

JOINT INDUSTRY OPERATIONAL AND SCIENTIFIC MONITORING PLAN FRAMEWORK

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australian petroleum production & exploration association limited

the voice of Australia's oil and gas industry

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1 INTRODUCTION

1.1 PURPOSE

Operational and Scientific Monitoring (OSM) is a key component of the environmental management document framework for offshore petroleum activities, which also include an Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP). OSM and its supporting documents are instrumental in providing situational awareness of a hydrocarbon spill, enabling Incident Management Teams/Emergency Management Teams (IMT/EMTs) to mount a timely and effective spill response and continually monitor the effectiveness of the response. OSM is also the principle tool for determining the extent, severity and persistence of environmental impacts from a hydrocarbon spill and resultant remediation activities.

As part of the Offshore Petroleum Greenhouse Gas Storage (OPGGS) (Environment) Regulations 2009 and various State/Territory regulations, Titleholders are required to ensure they have a suitable OSM Plan for their offshore petroleum activities. There is also a requirement to ensure these plans are fit for purpose, flexible and achievable, and ready to implement in the event of a spill. Titleholders must demonstrate that they have adequate capability to conduct the required monitoring activities and make informed decisions regarding its implementation, all of which are inspected by regulatory authorities.

To date, Australian Titleholders have worked independently to develop and implement their OSM frameworks. This has led to a variety of different procedures and methods being produced. In the event of a spill, Titleholders will inevitably use the same contractors and consultants to conduct their monitoring scopes and are likely to call upon each other via mutual aid arrangements to support implementation of monitoring programs. The diversity of OSM approaches mean that it would take considerable time for monitoring personnel to familiarise themselves with each individual Titleholder's approach and finalise the monitoring design, leading to inefficiencies and lost time in collecting valuable data.

Therefore, Titleholders have been working together on a collaborative OSM approach, which aims to align methodologies and develop a set of industry best practice guidelines. This includes this Joint Industry OSM Framework and a set of Operational Monitoring Plans (OMPs) and Scientific Monitoring Plans (SMPs). These documents align to individual Titleholders requirements through a Titleholder Bridging Implementation Plan (Section 10.1).

Benefits of a Joint Industry OSM Framework include:

- Common set of OMPs and SMPs, including standardised guidance on aims, initiation and termination criteria, monitoring design, resource requirements and reporting procedures
- Increased OSM capability across Australia, as Titleholders will be familiar with a shared OSM Framework (and can support each other) and contractors can be trained to a common set of procedures creating long-term efficiencies
- Control and Support Agencies will be familiar with the standardised approach, resulting in a more effective spill response
- Reduced need for regulators to review multiple and lengthy OSMPs
- A common set of arrangements across Australia, rather than several different approaches.

This OSM Framework is designed to be adopted by any Australian Titleholder, therefore the approach must be flexible enough to cater for different spill scenarios and sensitive receptors. It is not the intention of this Framework to design the OMPs and SMPs to the same level of detail that is possible for impacts of a known timing and location e.g. a dredging program. The individual OMPs and SMPs are guiding templates, sufficient in detail to enable rapid finalisation following a spill and which can be adapted to a specific spill and the specific sensitive receptors at risk.

The Joint Industry OSM Steering Committee is developing a shared service to establish and maintain a common set of implementation arrangements for the OSM Framework. However, in the interim, individual Titleholders are still required to ensure they are sufficiently resourced and have the arrangements and

capability in place for monitoring. This will need to be demonstrated through their Bridging Implementation Plan.

1.2 OBJECTIVES

The objectives of this Joint Industry OSM Framework are to:

- Provide guidance to Titleholders, consultants and contractors that are undertaking operational and scientific monitoring
- Provide a standardised approach and minimum standards for operational and scientific monitoring
- Describe the suite of OMPs and SMPs that provide the minimum content requirements to meet the monitoring objective of each plan
- Recommend a common set of implementation arrangements that can be maintained by a central organisation, resulting in improved industry-wide OSM capability.

1.3 DEFINITIONS

1.3.1 OPERATIONAL MONITORING

Operational monitoring¹ collects information about the spill and associated response activities to inform planning and decision-making for executing a timely and effective spill response or clean-up operations.

1.3.2 SCIENTIFIC MONITORING

Scientific monitoring² focuses on non-response objectives and evaluating environmental impact and post-impact recovery from the spill and response activities. Scientific monitoring may be undertaken over an extended period to fully understand impacts.

1.4 SCOPE

1.4.1 ACTIVITY TYPES

This OSM Framework is relevant to activities regulated under the OPGGS (Environment) Regulations 2009 and other corresponding State/Territory legislation, including but not limited to:

- Shipping
- Drilling and completions
- Well workovers and interventions
- Subsea activities
- Pipelay activities
- Operations
- Decommissioning.

1.4.2 HYDROCARBON TYPES AND STATES

Australia's petroleum resources are vast and diverse, ranging from gas to crude oils. This OSM Framework is applicable to all hydrocarbon types found in Australian Commonwealth, State and Territory waters, including persistent and non-persistent hydrocarbons, as described by ITOPF (Ref. 1). It also accounts for

¹ Also known as 'Response Phase' or 'Type I' Monitoring (Ref. 5)

² Also known as 'Recovery Phase' or 'Type II' Monitoring (Ref. 5)

the distribution of hydrocarbons in the marine environment, including surface, shoreline, entrained and dissolved fractions as well as fresh and weathered states.

1.4.3 GEOGRAPHICAL EXTENT

This OSM Framework is relevant and applicable to all marine and coastal areas (Commonwealth, State, and Territory) around Australia that are potentially at risk of exposure to hydrocarbons in the event of a spill resulting from offshore petroleum activities.

1.5 CONDITIONS OF USE

Titleholders are required to describe whether their individual activity/activities fall within the scope of this OSM Framework. To support Titleholders through this process, the Australian Petroleum Production and Exploration Association (APPEA) Joint Industry OSM Steering Committee has prepared an OSM Bridging Implementation Plan Template, outlining the information to be presented by individual Titleholders.

Titleholders that apply this OSM Framework will implement the minimum standards and commitments listed in Appendix A. If a Titleholder elects to use this Framework but wants to vary from these minimum standards and commitments, then they will need to justify why they have deviated from the Framework in their Bridging Implementation Plan.

1.6 TARGET AUDIENCE

Titleholders:

- Personnel responsible for the planning and implementation of Operational and Scientific Monitoring
- IMT/EMT personnel, including Environment Unit Lead, Incident Commander, Planning Section Chief, Operations Section Chief and Logistics Section Chief
- Environment Plan authors.

Commonwealth and State/Territory Agencies:

- National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)
- Australian Maritime Safety Authority (AMSA)
- State Control Agencies and/or Hazard Management Authorities.

Monitoring Providers:

- OSM Monitoring/Service Providers
- Independent scientific advisors.

2 OSM FRAMEWORK STRUCTURE

The purpose of the OSM Framework is to develop an industry standard for operational and scientific monitoring. Figure 2-1 illustrates the key documents that form part of this Framework and would be required to effectively implement the relevant monitoring programs. These plans include:

Individual Titleholder Documents:

- Titleholder OSM Bridging Implementation Plan – describes the interface between Titleholder’s existing environmental management framework (e.g. EP and OPEP) and the Joint Industry OSM Framework. This plan lists or refers out to the Titleholders key sensitive receptors, relevant baseline studies to the activity, and Titleholder-specific management systems required to implement monitoring (e.g. capability, logistics, communications, data reporting).
- Titleholder EP – outlines the Environment that may be Affected (EMBA) by the worst case spill scenarios (or area predicted to be affected by unplanned hydrocarbon releases), sensitive receptors, assesses the potential environmental impacts and risks and lists the control measures for the petroleum activity. The OSM Bridging Implementation Plan will form an essential part of the Implementation Strategy for an EP.
- Titleholder OPEP – forms an essential part of the EP, providing details on the oil spill response arrangements for specific spill scenarios. OPEPs usually contain information on the Titleholder’s OSM arrangements, typically in summary with the detail being contained in a dedicated OSM Plan.

