	Not Controlled Action (Particular Manner)	Post-Approval
Commonwealth Marine/Flying Fish Cove Jetty Extension	2012/6675	Not Controlled Action (Particular Manner)	Post-Approval
Conduct an exploration drilling campaign	2011/5964	Not Controlled Action (Particular Manner)	Post-Approval
Construct and operate a 132kV transmission line and upgrade Kemerton Terminal Si	2008/4484	Not Controlled Action (Particular Manner)	Post-Approval
Construction of a Power Station	2003/1177	Not Controlled Action (Particular Manner)	Post-Approval
Construction of Mandurah Entrance Road	2009/4692	Not Controlled Action (Particular Manner)	Post-Approval
Construction of urea production plant and supporting infrastructure	2009/5067	Not Controlled Action (Particular Manner)	Post-Approval
Consturction & operation of the Varanus Island kitchen & mess cyclone refuge building, compression p	2013/6952	Not Controlled Action (Particular Manner)	Post-Approval
Coodanup residential development	2006/3073	Not Controlled Action (Particular Manner)	Post-Approval
Coverack Marine Seismic Survey	2001/399	Not Controlled Action (Particular Manner)	Post-Approval
Crazy Ant Aerial Baiting Control Program	2002/722	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Cue Seismic Survey within WA-359-P, WA-361-P and WA-360-P	2007/3647	Not Controlled Action (Particular Manner)	Post-Approval
CVG 3D Marine Seismic Survey	2012/6654	Not Controlled Action (Particular Manner)	Post-Approval
DAVROS MC 3D marine seismic survey northwaet of Dampier, WA	2013/7092	Not Controlled Action (Particular Manner)	Post-Approval
Decommissioning of the Legendre facilities	2010/5681	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Drilling Program	2010/5532	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Demeter 3D Seismic Survey, off Dampier, WA	2002/900	Not Controlled Action (Particular Manner)	Post-Approval
develop and operate a new deepwater port	2010/5760	Not Controlled Action (Particular Manner)	Post-Approval
Development of a small 25 bed, tented Eco Resort	2012/6284	Not Controlled Action (Particular Manner)	Post-Approval
Development of Limestone and Sand Extraction Sites on Lots 1498 and 1504, and Upgrade of Finn and Ha	2009/5200	Not Controlled Action (Particular Manner)	Post-Approval
Dillon South-1 Exploration Well Drilling - AC/P4, Territory of Ashmore/Cartier	2013/6849	Not Controlled Action (Particular Manner)	Post-Approval
Diversion of Surface Water into Lake Mealup	2010/5467	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Draeck 3D Marine Seismic Survey, WA-205-P	2006/3067	Not Controlled Action (Particular Manner)	Post-Approval
Dredging of marine sediment to enable construction of eight berths and a turnin	2010/5678	Not Controlled Action (Particular Manner)	Post-Approval
Dredging of the Yunderup Approach Channel	2007/3415	Not Controlled Action (Particular Manner)	Post-Approval
Drilling 35-40 offshore exploration wells in deep water	2008/4461	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Audacious-5 appraisal well	2008/4327	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Exploration & Appraisal Wells Braveheart-1 & Cornea-3	2009/5160	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of two appraisal wells	2011/5840	Not Controlled Action (Particular Manner)	Post-Approval
Earthworks for kitchen/mess, cyclone refuge building & Compression Plant, Varanus Island	2013/6900	Not Controlled Action (Particular Manner)	Post-Approval
Eendracht Multi-Client 3D Marine Seismic Survey	2009/4749	Not Controlled Action (Particular Manner)	Post-Approval
Effect of marine seismic sounds to demersal fish and pearl oysters, north-west WA	2018/8169	Not Controlled Action (Particular Manner)	Post-Approval
Endurance 3D Marine Seismic Data Acquisition Survey	2007/3667	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Enfield M3 & Vincent 4D Marine Seismic Surveys	2008/3981	Not Controlled Action (Particular Manner)	Completed
Enfield M3 4D, Vincent 4D & 4D Line Test Marine Seismic Surveys	2008/4122	Not Controlled Action (Particular Manner)	Post-Approval
Enfield M4 4D Marine Seismic Survey	2008/4558	Not Controlled Action (Particular Manner)	Post-Approval
Enfield oilfield 3D Seismic Survey	2006/3132	Not Controlled Action (Particular Manner)	Post-Approval