Joint Industry Documents:

- Joint Industry OSM Framework – this document, which has been released to key stakeholders for review and input to ensure it aligns with regulatory and operational requirements
- OSM Bridging Implementation Plan Template – support document to the Framework, providing detailed guidance to enable Titleholders to develop their own Bridging Implementation Plan to the Joint Industry OSM Framework that addresses regulatory requirements
- Operational Monitoring Plans and Scientific Monitoring Plans – a series of plans developed through industry collaboration to provide detailed guidance to monitoring personnel, which can be finalised as applicable to the activity location and associated receptors, and the nature and scale of an individual spill

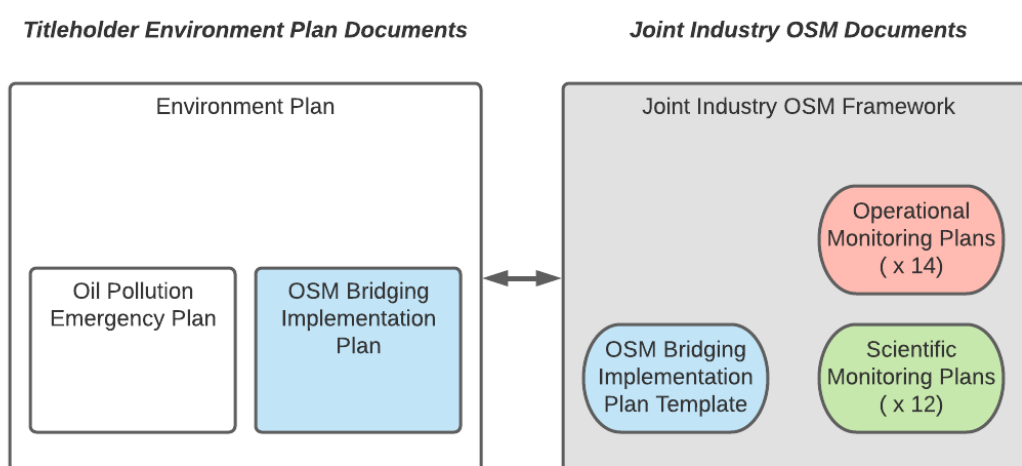


Figure 2-1: Relationship of Joint Industry and Titleholder OSM Documentation

3 REGULATORY REQUIREMENTS

Table 3-1 provides guidance on the requirements of the OPGGS (Environment) Regulations 2009 and reference to the relevant section of this document or the broader suite of documents, which addresses that requirement. State and Territory requirements have not been listed, as the OPGGS (Environment) Regulations 2009 typically require a greater level of detail than the State and Territory legislative requirements and are therefore considered to be addressed by Commonwealth legislation.

Table 3-1: OSM Regulatory Requirement and Corresponding Demonstration in OSM Framework

OPGGS (Environment) Regulations 2009 Requirement	Relevant section that addresses requirements
<p>Part 2, Division 2.3, Regulation 14 (5)</p> <p>The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training</p>	<p>Section 10.13 Roles and Responsibilities</p> <p>Section 11.3 Training and Competency</p>
<p>Part 2, Division 2.3, Regulation 14 (8AA)</p> <p>The oil pollution emergency plan must include adequate arrangements for responding to and monitoring oil pollution, including the following:</p> <p>(a) the control measures necessary for timely response to an emergency that results or may result in oil pollution;</p> <p>(b) the arrangements and capability that will be in place, for the duration of the activity, to ensure timely implementation of the control measures, including arrangements for ongoing maintenance of response capability;</p> <p>(c) the arrangements and capability that will be in place for monitoring the effectiveness of the control measures and ensuring that the environmental performance standards for the control measures are met;</p> <p>(d) the arrangements and capability in place for monitoring oil pollution to inform response activities.</p>	<p>Section 5 Operational Monitoring Overview</p> <p>Section 9 Initiation and Termination Criteria</p> <p>Section 10 Implementation Guidance and OSM Bridging Implementation Plan</p> <p>Section 11 Capability Operational Monitoring Plans</p>
<p>Part 2, Division 2.3, Regulation 14 (8D)</p> <p>The implementation strategy must provide for monitoring of impacts to the environment from oil pollution and response activities that:</p> <p>(a) is appropriate to the nature and scale of the risk of environmental impacts for the activity; and</p> <p>(b) is sufficient to inform any remediation activities</p>	<p>Section 6 Scientific Monitoring Overview</p> <p>Section 7</p> <p>Baseline Data Rationale and Approach</p> <p>Section 8 Scientific Monitoring Design</p> <p>Section 10 Implementation Guidance and OSM Bridging Implementation Plan</p> <p>Section 11 Capability Scientific Monitoring Plans</p>

OPGGs (Environment) Regulations 2009 Requirement	Relevant section that addresses requirements
<p>Part 2, Division 2.3, Regulation 14 (8A)</p> <p>The implementation strategy must include arrangements for testing the response arrangements in the oil pollution emergency plan that are appropriate to the response arrangements and to the nature and scale of the risk of oil pollution for the activity.</p> <p>Part 2, Division 2.3, Regulation 14 (8B)</p> <p>The arrangements for testing the response arrangements must include:</p> <ul style="list-style-type: none"> (a) a statement of the objectives of testing; and (b) a proposed schedule of tests; and (c) mechanisms to examine the effectiveness of response arrangements against the objectives of testing; and (d) mechanisms to address recommendations arising from tests. 	<p>Section 11.4 Testing</p> <p>Response Arrangements</p> <p>OSM Bridging</p> <p>Implementation Plan</p>

In addition to the OPGGS (Environment) Regulations 2009, relevant NOPSEMA assessment guidance documents have been reviewed and key aspects have been incorporated into this Framework or noted as being required to be addressed in individual OSM Bridging Implementation Plans. Table 3-2 outlines the relevance of each guidance document.

Table 3-2: NOPSEMA Guidance Documents Relevant to OSM Framework and Titleholder Bridging Implementation Plan

Guidance document	Relevance to OSM Framework/Titleholder Bridging Implementation Plan
NOPSEMA (2020) Operational and scientific monitoring programs: Information Paper (N-04750-IP1349 A343826))	Provides guidance to assist Titleholders in the development of an OSM Plan, with a focus on the design and implementation of scientific monitoring. This Framework and the individual SMPs address the points raised in this paper, with the exception of detailed information on baseline and demonstration of readiness which should be addressed in the Titleholder OSM Bridging Implementation Plan (Refer to Section 10)
NOPSEMA (2018) Oil pollution risk management: Guidance Note (GN1488 Rev 2)	Provides guidance to Titleholders on OPEP content requirements to support the development of an acceptable EP submission. This includes information on operational monitoring requirements. This Framework and the individual OMPs address operational monitoring. However, Titleholders will be required to provide additional detail in their OSM Bridging Implementation Plan on how this Framework applies to the nature and scale of their activities (e.g. appropriate capability and resourcing), their process for selecting locations for monitoring and their specific arrangements for activation and mobilisation of operational monitoring teams (Refer to Section 10)
NOPSEMA (2019) Oil spill modelling: Environment Bulletin #1 (A652993)	Provides guidance on selecting exposure values for floating, entrained and dissolved hydrocarbons to help inform spatial extent for risk evaluation and planning for monitoring. Titleholders should explain their risk assessment process, selected exposure values and resultant sensitive receptors in their EP. The OPEP should identify response and monitoring priorities, which should be explained or cross referenced in their OSM Bridging Implementation Plan (Refer to Section 10)

4 GOVERNANCE ARRANGEMENTS

The APPEA Joint Industry OSM Steering Committee is currently responsible for governance of the Joint Industry OSM Project, including the provision of funding and supporting the development of this OSM Framework and supporting documents.

5 OPERATIONAL MONITORING OVERVIEW

“Operational Monitoring” is a common term applied in oil spill response to encompass the following arrangements and capability that Titleholders are required to have in place in their OPEPs by the OPGGS (Environment) Regulations 2009:

- 1 Monitoring effectiveness of control measures (Reg. 14 (8AA)(c))
- 2 Monitoring oil pollution to inform response activities (Reg. 14(8AA)(d))
- 3 Monitoring to ensure that environmental performance standards (EPS) for response control measures are met (Reg. 14 (8AA)(c)).

Operational monitoring is crucial to ensure an effective oil spill response. Information obtained through operational monitoring provides the IMT/EMT with situational awareness on the trajectory of the spill, its weathering state and hydrocarbon concentrations and its potential impacts to sensitive receptors. This phase of monitoring is also designed to inform the effectiveness of the response options (control measures) being used to treat the spill, so that the IMT/EMT can make informed decisions as the response progresses through subsequent operational periods. Table 5-1 lists the OMPs included under the Joint Industry OSM Framework.