Establishment of AQIS washdown facility, logistics support base and ancillary businesses	2012/6364	Not Controlled Action (Particular Manner)	Post-Approval
Exmouth West 2D Marine Seismic Survey	2008/4132	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling in Permit Areas WA-402-P & WA-403-P	2010/5297	Not Controlled Action (Particular Manner)	Post-Approval
Exploration drilling of Zeus-1 well	2008/4351	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Program - Permit areas - WA-314-P, WA-315-P, WA-398-P.	2008/4064	Not Controlled Action (Particular Manner)	Post-Approval
Extension and Renewal of Existing Sand Quarry	2008/4326	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Fletcher-Finucane Development, WA26-L and WA191-P	2011/6123	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Foxhound 3D Non-Exclusive Marine Seismic Survey	2009/4703	Not Controlled Action (Particular Manner)	Post-Approval
Gazelle 3D Marine Seismic Survey in WA-399-P and WA-42-L	2010/5570	Not Controlled Action (Particular Manner)	Post-Approval
Geco Eagle 3D Marine Seismic Survey	2008/3958	Not Controlled Action (Particular Manner)	Post-Approval
Geoscience Australia - Marine survey in Browse Basin to acquire data to assist assessment of CO2 sto	2013/6747	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Gigas 2D Pilot Ocean Bottom Cable Marine Seismic Survey	2007/3839	Not Controlled Action (Particular Manner)	Post-Approval
Glencoe 3D Marine Seismic Survey WA-390-P	2007/3684	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Grand Southern Margin 2D Marine Seismic Survey	2008/4599	Not Controlled Action (Particular Manner)	Post-Approval
Greater Western Flank Phase 1 gas Development	2011/5980	Not Controlled Action (Particular Manner)	Post-Approval
Grimalkin 3D Seismic Survey	2008/4523	Not Controlled Action (Particular Manner)	Post-Approval
Guacamole 2D Marine Seismic Survey	2008/4381	Not Controlled Action (Particular Manner)	Post-Approval
Harmony 3D Marine Seismic Survey	2012/6699	Not Controlled Action (Particular Manner)	Post-Approval
Harpy 1 exploration well	2001/183	Not Controlled Action (Particular Manner)	Post-Approval
Helicopter baiting of exotic yellow crazy ant supercolonies, Christmas Island, Indian Ocean	2009/5016	Not Controlled Action (Particular Manner)	Post-Approval
Home Island Slipway Redevelopment	2010/5511	Not Controlled Action (Particular Manner)	Post-Approval
Honeycombs MC3D Marine Seismic Survey	2012/6368	Not Controlled Action (Particular Manner)	Post-Approval
Huzzas MC3D Marine Seismic Survey (HZ-13) Carnarvon Basin, offshore WA	2013/7003	Not Controlled Action (Particular Manner)	Post-Approval
Huzzas phase 2 marine seismic survey, Exmouth Plateau, Northern Carnarvon Basin, WA	2013/7093	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
John Ross & Rosella Off Bottom Cable Seismic Exploration Program	2008/3966	Not Controlled Action (Particular Manner)	Post-Approval
Judo Marine 3D Seismic Survey within and adjacent to WA-412-P	2008/4630	Not Controlled Action (Particular Manner)	Post-Approval
Judo Marine 3D Seismic Survey within and adjacent to WA-412-P	2009/4801	Not Controlled Action (Particular Manner)	Post-Approval
Julimar Brunello Gas Development Project	2011/5936	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Klimt 2D Marine Seismic Survey	2007/3856	Not Controlled Action (Particular Manner)	Post-Approval
Koolama 2D Seismic Survey Dampier Basin	2010/5420	Not Controlled Action (Particular Manner)	Post-Approval
Kraken, Lusca & Asperus 3D Marine Seismic Survey	2013/6730	Not Controlled Action (Particular Manner)	Post-Approval
Lake Richmond Boardwalk installation, Rockingham, WA	2013/6977	Not Controlled Action (Particular Manner)	Post-Approval
Laverda 3D Marine Seismic Survey and Vincent M1 4D Marine Seismic Survey	2010/5415	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Laying a submarine optical fibre telecommunications cable, Perth to Singapore and Jakarta	2014/7332	Not Controlled Action (Particular Manner)	Post-Approval
Leopard 2D marine seismic survey	2005/2290	Not Controlled Action (Particular Manner)	Post-Approval
Limestone Excavation - Ludlow Road, Myalup	2008/3956	Not Controlled Action (Particular Manner)	Post-Approval
Limestone Extraction on Lot 5 Old Coast Road, Myalup, WA	2012/6468	Not Controlled Action (Particular Manner)	Post-Approval