An Environment Plan should define EPS that present statements of performance for the arrangements and capability in place for implementation of adopted spill response control measures. The outcomes of operational monitoring should allow Titleholders to confirm that the required levels of performance of the response control measures are being met (e.g. when, where and how response resources are being deployed and response options implemented). The implementation of the spill response control measures will be subject to continual review during a response to determine if a strategy should commence, continue, continue with variations or cease. Operational monitoring provides the necessary information to support that response decision-making (Section 10.9).

Operational monitoring also provides information on the impacts of the response activities (Section 10.9.2), for example the impacts from shoreline clean-up activities are monitored via OMP: Shoreline Clean-up Assessment Technique. Control measures will be identified to manage the impacts and risks of implementing a spill response (e.g. locations where surface dispersants can be deployed, restrictions on disturbance of sensitive shorelines by shoreline responders etc.). Operational monitoring should also confirm that these control measures are being followed and their corresponding EPS are being met (Section 10.9.3.)

Depending on the size and nature of the spill, OMP 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 IMT/EMT.

Table 5-1: Joint Industry Operational Monitoring Plans

Operational Monitoring Plan	Aim/Objective
Hydrocarbon properties and weathering behaviour at sea	To provide in field information on the hydrocarbon properties, behaviour and weathering of the spilled hydrocarbons to assist in determining suitability of spill response tactics and strategies
Shoreline clean-up assessment	<p>Provide information on the physical and biological characteristics of shorelines within the predicted trajectory of the hydrocarbon spill or that have been exposed to the spill</p> <p>Conduct sectorisation of shorelines to aid in response planning and implementation of response activities</p> <p>Inform suitable pre-impact and post-impact response options/activities to minimise the threat posed to sensitive receptors from the spill, taking into account shoreline character</p> <p>Establish clean-up end points for the shoreline</p> <p>Monitor effectiveness of shoreline protection and/or clean-up activities</p> <p>Inform the IMT/EMT of any potential or actual impacts to sensitive receptors from response options/activities</p> <p>Inform the IMT/EMT of any sensitive receptors that may be relevant to scientific monitoring programs</p>
Surface chemical dispersant effectiveness and fate assessment	To monitor the effectiveness of chemical dispersants by examining the distribution and fate (surface and subsurface) of surface chemical dispersants to verify impact and contact predictions for response planning (e.g. Net Environmental Benefit Analysis (NEBA)/ Spill Impact Mitigation Assessment (SIMA)) and other monitoring plans and to provide the IMT/EMT with sufficient information to determine if dispersant application should be continued, modified or ceased
Subsea dispersant injection monitoring	To monitor the effectiveness of chemical dispersants by examining the distribution and fate (surface and subsurface) of subsea chemical dispersants to verify impact and contact predictions for response planning (e.g. NEBA/SIMA) and other monitoring plans and to provide the IMT/EMT with sufficient information to determine if dispersant application should be continued, modified or ceased
Water quality assessment	To provide a rapid assessment of the presence, type, concentrations and character of hydrocarbons in marine water to assess the extent of spill contact and inform impact predictions for other monitoring plans
Sediment quality assessment	To provide a rapid assessment of the presence, type, concentrations and character of hydrocarbons in marine sediments to assess the extent of spill contact and inform impact predictions for other monitoring plans
Marine fauna assessment	<p>To undertake a rapid assessment of marine fauna to understand the species, populations, habitats and geographical locations at greatest risk from potential spill impacts</p> <ul style="list-style-type: none"> • Reptiles • Cetaceans (observational only) • Dugongs • Pinnipeds <p>To provide the IMT/EMT with information that assists in deciding protection priorities and selecting response options that minimise the potential impact on marine fauna</p> <p>To provide the IMT/EMT with information on the effects of response activities on marine fauna</p>

Operational Monitoring Plan	Aim/Objective
<ul style="list-style-type: none"> Seabirds and shorebirds 	<p>Assess and document mortality of fauna during the spill event and response activities</p> <p>Establish the need for scientific monitoring of fauna affected by the spill event and/or response activities.</p>
<p>Marine fauna assessment</p> <ul style="list-style-type: none"> Fish 	<p>Identify, report and monitor potential impacts on fish, sharks and rays resulting from the hydrocarbon and/or response activities</p> <p>To provide the IMT/EMT with information that assists in deciding protection priorities and selecting response options that minimise the potential impact on fish</p> <p>Determine the extent and level of hydrocarbon contamination and tainting of fish</p> <p>Determine any mortality of fish species and document any fish-kills during the spill event</p> <p>Determine if fish harvested from the spill area meets statutory limits for hydrocarbon residues and is marketable</p> <p>Provide regulatory agencies, fisheries managers and other spill responders with information to help them evaluate the likelihood that a hydrocarbon spill will contaminate seafood (fish) for commercial, aquaculture, recreational, traditional purposes</p> <p>Assist in the decision-making process to restrict, ban, close or re-open a fishery</p> <p>Establish the need for scientific monitoring of fish affected by the spill event and/or response activities.</p>
<p>Air quality modelling (responder health and safety)</p>	<p>To assess the impact of the hydrocarbon spill on human health, particularly that of the public and response personnel</p> <p>To help predict zones safe for response personnel to conduct response operations</p>

The information provided in the OMPs is designed to enable Titleholders and Monitoring Providers to finalise the monitoring program design, so that it is appropriate to the activity location and associated environmental receptors, as well as the nature and scale of the event. The plans include:

- A description of Industry's minimum requirements, adopted standards and/or best practice guidance for monitoring design, sampling techniques and reporting requirements
- A list of resources recommended to implement the monitoring
- Draft standard operating procedures, which would be finalised by the relevant Monitoring Provider in the event of a spill.

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

- Department of Transport (Western Australia [WA]) shoreline assessment form (Ref. 2)
- Special Monitoring of Applied Resource Technologies (SMART) protocol (Ref. 3) and the American Petroleum Institute (API) Subsea Dispersant Monitoring method (Ref. 4) for dispersants
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) Oil Spill Monitoring Handbook (Ref. 5)
- AMSA Oil Spill Monitoring Handbook (Ref. 6)
- Water Quality Australia, Water Quality Guidelines (Ref. 7)
- Water Quality Australia, Sediment Quality Guidelines (Ref. 9) and Toxicant default guideline values for sediment quality (Ref. 9).

Operational monitoring plans may be carried out simultaneously and in conjunction with response activities. Table 5-2 identifies the operational monitoring components that may be triggered for the different response options and activities.

Table 5-2: Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Response Option	Operational Monitoring Plan							
	A	B	C	D	E	F	G	H
Source Control	X				X	X	X	X
Natural Recovery	X				X	X	X	
Surface Dispersant Application	X		X		X	X	X	X
Subsea Dispersant Injection	X			X	X	X	X	X
Containment and Recovery	X				X		X	X
Shoreline Protection	X	X			X	X	X	X
Shoreline Clean-up	X	X			X	X	X	X
Oiled Wildlife Response	X	X					X	X
Waste Management	X	X			X	X	X	X
A Hydrocarbon properties and weathering behaviour at sea	G Marine fauna assessment							
B Shoreline clean-up assessment	<ul style="list-style-type: none"> • Reptiles 							
C Surface chemical dispersant effectiveness and fate	<ul style="list-style-type: none"> • Cetaceans (observational only) 							
D Subsea dispersant injection monitoring	<ul style="list-style-type: none"> • Dugongs • Pinnipeds 							

E	Water quality assessment	• Seabirds and shorebirds
F	Sediment quality assessment	• Fish
H	Air quality modelling (responder health and safety)	

Note: This table outlines the operational monitoring component that should be used to monitor and inform response options during the response. For example, the 'dispersant application' response option is monitored through hydrocarbon properties and weathering behaviour, chemical dispersant effectiveness assessment, water quality assessment, sediment quality assessment, marine fauna assessment and air quality modelling and therefore these monitoring components are triggered if this option is used.

5.1 OPERATIONAL MONITORING EXCLUDED FROM THE FRAMEWORK

The OSM Framework does not address a range of operational monitoring techniques which fall into the category commonly referred to as monitoring, evaluation and surveillance (MES) including aerial and vessel surveillance, spill trajectory modelling, surface tracking buoys and remote sensing (satellite) surveillance.

While the above mentioned forms of operational monitoring provide vital information to support a response, the arrangements to support their implementation are typically less complex and they have not been included in the Joint Industry OMPs. Titleholders electing to use this Framework and the OMPs should ensure they have adequate arrangements and capability in place to meet all MES requirements detailed in their OPEP. The linkages between MES activities and OMPs (including opportunities for co-mobilisation) should also be addressed in their Bridging Implementation Plan.

The OSM Framework does not address operational monitoring of in-situ burning.

6 SCIENTIFIC MONITORING OVERVIEW

"Scientific Monitoring" is a common term applied to encompass the following arrangements and capability that Titleholders are required to have in place in their OPEPs by the OPGGS (Environment) Regulations 2009:

- 1 Monitoring impacts to the environment from oil pollution and response activities that is sufficient to inform any remediation activities (Reg. 14 (8D)(b))
- 2 Monitoring to ensure that environmental performance standards (EPS) for response control measures are met (Reg. 14 (8AA)(c)).

Scientific monitoring generally has objectives relating to attributing cause-effect interactions of the spill with changes to the surrounding environment. Consequently, such studies are required to account for natural or sampling variation, and study designs must be robust and produce defensible data. Scientific monitoring is typically conducted over a wider study area, extending beyond the spill footprint, and a longer time period, extending beyond the spill response. It is also more systematic and quantitative. Table 6-1 lists the scientific monitoring plans included under the Joint Industry OSM Framework. Titleholders that apply this Framework will implement, as a minimum, the SMPs listed in Table 6-1 where initiation criteria for each of these studies are met.

Table 6-1: Joint Industry Scientific Monitoring Plans

Scientific Monitoring Plan	Aim/Objective
Water quality impact assessment	<p>Detect and monitor the presence, concentration and persistence of hydrocarbons in marine waters following the spill and associated response activities.</p> <p>The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Assess and document the temporal and spatial distribution of hydrocarbons and dispersants in marine waters of sensitive receptors; • Consider the potential sources of any identified hydrocarbons • Verify the presence and extent of hydrocarbons (both on water and in water) that may be directly linked to the source of the spill • Assess hydrocarbon/dispersant content of water samples against accepted environmental guidelines or benchmarks to predict potential areas of impact • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs
Sediment quality impact assessment	<p>Detect and monitor the presence, concentration and persistence of hydrocarbons in marine sediments following the spill and associated response activities. The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Assess and document the temporal and spatial distribution of hydrocarbons and dispersants in marine sediments of sensitive receptors • Consider the potential sources of any identified hydrocarbons; and • Verify the presence and extent of hydrocarbons that may be directly linked to the source of the spill • Assess hydrocarbon content of sediment samples against accepted environmental guidelines or benchmarks to predict potential areas of impact
Intertidal and coastal habitat assessment	<p>To assess the impact (extent, severity, and persistence) and subsequent recovery of intertidal and coastal habitats and associated biological communities in response to a hydrocarbon release and associated response activities.</p> <p>The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Collect quantitative data to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response activities) on intertidal and coastal habitats and associated biological communities, post-spill and post-response recovery • Monitor the subsequent recovery of intertidal and coastal habitats and associated biological communities from the impacts of the hydrocarbon release and response activities

Scientific Monitoring Plan	Aim/Objective
Seabirds and shorebirds	<p>Document and quantify shorebird and seabird presence; and any impacts and potential recovery from hydrocarbon exposure and response activities. The objectives are to:</p> <ul style="list-style-type: none"> • 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 and assess, the impacts from exposure of shorebirds and seabirds to hydrocarbons (i.e. post-impact) and to the response activities, including abundance, oiling, mortality, and sub-lethal effects • Identify, quantify and evaluate the post-impact status and if applicable, recovery of key behaviour and breeding activities of shorebirds and seabirds (e.g. foraging and/or nesting activity and reproductive success) over time and with regard to control sites
<p>Marine mega-fauna assessment</p> <ul style="list-style-type: none"> • Reptiles • Pinnipeds • Whale sharks, dugongs and cetaceans 	<p>Reptiles</p> <p>Identify and quantify the status and recovery of marine reptiles, including marine turtles, sea snakes and estuarine crocodiles, related to a hydrocarbon spill and response activities.</p> <p>The objectives are to:</p> <ul style="list-style-type: none"> • To observe and quantify the presence of marine reptiles (including life stage) within the area affected by hydrocarbons • Where possible, assess and quantify lethal impacts and/or sub-lethal impacts directly related to the hydrocarbon spill or other secondary spill-related impacts (including vessel strike and/or use of dispersants); • Assess the impact of the hydrocarbon spill on nesting turtles, nests, and hatchlings • Understand changes in nesting beach usage by marine turtles following the hydrocarbon spill <p>Pinnipeds</p> <p>Identify and quantify the status and recovery of pinniped populations (Australian Sea Lion, <i>Neophoca cinerea</i>, New Zealand Fur Seal, <i>Arctocephalus forsteri</i> and the Australian Fur Seal, <i>A. pusillus</i>) related to a hydrocarbon spill and response activities.</p> <p>The objectives are to:</p> <ul style="list-style-type: none"> • Identify mortality of pinnipeds, where possible, that is directly related to the hydrocarbon spill or indirectly associated to 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 <p>Whale sharks, dugongs and cetaceans</p> <p>Identify and quantify the status and recovery of whale sharks, dugongs and cetaceans related to a hydrocarbon spill and response activities.</p>

Scientific Monitoring Plan	Aim/Objective
	<p>The objectives are to:</p> <ul style="list-style-type: none"> • Observe and quantify the presence of whale sharks, dugongs and cetaceans within the area that may be affected by hydrocarbons • Where possible, assess and quantify lethal impacts and/or sub-lethal impacts directly related to the hydrocarbon spill or other indirect impacts (including vessel strike and/or use of dispersants and impacts to important habitats) • If applicable, evaluate recovery of key biological activities of impacted species following impacts due to a hydrocarbon spill and undertaking response options.
Benthic habitat assessment	<p>To assess the impact (extent, severity, and persistence) and subsequent recovery of subtidal benthic habitats and associated biological communities in response to a hydrocarbon release and associated response activities.</p> <p>The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Collect quantitative data to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response options) on benthic habitats and associated biological communities, post-spill and post-response recovery • Monitor the subsequent recovery of benthic habitats and associated biological communities from the impacts of the hydrocarbon release
Marine fish and elasmobranch assemblages assessment	<p>To assess the impacts to and subsequent recovery of fish assemblages associated with specific benthic habitats (as identified in SMP: Benthic Habitat Assessment) in response to a hydrocarbon release and associated response activities.</p> <p>The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Characterise the status of resident fish populations associated with habitats monitored in SMP: Benthic Habitat Assessment that are exposed/contacted by released hydrocarbons • Quantify any impacts to species (abundance, richness and density) and resident fish population structure (representative functional trophic groups) • Determine and monitor the impact of the released hydrocarbons and potential subsequent recovery to residual demersal fish populations
Fisheries impact assessment	<p>To monitor potential contamination and tainting of important finfish and shellfish species from commercial, aquaculture and recreational fisheries to evaluate the likelihood that a hydrocarbon spill will have an impact on the fishing and/or aquaculture industry.</p> <p>The specific objectives of this SMP are as follows:</p> <ul style="list-style-type: none"> • Assess any physiological impacts to important fish and shellfish species and if applicable, seafood quality and safety • Assess targeted fish and shellfish species for hydrocarbon contamination

Scientific Monitoring Plan	Aim/Objective
	<ul style="list-style-type: none"> • Provide information that can be used to make inferences on the health of fisheries and the potential magnitude of impacts to fishing industries (commercial, aquaculture and recreational)
Heritage features assessment	To detect changes in the integrity of significant shipwrecks as a result of a hydrocarbon release and/or associated response activities.
Social impact assessment	<p>To assess the extent, severity and likely persistence of impacts on cultural, commercial, recreational and/or industrial users from a hydrocarbon release and associated response activities.</p> <p>The specific objective of this SMP is as follows:</p> <ul style="list-style-type: none"> • Determine direct and indirect impacts of a hydrocarbon or chemical spill and associated response activities on cultural, commercial, recreational and/or industrial users and identify areas where monitoring may need to continue for an extended period of time following termination of the response.

In practice these plans may be carried out simultaneously, and scientific monitoring may commence while response activities are still occurring.

The information provided in the SMPs is designed to enable Titleholders and Monitoring Providers to finalise the monitoring program design so that it is appropriate to the activity location and associated environmental receptors, as well as the nature and scale of the event. The plans include:

- A description of Industry's minimum requirements, industry standards and/or best practice guidance for monitoring design
- A list of resources recommended to implement the monitoring
- Draft standard operating procedures, which would be finalised by the relevant monitoring contractor in the event of a spill.