Lion 2D Marine Seismic Survey	2007/3777	Not Controlled Action (Particular Manner)	Post-Approval
Macedon Gas Field Development	2008/4605	Not Controlled Action (Particular Manner)	Post-Approval
Maintenance Channel Dredging	2010/5528	Not Controlled Action (Particular Manner)	Post-Approval
Malita West 3D Seismic Survey WA-402-P and WA-403-P	2007/3936	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey	2012/6275	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey 2012	2012/6310	Not Controlled Action (Particular Manner)	Post-Approval
Marine Geotechnical Drilling Program	2008/4012	Not Controlled Action (Particular Manner)	Post-Approval
Marine reconnaissance survey	2008/4466	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Mariner Non-Exclusive 2D Seismic Survey	2011/6172	Not Controlled Action (Particular Manner)	Post-Approval
Marine Seismic Survey for oil and gas in Commonwealth waters off the WA coast.	2004/1802	Not Controlled Action (Particular Manner)	Post-Approval
Marine Seismic Survey in Permit WA-481P	2012/6626	Not Controlled Action (Particular Manner)	Post-Approval
Moosehead 2D seismic survey within permit WA-192-P	2005/2167	Not Controlled Action (Particular Manner)	Post-Approval
Multipurpose development stage 1 within 340ha	2004/1913	Not Controlled Action (Particular Manner)	Post-Approval
Munmorah 2D seismic survey within permits WA-308/9-P	2003/970	Not Controlled Action (Particular Manner)	Post-Approval
Nelson Point Dredging	2009/4920	Not Controlled Action (Particular Manner)	Post-Approval
New Housing Program	2011/6056	Not Controlled Action (Particular Manner)	Post-Approval
Nexus Energy Seismic survey WA	2006/2569	Not Controlled Action (Particular Manner)	Post-Approval
North Perth Marine Survey	2011/6067	Not Controlled Action (Particular Manner)	Post-Approval
Nova 3D Seismic Survey	2013/6825	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
NT/P80 2010 2D Marine Seismic Survey	2010/5487	Not Controlled Action (Particular Manner)	Post-Approval
Ocean Bottom Cable Seismic Program, WA-264-P	2007/3844	Not Controlled Action (Particular Manner)	Post-Approval
Ocean Bottom Cable Seismic Survey	2005/2017	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Canning Multi Client 2D Marine Seismic Survey	2010/5393	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Drilling Campaign	2011/5830	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Exploration Drilling Campaign	2011/6222	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Gas Exploration Drilling Campaign	2012/6384	Not Controlled Action (Particular Manner)	Post-Approval
Onslow Seawater Desalination Plant Marine Geophysical Investigation	2020/8794	Not Controlled Action (Particular Manner)	Post-Approval
Orcus 3D Marine Seismic Survey in WA-450-P	2010/5723	Not Controlled Action (Particular Manner)	Post-Approval
Osprey and Dionysus Marine Seismic Survey	2011/6215	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Outer Canning exploration drilling program off NW coast of WA	2012/6618	Not Controlled Action (Particular Manner)	Post-Approval
Palta-1 exploration well in Petroleum Permit Area WA-384-P	2011/5871	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Phoenix 3D Seismic Survey, Bedout Sub-Basin	2010/5360	Not Controlled Action (Particular Manner)	Post-Approval
Pilot Appraisal Well - Torosa South 1	2008/3991	Not Controlled Action (Particular Manner)	Post-Approval
Pomodoro 3D Marine Seismic Survey in WA-426-P and WA-427-P	2010/5472	Not Controlled Action (Particular Manner)	Post-Approval
Port Headland Outer Harbour Pre-construction Pilling program	2012/6341	Not Controlled Action (Particular Manner)	Post-Approval
Port of Port Hedland channel marker replacement project, WA	2017/8010	Not Controlled Action (Particular Manner)	Post-Approval
Port Walcott upgrade, dredging & spoil disposal, & channel realignment	2006/2806	Not Controlled Action (Particular Manner)	Post-Approval
Pyrenees 4D Marine Seismic Monitor Survey, HCA12A	2012/6579	Not Controlled Action (Particular Manner)	Post-Approval
Pyrenees-Macedon 3D marine seismic survey	2005/2325	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Quiberon 2D Seismic Survey, permit area WA-385P, offshore of Carnarvon	2009/5077	Not Controlled Action (Particular Manner)	Post-Approval