Guidance on various experimental monitoring approaches for scientific monitoring can be found in Appendix B. These approaches 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.

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 will be 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).

The SMPs provide comprehensive information on monitoring design for each receptor including sampling techniques, methods, parameters, metrics (where applicable), site selection, sampling frequency and duration. The monitoring design information in each SMP will be considered by the Monitoring Provider in the review and finalisation of the monitoring design, including sampling techniques and standard operating procedures.

Finalisation of monitoring designs are considered to be a key decision in the OSM process and monitoring designs will need to be approved by personnel holding the competencies outlined in Table 11-1.

If benchmarks³ are relevant in the scientific studies, they will be selected taking into consideration guideline values that have already been established (e.g. Ref. 7, Ref. 8, Ref. 9, Ref. 10) or if appropriate, follow the process as outlined by Water Quality Australia (Ref. 7) or, if in WA, the Environmental Protection Authority's (EPA) Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (Ref. 11) to develop a relevant benchmark value with appropriate statistical power.

Benchmark values will also need to take into consideration levels of protection. Levels of protection are defined as the degree of protection afforded based on ecosystem condition (Ref. 7). When finalising monitoring design, the levels of protection for that jurisdiction will need to be investigated. Water Quality Australia (Ref. 7) lists the following levels of protection:

- High ecological/conservation value —99% species protection

³ Benchmarks are used to describe concentrations above which there is the possibility of risk to the environmental receptor.

- Slightly to moderately disturbed system —95% species protection
- Highly disturbed system —90 or 80% species protection

WA has a localised approach to levels of ecological protection, outlined in its EPA Technical Guidance: Protecting the Quality of Western Australia’s Marine Environment (Ref. 11). In addition, WA has also identified (through public consultation) and mapped levels of ecological protection for the Pilbara Region from the Exmouth Gulf to Cape Keraudren (Ref. 12). EPA Technical Guidance: Protecting the Quality of Western Australia’s Marine Environment (Ref. 11) will be consulted when investigating levels of protection.

7 BASELINE DATA RATIONALE AND APPROACH

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 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 and evaluate impact from the spill (compared to natural variation and/or impacts unrelated to the spill) is necessary.

There are a number of existing baseline data sources listed in Table 7-1 that are readily available to Titleholders, which may contain suitable baseline data for their monitoring requirements. In addition to these data sources, some Titleholders have elected to analyse existing data sources and compile a list of baseline data relevant to the high value receptors in their EMBA.

Where possible and practicable, baseline data will be comparable to data gathered by OMPs and SMPs. This will require Titleholders to examine baseline data sets they plan to use for operational and scientific monitoring. This assessment will need to be addressed as part of their Bridging Implementation Plan. The Bridging Implementation Plan Template provides detailed guidance on this review process.

Table 7-1: Existing Baseline Data Sources

Data Source	Description	Access
Industry-Government Environmental Metadata System (I-GEMS)	<p>The I-GEMS Project is facilitated by APPEA. The project is a collaborative approach between industry, marine research institutes and WA government agencies to share metadata on quantitative ecological data for key receptors in the mid to north-west of WA (approximately from the Abrolhos Islands to the Timor Sea) and to represent these in a geospatial database.</p> <p>The marine environmental metadata includes instant online access to a list of available data sets on key receptor sensitivities in the event of spill</p>	<p>I-GEMS metadata can be accessed via the Index of Marine Surveys for Assessments website –</p> <p>https://biocollect.ala.org.au/imsa#max%3D500%26sort%3DdateCreatedSort</p>
Australian Ocean Data Network (AODN)	<p>The AODN is the primary access point for search, discovery, access and download of data collected by the Australian marine community. Data are presented as a regional view of all the data available from the AODN. Primary datasets are contributed to by Commonwealth government agencies, State government agencies, universities, the Integrated Marine Observing System an Australian Government</p>	<p>Access is via the following link</p> <p>https://portal.aodn.org.au/search</p>

Data Source	Description	Access
	Research Infrastructure project, and the Western Australia Marine Science Institution (WAMSI)	
Oil Spill Response Atlas (OSRA)	<p>An OSRA is a spatial database of environmental, logistical and oil spill response data. Using a geographical information system (GIS) platform, OSRA displays datasets collated from a range of custodians allowing decision-makers to visualise environmental sensitivities and response considerations in a selected location.</p> <p>Oil spill trajectory modelling can be overlaid to assist in determining protection priorities, establishing suitable response options and identifying available resources for both contingency and incident planning.</p>	<p>Access is via the following links:</p> <ul style="list-style-type: none"> WA: https://www.transport.wa.gov.au/i-marine/oil-spill-response-and-planning-tools.asp Victoria: https://www.ccmaknowledgebase.vic.gov.au/soilhealth/soils_resource_details.php?resource_id=1234
The Atlas of Living Australia (ALA)	The ALA is a collaborative, online, open resource that contains information on all the known species in Australia aggregated from a wide range of data providers. It provides a searchable database when considering species within the EMBA. The ALA receives support from the Australian Government through the National Collaborative Research Infrastructure Strategy and is hosted by the CSIRO	<p>Access is via the following link</p> <p>https://www.ala.org.au/</p>

There are operational and scientific monitoring components that are suited to pre-impact/reactive baseline monitoring, although this is not the case for all receptors, especially if a more detailed understanding of natural variability is required to assess the extent of oil spill impacts. In this case, more detailed baseline planning will need to occur and consideration should be given to the relevance of baseline data (including metrics and parameters) used in EPs and its relationship to the data required for the OSM. As outlined in Ref. 26:

“An environmental baseline data set may be considered adequate if it would allow the Titleholder to confidently detect spill effects in view of natural background spatial and temporal variability, and determine the extent, severity and persistence of oil spill impacts on environmental values and sensitivities”.

Reactive pre-impact monitoring can be useful in supplementing existing baseline data to provide a more current view of the state of the environment. Understanding priority areas for reactive pre-impact baseline monitoring is important, as there may be limited time to conduct the monitoring prior to the spill contacting the area. Stochastic modelling used during the EP/OPEP risk assessment process may be used to determine areas likely to be contacted with hydrocarbons above impact thresholds within a specified timeframe and provide direction for baseline monitoring priorities. Titleholders will be required to assess modelling results (or other relevant information) and determine locations where there is sufficient time to obtain reactive baseline data, taking into account operational readiness of monitoring teams (refer to Section 10.5). If there is insufficient time to obtain reactive baseline data then Titleholders will need consider whether additional baseline data are required to be collected .

Control sites (i.e. similar to the impact or disturbance location) are sometimes more relevant than reference sites (undisturbed or natural sites) for determining the impact of a hydrocarbon spill as separate from other human or natural stressors (Ref. 17). In the event of a spill, existing baseline information should be used to select relevant control sites outside the impact area of a single spill. It is expected that most

control sites will be within the predicted zones of exposure or EMBA, but outside the impacted area for any given single spill. As all possible permutations or combination of sites cannot be realistically assessed in advance, control sites should be selected post spill.

The number of samples and/or sampling sites for a particular spill depends on the extent of the spill, and the statistical power necessary to determine whether there is an impact and the ability of the monitoring program to determine recovery and termination criteria.

Post-spill, the OSM Implementation Lead will be required to approve reactive baseline data requirements, determine if control sites are required and determine the number of samples and sampling sites as part of finalising the monitoring designs for each SMP.

8 SCIENTIFIC MONITORING DESIGN

The design of monitoring programs should be based on clear and well thought out aims and objectives and should ensure, as far as possible, that the planned monitoring activities are practicable and that the objectives of the program will be met. The design must result in collection of meaningful data and, where practicable, data that are sufficiently powerful to detect ecologically relevant changes. See Appendix A for guidance.

9 INITIATION AND TERMINATION CRITERIA

Typically, operational monitoring is initiated by:

- The spill event itself;
- Through monitoring, evaluation and surveillance information collected during the response; and/or
- By implementation of a response (control measure).

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 initiated by:

- The spill itself;
- Data generated by monitoring and evaluation during the response; and/or
- Data generated through operational monitoring.

Scientific monitoring may occur in parallel to operational monitoring and can continue for some time after the hydrocarbon/chemical spill event.

The initiation and termination criteria for all OMPs and SMPs are provided in Table 9-1 (Operational Monitoring) and Table 9-2 (Scientific Monitoring). It is the responsibility of the Titleholder to identify the relevant Jurisdictional Authority in their Bridging Implementation Plan that may be involved in the decision to terminate the response and/or individual monitoring component. Guidance on relevant Jurisdictional Authorities is provided in Table 10-2.

Note: in Table 9-1 and Table 9-2, “Or” means only one of the possible options, “and” means both need to occur before initiation/termination.

Table 9-1: Operational Monitoring Plan Initiation and Termination Criteria

Operational Monitoring Plan	Initiation criteria	Termination criteria
Hydrocarbon properties and weathering behaviour at sea	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred 	<ul style="list-style-type: none"> The IMT/EMT Incident Commander (or delegate) considers that continuation of monitoring under this OMP will not result in a change to the scale or location of active response options; or The IMT/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 This OMP is no longer contributing to or influencing spill response decision-making; or Relevant scientific monitoring components initiation criteria have been triggered.
Shoreline clean-up assessment	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and Analysis of data from hydrocarbon spill modelling, monitoring, evaluation and/or surveillance (MES) predicts an exposure of hydrocarbons to shoreline habitat; or Relevant response activities are being undertaken. 	<ul style="list-style-type: none"> This OMP will not result in a change to the scale or location of active response options; or Agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or Continuation of monitoring of this OMP is likely to increase overall environmental impact; or Relevant scientific monitoring components initiation criteria have been triggered.
Surface chemical dispersant effectiveness and fate	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and, Application of surface dispersant has been selected as a response option. 	<ul style="list-style-type: none"> Dispersant operations have ceased; and Measurements indicate that dispersed hydrocarbons are diluted to below levels of detection or below levels of concern; or Monitoring data indicates that dispersant operations are unlikely to cause harm; or Continuation of monitoring of this OMP is likely to increase overall environmental impact; or

Operational Monitoring Plan	Initiation criteria	Termination criteria
Subsea dispersant injection monitoring	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and Application of subsea dispersant has been selected as a response option. 	<ul style="list-style-type: none"> Relevant scientific monitoring components initiation criteria have been triggered. Dispersant operations have ceased; and Measurements indicate that dispersed hydrocarbons are diluted to below levels of detection or below levels of concern; or Monitoring data indicates that dispersant operations are unlikely to cause harm; or Continuation of monitoring of this OMP is likely to increase overall environmental impact; or Relevant scientific monitoring components initiation criteria have been triggered.
Water quality assessment	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred. 	<ul style="list-style-type: none"> The IMT/EMT Incident Commander (or delegate) considers that continuation of monitoring under this OMP will not result in a change to the scale or location of active response options; or The IMT/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 spill is or is likely to be below visible criteria for surface oil (0.5 g/m²), and below thresholds for entrained (10 ppb) and dissolved (6 ppb) oil concentrations; or The Monitoring Coordinator (or delegate) considers that continuation of monitoring under this OMP is likely to increase overall environmental impact; or Relevant scientific monitoring components initiation triggers have been assessed.
Sediment quality assessment	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and 	<ul style="list-style-type: none"> The IMT/EMT Incident Commander (or delegate) considers that continuation of monitoring under this OMP will not

Operational Monitoring Plan	Initiation criteria	Termination criteria
	<ul style="list-style-type: none"> Modelling and/or analysis of data from MES predicts an exposure of hydrocarbons to marine and/or coastal sediment. 	<ul style="list-style-type: none"> result in a change to the scale or location of active response options; or The IMT/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 continuation of monitoring under this OMP is likely to increase overall environmental impact; or Relevant scientific monitoring components initiation triggers have been assessed.
<p>Marine fauna assessment</p> <ul style="list-style-type: none"> Reptiles Cetaceans (observational only) Dugongs Pinnipeds Seabirds and shorebirds Fish 	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and Modelling and/or analysis of data from MES predicts, or has reported, an exposure of hydrocarbons to known sensitive fauna habitat. 	<ul style="list-style-type: none"> The IMT/EMT Incident Commander (or delegate) considers that continuation of monitoring under this OMP will not result in a change to the scale or location of active response options; or The IMT/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 continuation of monitoring under this OMP is likely to increase overall environmental impact; or Relevant scientific monitoring components initiation triggers have been assessed.
<p>Air quality modelling (responder health and safety)</p>	<ul style="list-style-type: none"> The IMT/EMT has determined that Level 2 or 3 hydrocarbon spill to marine or coastal waters has occurred; and Response operations that may pose a risk to the air quality of response personnel and/or public will occur. 	<ul style="list-style-type: none"> Completion of the gas, vapour and hydrocarbon discharge, containment and recovery, dispersant operations and shoreline clean-up operations; and Continuing hazardous and noxious plume detection modelling has a low probability of contributing or influencing spill response decision-making.

Table 9-2: Scientific Monitoring Plan Initiation and Termination Criteria

Scientific Monitoring Plan	Initiation criteria	Termination criteria
Water quality impact assessment	<ul style="list-style-type: none"> • Spill modelling and/or MES has indicated that contact on a sensitive resource is possible and it is considered likely that ongoing (scientific) monitoring of impacts will be required, supported by scientifically rigorous water quality monitoring; or • OMP: Water quality assessment has identified hydrocarbon and/or dispersant concentrations exceed accepted guidelines and benchmarks; or • Chemical dispersants have been applied as part of the spill response program. 	<ul style="list-style-type: none"> • The relevant Jurisdictional Authority/ Government Agency has been consulted and has agreed that water quality monitoring can be ceased; and • Hydrocarbon concentrations in marine waters are below benchmark levels which can be defined as: <ul style="list-style-type: none"> • Toxicant default guideline values for water quality in aquatic ecosystems (Ref. 7); or • the relevant regulatory site-specific trigger level (where these exist); or • below baseline levels; or • control site values (whichever is applicable).
Sediment quality impact assessment	<ul style="list-style-type: none"> • OMP: Sediment quality assessment has identified hydrocarbon concentrations exceed accepted guidelines and benchmarks; or • Spill modelling and/or MES has indicated that an impact on a sensitive resource that is closely linked to marine sediments is possible, and it is considered likely that ongoing (scientific) monitoring of a biological parameter will be required and supported by scientifically rigorous sediment quality monitoring. 	<ul style="list-style-type: none"> • The relevant Jurisdictional Authority/ Government Agency has been consulted and has agreed that water quality monitoring can be ceased; and • All hydrocarbon concentrations in sediments are below benchmark/guideline levels, which can be defined as: <ul style="list-style-type: none"> • toxicant default guideline values for sediment quality (Ref. 9); or • the relevant regulatory site-specific trigger level (where these exist); or • below baseline levels; or • control site values (whichever is applicable).
Intertidal and coastal habitat assessment	<ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts or confirms exposure of coastal or intertidal habitats or communities to hydrocarbons. 	<ul style="list-style-type: none"> • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor; and • There has been no impact to coastal and intertidal habitats and associated biological communities (confirmation that habitats and species were not exposed to hydrocarbons); or

Scientific Monitoring Plan	Initiation criteria	Termination criteria
Seabirds and shorebirds assessment	<ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts contact is possible to seabirds and/or shorebird populations or any of their habitats of importance for breeding, nesting or foraging; or • Monitoring (OMP: Marine fauna assessment seabirds and shorebirds) has identified contact or an impact to seabirds and/ or shorebird populations as a result of the hydrocarbon spill; or • There are reports or scientific evidence of oiled seabirds and/or shorebird populations. 	<ul style="list-style-type: none"> • Measured parameters of coastal and intertidal habitats and associated biological communities impacted by hydrocarbons spills have returned to within the expected natural dynamics of baseline state (taking into account natural variability) and/or control sites. • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor; and • There has been no impact on seabirds and/or shorebirds or their key biological activities; or • The extent of damage and rate of recovery of key seabird and/or shorebird behaviour and breeding activities has been quantified; and <ul style="list-style-type: none"> • Measured parameters have returned to baseline conditions (taking into account natural variability) in terms of breeding population (for seabirds) or counts (for shorebirds) and impacts on species and taxa are no longer detectable, with regard to control sites; or • Oil pollution effects/impacts on critical species and taxa are no longer detectable.
Marine mega-fauna assessment <ul style="list-style-type: none"> • Reptiles • Pinnipeds • Whale sharks, dugongs and cetaceans 	Reptiles <ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts contact is possible at important habitat locations for turtles (foraging and rookery), sea snakes and/or estuarine crocodiles; or • Monitoring (OMP: Marine fauna assessment – reptiles) has identified contact or an impact to reptiles (dead, oiled, or injured reptiles) within area affected by hydrocarbons 	Reptiles <ul style="list-style-type: none"> • There has been no impact on reptiles or their key biological activities from the hydrocarbon spill; or • The extent of damage of impacted reptiles has been quantified; and • Measured parameters of turtle (and sea snakes and/or estuarine crocodiles, if determined appropriate) communities impacted by hydrocarbon spill have returned to within the expected natural dynamics of baseline state and/or control sites; and