Reindeer gas reservior development, Devil Creek, Carnarvon Basin - WA	2007/3917	Not Controlled Action (Particular Manner)	Post-Approval
Repsol 3d & 2D Marine Seismic Survey	2012/6658	Not Controlled Action (Particular Manner)	Post-Approval
Residential Development, Lot 101 Cocos (Keeling) Island	2011/5856	Not Controlled Action (Particular Manner)	Post-Approval
Rezoning and Residential Development, Lot 2942, Old Bunbury Road	2007/3768	Not Controlled Action (Particular Manner)	Post-Approval
Rose 3D Seismic Program	2008/4239	Not Controlled Action (Particular Manner)	Post-Approval
Rosebud 3D Marine Seismic Survey in WA-30-R and TR/5	2012/6493	Not Controlled Action (Particular Manner)	Post-Approval
Rydal-1 Petroleum Exploration Well, WA	2012/6522	Not Controlled Action (Particular Manner)	Post-Approval
Salsa 3D Marine Seismic Survey	2010/5629	Not Controlled Action (Particular Manner)	Post-Approval
Sandalford 3D Seismic Survey	2012/6261	Not Controlled Action (Particular Manner)	Post-Approval
Santos Petrel-7 Offshore Appraisal Drilling Programme (Bonaparte Basin)	2011/5934	Not Controlled Action (Particular Manner)	Post-Approval
Santos Winchester three dimensional seismic survey - WA-323-P & WA-330-P	2011/6107	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Scarborough Development nearshore component, NWS, WA	2018/8362	Not Controlled Action (Particular Manner)	Post-Approval
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Scott Reef Seismic Research	2006/2647	Not Controlled Action (Particular Manner)	Post-Approval
Searcher bathymetry & geochemical seismic survey, Brawse Basin,Timor Sea,WA	2013/6980	Not Controlled Action (Particular Manner)	Post-Approval
search for HMAS Sydney	2006/3071	Not Controlled Action (Particular Manner)	Post-Approval
Skorpion Marine Seismic Survey WA	2001/416	Not Controlled Action (Particular Manner)	Post-Approval
Sonar and Acoustic Trials	2001/345	Not Controlled Action (Particular Manner)	Post-Approval
Songa Venus Drilling and Testing Operations	2009/5122	Not Controlled Action (Particular Manner)	Post-Approval
Songa Venus Drilling Programme, Bonaparte Basin	2009/4990	Not Controlled Action (Particular Manner)	Post-Approval
South West Metropolitan Railway Project	2003/1175	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Sovereign 3D Marine Seismic Survey	2011/5861	Not Controlled Action (Particular Manner)	Post-Approval
Stag 4D & Reindeer MAZ Marine Seismic Surveys, WA	2013/7080	Not Controlled Action (Particular Manner)	Post-Approval
Stag Off-bottom Cable Seismic Survey	2007/3696	Not Controlled Action (Particular Manner)	Post-Approval
Study of behavioural responses of Austn Humpback Whales to seismic surveys, offshore Dongara, WA	2013/6927	Not Controlled Action (Particular Manner)	Post-Approval
Stybarrow 4D Marine Seismic Survey	2011/5810	Not Controlled Action (Particular Manner)	Post-Approval
Stybarrow Baseline 4D marine seismic survey	2008/4530	Not Controlled Action (Particular Manner)	Post-Approval
Supply of road building material areas Shark Bay Region WA	2012/6280	Not Controlled Action (Particular Manner)	Post-Approval
Swimming Pool modification	2007/3312	Not Controlled Action (Particular Manner)	Post-Approval
Tantabiddi Boat Ramp Sand Bypassing	2015/7411	Not Controlled Action (Particular Manner)	Post-Approval
Thoar 3D Marine Seismic Survey	2010/5668	Not Controlled Action (Particular Manner)	Post-Approval
Tidepole Maz 3D Seismic Survey Campaign	2007/3706	Not Controlled Action (Particular Manner)	Post-Approval
Tiffany 3D Seismic Survey	2010/5339	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Torosa-5 Apraisal Well, WA-30-R	2008/4430	Not Controlled Action (Particular Manner)	Post-Approval
Tortilla 2D Seismic Survey, WA	2011/6110	Not Controlled Action (Particular Manner)	Post-Approval
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval
Translocation of T.gigas for breeding and release	2005/1958	Not Controlled Action (Particular Manner)	Post-Approval
Trials of a bait delivery system for the control of Yellow Crazy Ants	2009/4763	Not Controlled Action (Particular Manner)	Post-Approval
Tridacna 3D Ocean Bottom Cable Marine Seismic Survey	2011/5959	Not Controlled Action (Particular Manner)	Post-Approval