Scientific Monitoring Plan	Initiation criteria	Termination criteria
	<p>Pinnipeds</p> <ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts contact is possible at important habitat locations for pinnipeds (foraging, breeding colonies, and haul out sites); or • Monitoring (OMP: Marine fauna assessment – pinnipeds) has identified contact or an impact to pinnipeds (dead, oiled, or injured pinnipeds) within the area affected by hydrocarbons 	<ul style="list-style-type: none"> • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor. <hr/> <p>Pinnipeds</p> <ul style="list-style-type: none"> • There has been no impact on pinnipeds or their key biological activities from the hydrocarbon spill; or • The extent of damage and rate of recovery of impacted pinnipeds has been quantified at breeding colonies and haul out sites within the area affected by hydrocarbons; and • Measured parameters of pinniped populations impacted by hydrocarbon spill have returned to within the expected natural dynamics of baseline state and/or control sites; and • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor. <hr/> <p>Whale sharks, dugongs and cetaceans</p> <ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts contact is possible at important habitat locations for whale sharks, dugongs and/or cetaceans (foraging, migratory routes, breeding locations); or • Monitoring (OMP: Marine fauna assessment – cetaceans or dugongs) has identified contact or an impact to whale sharks, dugongs and/or cetaceans within the area affected by hydrocarbons
		<p>Whale sharks, dugongs and cetaceans</p> <ul style="list-style-type: none"> • There has been no demonstratable impact on whale sharks, dugongs and/or cetaceans or their key biological activities from the hydrocarbon spill; or • The extent of damage of impacted whale sharks, dugongs and/or cetaceans and/or their biologically important areas has been quantified; and • Measured parameters of whale sharks, dugongs and/or cetaceans and/or their biologically important areas impacted by hydrocarbon spill have returned to within the expected natural dynamics of baseline state and/or control sites; and

Scientific Monitoring Plan	Initiation criteria	Termination criteria
Benthic habitat assessment	<ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts or confirms exposure of benthic habitats or communities to hydrocarbons. 	<ul style="list-style-type: none"> • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor. <hr/> <ul style="list-style-type: none"> • There has been no impact to benthic habitats and associated biological communities (confirmation that benthic habitats were not exposed to hydrocarbons); or • Measured parameters of benthic habitats and associated biological communities impacted by hydrocarbons spills have returned to within the expected natural dynamics of baseline state (taking into account natural variability) and/or control sites; and • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor.
Marine fish and elasmobranch assemblages assessment	<ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts or confirms exposure to fish areas or fish habitat. 	<ul style="list-style-type: none"> • There has been no impact on fish and fish population structure; or • Measured parameters of fish, fish habitat, and marine fisheries locations impacted by hydrocarbon spills have returned to within the expected natural dynamics of baseline state and/or control sites; and • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor.
Fisheries impact assessment	<ul style="list-style-type: none"> • Spill trajectory modelling, surveillance or monitoring predicts contact is possible to commercial, recreational, traditional species and or aquaculture species; or • Advice has been provided to government to restrict, ban or close a fishery; or 	<ul style="list-style-type: none"> • Agreement has been reached with the relevant Jurisdictional Authorities to cease monitoring of fisheries; and • Contamination in the edible portion or in the stomach/intestinal contents attributable to the spill is no longer detected; or

Scientific Monitoring Plan	Initiation criteria	Termination criteria
	<ul style="list-style-type: none"> Declarations of intent by commercial fisheries or government agencies to seek compensation for alleged or possible damage. 	<ul style="list-style-type: none"> No differences are detected in commercial, recreational or aquaculture fisheries from control and impact sites; or The physiological and biochemical parameters in the studied species have returned to baseline levels; or Evidence that catch rates, species composition, community abundance, distribution and age structure of commercial fisheries and their by-catches have returned to baseline levels.
Heritage features assessment	<ul style="list-style-type: none"> Spill trajectory modelling, surveillance or monitoring predicts or confirms hydrocarbon exposure to known heritage features. 	<ul style="list-style-type: none"> There has been no detectable impact to the integrity of the heritage feature/s; or Measured parameters of heritage feature/s impacted by hydrocarbon spills have returned to within the expected natural dynamics of baseline state and/or control sites; and Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring this receptor.
Social impact assessment	<ul style="list-style-type: none"> Spill trajectory modelling, surveillance or monitoring predicts or confirms hydrocarbon exposure to high value socio-economic features. 	<ul style="list-style-type: none"> There has been no detectable impact to known socio-economic features; or Measured parameters of socio-economic features impacted by hydrocarbon spills have returned to within the expected natural dynamics of baseline state and/or control sites; or This SMP has been replaced by more detailed investigations; and Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring these receptor.

10 IMPLEMENTATION GUIDANCE

10.1 OSM BRIDGING IMPLEMENTATION PLAN

The Joint Industry OSM Framework and the supporting OMPs and SMPs provide a standardised approach to the finalisation and implementation of monitoring programs in the event of a spill. However, there are too many variables across the various spill scenarios, sensitive receptors and Titleholder management systems to develop a one-size-fits-all approach. The Framework needs to be aligned to each Titleholder's activities and spill risks. This interface will need to be outlined through an OSM Bridging Implementation Plan, prepared by individual Titleholders.

The OSM Bridging Implementation Plan will form part of the environmental management document framework for offshore petroleum activities and will need to be integrated with the activity's Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP). Titleholders will be required to provide the following information to demonstrate they meet the regulatory requirements associated with OSM implementation. It is likely that this information will be spread across the Titleholder's environmental management framework documentation. However, it is recommended the Bridging Implementation Plan repeat or cross references this content (with an appropriate summary) for ease of use during exercises and incidents.

The information required to be addressed in the OSM Bridging Implementation Plan, includes but may not be limited to:

- Description of the activities, spill scenarios, risk assessment process, resultant area predicted to be affected by hydrocarbons (e.g. EMBA) and summary of receptors;
- Description of existing baseline data information sources (in addition to those listed in Section 7), details of how to access them, noting of any protected matters;
- Review of baseline data and identification of priority monitoring locations that may require rapid post-spill, reactive baseline data collection;
- Individual Titleholder OSM Management structure and explanation of how this integrates with the IMT/EMT;
- Roles and responsibilities for OSM and key IMT/EMT personnel;
- Description of relevant individual Titleholder management systems related to operational and scientific monitoring, including health and safety, incident command, logistics, communications, aviation and marine operations requirements;
- Details of linkages between the response needs and information outputs of the OMPs and other operational monitoring (i.e. monitoring, evaluation and surveillance) to be implemented under the OPEP response arrangements;
- Mobilisation and timing of OMP and SMP implementation, linked to the risk assessment process and mobilisation constraints;
- Resource requirements (personnel and equipment) to implement identified OMPs and SMPs and demonstration that response capability and arrangements meet response needs;
- Activation and mobilisation process to engage contracted OSM Monitoring Provider/s;
- Process for finalisation of monitoring design;
- Process for identifying and obtaining permits required for monitoring within the EMBA;
- Reporting requirements, including how data and information from the monitoring shall be provided to and used by the Titleholder's IMT/EMT during a response, and roles and responsibilities for managing data from scientific monitoring programs;
- Process for communicating relevant information to stakeholders (consistent with the EP communication plan/protocols).

Titleholders who use this Framework are committing to implementation of all OMPs and SMPs, where the initiation criteria are met. If the initiation criteria (Table 9-1 and Table 9-2) are not met, then that OMP and/or SMP would not be implemented.

An OSM Bridging Implementation Plan Template has been developed as a supporting document to this Framework and to aid Titleholders in the development of their OSM Bridging Implementation Plan.

If a Titleholder chooses to adopt the Joint Industry OSM Framework, they will remain responsible for demonstrating its applicability and relationship to their activity. Additional guidance on this is provided below and in the corresponding section in the OSM Bridging Implementation Plan Template.