Triton 3D Marine Seismic Survey, WA-2-R and WA-3-R	2006/2609	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a 3D marine seismic survey	2010/5695	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5715	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5679	Not Controlled Action (Particular Manner)	Post-Approval
upgrade of 3 community recreation sites	2005/2349	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Ursa 3D Marine Seismic Survey	2008/4634	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval
Veritas Voyager 2D Marine Seismic Survey	2009/5151	Not Controlled Action (Particular Manner)	Post-Approval
Vincent M1 and Enfield M5 4D Marine Seismic Survey	2010/5720	Not Controlled Action (Particular Manner)	Post-Approval
Warramunga Non-Inclusive 3D Seismic Survey	2008/4553	Not Controlled Action (Particular Manner)	Post-Approval
Water supply upgrade	2005/2269	Not Controlled Action (Particular Manner)	Post-Approval
West Anchor 3D Marine Seismic Survey	2008/4507	Not Controlled Action (Particular Manner)	Post-Approval
West Panaeus 3D seismic survey	2006/3141	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone 3D MAZ Marine Seismic Survey	2011/6058	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone Iago Appraisal Well Drilling	2007/3941	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone Iago Appraisal Well Drilling	2008/4134	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Woodside Southern Browse 3D Seismic Survey, WA	2007/3534	Not Controlled Action (Particular Manner)	Post-Approval
Zeemeermin MC3D seismic survey, Browse Basin, Offshore WA	2009/5023	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
3D Marine Seismic survey	2007/3729	Referral Decision	Completed
3D Marine Seismic survey	2007/3725	Referral Decision	Completed
3D Marine Seismic Survey in the offshore northwest Carnarvon Basin	2011/6175	Referral Decision	Completed
3D Seismic Survey	2008/4219	Referral Decision	Completed
3D Seismic Survey	2012/6245	Referral Decision	Completed
Alterations and Improvements to existing residence at Lot 3015 Gaze Rd, Christmas Island	2009/5039	Referral Decision	Completed
Aurora extension MC3D Marine Seismic Survey	2011/5887	Referral Decision	Completed
Bianchi 3D Marine Seismic Survey, Carnavon Basin, WA	2013/7078	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Bunbury Port Berth 14 Development, Bunbury Port Inner Harbour	2011/6023	Referral Decision	Completed
CO2 3D Seismic Survey Vlaming Sub-Basin	2012/6343	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Cocos West Island Seawater Desalination Plant	2022/9153	Referral Decision	Referral Publication
CVG 3D Marine Seismic Survey	2012/6270	Referral Decision	Completed
Enfield 4D Marine Seismic Surveys, Production Permit WA-28-L	2005/2370	Referral Decision	Completed
Experimental Study of Behavioural and Physiological Impact on Fish of Seismic Ex	2006/2625	Referral Decision	Completed
Exploration Drilling 2014/2015 WA-481-P	2013/7043	Referral Decision	Completed
Field efficacy trial of the Hisstory bait for feral cats, at Yampi Sound Defence Training Area, Kimb	2017/7977	Referral Decision	Completed
Grand Southern Margin 2D Marine Seismic Survey	2008/4573	Referral Decision	Completed
Kennedy Bay Urban Development,PortKennedy,Rockingh	2013/7022	Referral Decision	Completed
Kimberley Multi-commodity Exploration Program	2013/6780	Referral Decision	Completed
Lots 1-5 Bluerise Cove & Lots 801 & 124 Pleasant Grove Rezoning and Subdivision	2008/4295	Referral Decision	Completed
Mardie Salt Project, Pilbara region, WA	2018/8183	Referral Decision	Completed
Narelle 3D Marine Seismic Survey	2008/4575	Referral Decision	Completed
Nirimba Rural Residential Development	2020/8690	Referral Decision	Completed
Nova 3D Seismic Survey, WA 442-NT/P81, Joseph Bonaparte Gulf	2013/6820	Referral Decision	Completed
Outer Harbour Development and associated marine and terrestial infrastructure	2008/4148	Referral Decision	Completed
Pilot Appraisal Well - Torosa South-1	2008/3985	Referral Decision	Completed
Proposed exploration drilling activities, Abrolhos Commonwealth Marine Reserve	2013/6949	Referral Decision	Completed
Puffin South-West Development of Oil Reserves	2007/3834	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Residential Subdivision Lot 801 Pleasant Grove Circle, Falcon, WA	2012/6507	Referral Decision	Referral Publication
Residential Subdivision of 60ha, Swan Location 2424	2004/1928	Referral Decision	Completed
Rocky Point Dwelling Redevelopment	2005/2203	Referral Decision	Referral Decision
Rose 3D Seismic acquisition survey	2008/4220	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed
Sonar Trials and Acoustic Trials	2001/538	Referral Decision	Completed
Stybarrow Baseline 4D Marine Seismic Survey (Permit Areas WA-255-P, WA-32-L, WA-	2008/4165	Referral Decision	Completed
Tidal Power Generation Turbine	2009/5235	Referral Decision	Completed
Two Dimensional Transition Zone Seismic Survey - TP/7 (R1)	2010/5507	Referral Decision	Completed
Varanus Island Compression Project	2012/6698	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Ancient coastline at 90-120m depth	South-west
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	North-west
Canyons linking the Argo Abyssal Plain with the Scott Plateau	North-west
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	North-west
Cape Mentelle upwelling	South-west
Carbonate bank and terrace system of the Sahul Shelf	North-west

Name	Region
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	South-west
Commonwealth marine environment within and adjacent to Geographe Bay	South-west
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	South-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	North-west
Naturaliste Plateau	South-west
Perth Canyon and adjacent shelf break, and other west coast canyons	South-west
Pinnacles of the Bonaparte Basin	North
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	North-west
Wallaby Saddle	North-west
Western demersal slope and associated fish communities	South-west
Western rock lobster	South-west

Biologically Important Areas

Scientific Name	Behaviour	Presence
Dolphins		
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Breeding	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Calving	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging (high density prey)	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging likely	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Resting	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Significant habitat	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Significant habitat - unknown behaviour	Likely to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Calving	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Foraging	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Foraging likely	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Migration likely	Known to occur
Dugong		
Dugong dugon Dugong [28]	Breeding	Known to occur
Dugong dugon Dugong [28]	Calving	Known to occur
Dugong dugon Dugong [28]	Foraging	Likely to occur
Dugong dugon Dugong [28]	Foraging	Known to occur
Dugong dugon Dugong [28]	Foraging (high density seagrass beds)	Known to occur
Dugong dugon Dugong [28]	Migration	Known to occur
Dugong dugon Dugong [28]	Migration likely	Known to occur
Dugong dugon Dugong [28]	Nursing	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Caretta caretta Loggerhead Turtle [1763]	Internesting	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Internesting buffer	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Nesting	Known to occur
Chelonia mydas Green Turtle [1765]	Aggregation	Known to occur
Chelonia mydas Green Turtle [1765]	Basking	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Mating	Likely to occur
Chelonia mydas Green Turtle [1765]	Mating	Known to occur
Chelonia mydas Green Turtle [1765]	Migration corridor	Known to occur
Chelonia mydas Green Turtle [1765]	Nesting	Likely to occur

Scientific Name	Behaviour	Presence
[Chelonia mydas] Green Turtle [1765]	Nesting	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Foraging	Likely to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Foraging	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Internesting	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Internesting buffer	Likely to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Internesting buffer	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Mating	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Migration corridor	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Nesting	Known to occur
[Eretmochelys imbricata] Hawksbill Turtle [1766]	Nesting	Likely to occur
[Lepidochelys olivacea] Olive Ridley Turtle [1767]	Foraging	Known to occur
[Natator depressus] Flatback Turtle [59257]	Aggregation	Known to occur
[Natator depressus] Flatback Turtle [59257]	Foraging	Known to occur
[Natator depressus] Flatback Turtle [59257]	Internesting	Known to occur
[Natator depressus] Flatback Turtle [59257]	Internesting buffer	Known to occur

Scientific Name	Behaviour	Presence
Natator depressus Flatback Turtle [59257]	Mating	Known to occur
Natator depressus Flatback Turtle [59257]	Migration corridor	Known to occur
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
River shark		
Pristis clavata Dwarf Sawfish [68447]	Foraging	Known to occur
Pristis clavata Dwarf Sawfish [68447]	Juvenile	Known to occur
Pristis clavata Dwarf Sawfish [68447]	Nursing	Known to occur
Pristis clavata Dwarf Sawfish [68447]	Pupping	Known to occur
Pristis pristis Freshwater Sawfish [60756]	Foraging	Known to occur
Pristis pristis Freshwater Sawfish [60756]	Juvenile	Known to occur
Pristis pristis Freshwater Sawfish [60756]	Nursing	Likely to occur
Pristis pristis Freshwater Sawfish [60756]	Nursing	Known to occur
Pristis pristis Freshwater Sawfish [60756]	Pupping	Likely to occur
Pristis pristis Freshwater Sawfish [60756]	Pupping	Known to occur
Pristis zijsron Green Sawfish [68442]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Pristis zijsron Green Sawfish [68442]	Nursing	Known to occur
Pristis zijsron Green Sawfish [68442]	Pupping	Known to occur
Seabirds		
Anous stolidus Common Noddy [825]	Foraging	Known to occur
Anous stolidus Common Noddy [825]	Foraging (provisioning young)	Known to occur
Anous tenuirorstris melanops Australian Lesser Noddy [26000]	Foraging (provisioning young)	Known to occur
Ardenna carneipes Flesh-footed Shearwater [82404]	Aggregation	Known to occur
Ardenna carneipes Flesh-footed Shearwater [82404]	Foraging (in high numbers)	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging (provisioning young)	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur

Scientific Name	Behaviour	Presence
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Known to occur
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Former Range
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Onychoprion fuscata Sooty Tern [82847]	Foraging	Known to occur
Pelagodroma marina White-faced Storm petrel [1016]	Foraging (in high numbers)	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur
Pterodroma macroptera macroptera Great-winged Petrel (macroptera race) [1035]	Foraging (provisioning young)	Known to occur
Pterodroma mollis Soft-plumaged Petrel [1036]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging (provisioning young)	Known to occur

Scientific Name	Behaviour	Presence
Sterna dougallii Roseate Tern [817]	Resting	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur
Sternula nereis Fairy Tern [82949]	Breeding	Known to occur
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur
Neophoca cinerea Australian Sea Lion [22]	Foraging (male and female)	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Rhincodon typus Whale Shark [66680]	Foraging (high density prey)	Known to occur

Scientific Name	Behaviour	Presence
Whales		
Balaenoptera musculus Blue and Pygmy Blue Whale [36]	Foraging (abundant food source)	Known to occur
Balaenoptera musculus Blue and Pygmy Blue Whale [36]	Foraging (high density)	Known to occur
Balaenoptera musculus Blue and Pygmy Blue Whale [36]	Foraging (on migration)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging Area (annual high use area)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Eubalaena australis Southern Right Whale [40]	Calving buffer	Known to occur
Eubalaena australis Southern Right Whale [40]	Seasonal calving habitat	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Calving	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north)	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (south)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Nursing	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Resting	Known to occur
Physeter macrocephalus Sperm Whale [59]	Foraging (abundant food source)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.