10.2 IMPLEMENTATION CONSIDERATIONS

OSM implementation may be broken down into a number of phases to help identify considerations for each phase. Table 10-1 outlines these phases and key actions, which are explained in more detail throughout Sections 10 and 11.

Table 10-1: Considerations for Monitoring and Response Phases

Phase		Considerations	
		Operational Monitoring	Scientific Monitoring
Pre-spill (Preparedness Phase)	Aim	Understand area of operations, EMBA, baseline data sources and needs and ensure sufficient operational readiness to implement OSM	
	Actions	Prepare OSM Bridging Implementation Plan. Titleholders will need to undertake the following actions to support their OSM Bridging Implementation Plan: <ul style="list-style-type: none"> • Assign OSM roles and responsibilities (internal and external) • Establish external contracts to maintain OSM capability and readiness • Determine internal and external personnel competencies and availability (to be monitored and reviewed on a regular basis) • Determine equipment providers and laboratories and establish processes/contracts as required • Liaise with internal logistics and supply chain departments to advise of OSM requirements • Analyse available baseline data and comparability to SMPs 	

Phase		Considerations	
		Operational Monitoring	Scientific Monitoring
Post-spill /Pre-impact Phase	Aim	Gain situational awareness and understanding of receptors that may be impacted by the spill	Gather reactive baseline monitoring data
	Actions	Finalise OMPs (for more detail, refer to Part B of the OSM Bridging Implementation Plan Template) <ul style="list-style-type: none"> • Activate internal OSM personnel and external contracts • Select priority sites • Finalise sampling technique • Determine suitable sampling frequency • Finalise standard operating procedures • Allocate number of teams, personnel, equipment and supporting resource requirements for each OMP • Finalise HES documentation prior to mobilisation of field teams • Confirm logistics (e.g. flights, accommodation, vessels) • Commence deployment of OMP Field Teams • Initiate OMPs, in particular desktop assessments that can be easily commenced (e.g. air quality modelling) 	Finalise SMPs (for more detail, refer to Part B of the OSM Bridging Implementation Plan Template) <ul style="list-style-type: none"> • Activate internal OSM personnel and external contracts • Gather baseline data and/or establish control/reference sites • Confirm monitoring design and technique • Confirm sampling sites • Determine suitable sampling frequency • Establish benchmarks and guidelines to be used • Confirm indicator species • Confirm parameters and metrics • Finalise standard operating procedures • Allocate number of teams, personnel, equipment and supporting resource requirements • Finalise HES documentation prior to mobilisation of field teams • Confirm logistics (e.g. flights, accommodation, vessels) • Commence deployment of SMP Field Teams
Impact Phase	Aim	Identify impacted receptors and assess effectiveness of oil spill response operations and techniques	Monitor for effects
	Actions	<ul style="list-style-type: none"> • Collect samples, video, photographs etc, as relevant • Conduct laboratory analysis, if relevant to OMP • Rapid analysis of data and reporting to IMT/EMT to aid in decision-making • Refine monitoring design, as appropriate 	<ul style="list-style-type: none"> • Collect samples, video, photographs, in-situ data etc • Conduct laboratory and/or specialist data analysis • Conduct data quality assurance / quality control (QA/QC) • Conduct trend analysis and statistical analysis • Refine monitoring design, as appropriate

Phase	Operational Monitoring		Considerations
			Scientific Monitoring
Termination of Response Operations / Recovery Phase	Aim	Terminate monitoring once criteria are met	Monitor for change and/or recovery
	Actions	Rapid analysis of data and reporting to IMT/EMT to aid in decisions to terminate response	<ul style="list-style-type: none"> • Collect samples, video, photographs, in-situ data etc • Conduct laboratory and/or specialist data analysis • Conduct data QA/QC • Conduct trend analysis and statistical analysis • Refine monitoring design, as appropriate
Post-recovery Phase	Aim	Review and incorporate learnings into OMPs and OSM documentation	Incorporate change, effects, refine methods and assess against termination criteria
	Actions	Update OMPs and OSM as appropriate	<ul style="list-style-type: none"> • Collect samples, video, photographs, in-situ data etc • Conduct laboratory and/or specialist data analysis • Conduct data QA/QC • Conduct trend analysis and statistical analysis • Refine monitoring design, as appropriate

10.3 MONITORING PRIORITIES

As part of the risk assessment process, Titleholders are required to identify in the EP a spatially defined area that may be affected by an oil spill from its activities, which is commonly referred to as the Environment that may be Affected (EMBA) or predicted zone of exposure. The EP will comprehensively describe the receptors in that area and any potential impacts from activities (including spills). A summary of values and sensitivities and the relevant OMPs and SMPs is provided in Appendix C.

This spatial extent of the EMBA is typically identified through the use of stochastic modelling, which is based on the possible outcomes of a number of spill runs (typically 100–200 simulations). Titleholders will be required to identify in their OSM Bridging Implementation Plan how they have used the results of their risk assessment process, in particular the modelling results, to help determine their likely initial monitoring priorities from their list of receptors. This should include a process to identify priority monitoring locations and suitable control or reference sites for scientific monitoring, noting that some control or reference sites may be situated outside the EMBA.

Priority monitoring locations should take into account the protection priorities within the EMBA, as identified in the EP and/or OPEP. Titleholders have a range of methods to help determine initial protection priorities, which can be aligned to monitoring priorities. A common method for determining protection priorities includes:

- 1 Identifying receptors with high environmental value within EMBA, including (but not limited to):
 - high conservation value habitat or species (e.g. World Heritage Areas, State/Commonwealth protected areas, protected species)
 - sensitivity and/or recoverability of receptors to hydrocarbon impacts
 - areas with important socio-economic/heritage value
- 2 Using modelling results, identifying high value receptors that have the shortest potential timeframes to contact above impact thresholds. This can be evaluated for any relevant season the activity will occur (e.g. summer, winter and transitional).

Note that thresholds for response protection may vary to thresholds used for monitoring. Titleholders commonly align response protection thresholds to the moderate exposure thresholds of 10 g/m² for floating oil and 100 g/m² for shoreline accumulation. However, this may not be suitable for monitoring thresholds. It is likely that water quality triggers and monitoring for some receptors may need to commence at the low exposure thresholds. Titleholders will need to identify their relevant thresholds in the EP or Bridging Implementation Plan. Ref. 24 provides guidance on thresholds.

In WA, Tasmania and Victoria, state government agencies have conducted protection prioritisation assessments for coastal environments⁴. These projects are designed to assist in decision-making during both the preparedness and response phases of marine oil pollution incidents. Titleholders should consult with their respective State Government Agency to integrate this information into their EPs/OPEPs and OSM Bridging Implementation Plans and they should be checked for updates when establishing monitoring priorities during a spill.

As outlined above, Titleholders will be required to outline their initial monitoring priorities in their OSM Bridging Implementation Plan. Section 13 of the OSM Bridging Implementation Plan Template provides a checklist to assist in confirming monitoring priorities at the time of a spill, as they may vary subject to the following influences:

⁴ Western Australian Marine Oil Pollution Risk Assessment (Department of Transport) - <https://www.transport.wa.gov.au/imate/oil-spill-response-and-planning-tools.asp> ; Tasmanian Marine Environmental Prioritisation Project and Marine Oil Spill Sensitivity Rating; and Victorian Marine Risk Assessment 2011 and Assessment of the Values of Victoria's Marine Environment Atlas - https://www.vgls.vic.gov.au/client/en_AU/search/asset/1299250/0

- Seasonality of receptors
- Availability of baseline data and/or ability and timeframe to rapidly obtain pre-impact data
- Availability of appropriate control sites
- Statistical approach proposed to analyse the data (particularly relevant for the SMPs)
- Available resources and equipment to conduct the work in terms of personnel, logistics, and access
- Protected matters (Section 10.4).

In addition, Titleholders electing to use this Framework will need to consult with key stakeholders (i.e. Jurisdictional Authority for receptor, appointed State/Territory Environment and Science Coordinator) and monitoring service providers (including subject matter experts, where available) regarding monitoring priorities at the time of the spill (taking into account situational awareness information).

It should be noted that monitoring priorities may also change throughout the duration of the monitoring program.

10.4 PROTECTED MATTERS REQUIREMENTS

There are a number of receptors that attract protected status under various Commonwealth and State legislation, plans, policies including World Heritage Areas, National and Commonwealth Heritage Areas, Australian Marine Parks, Ramsar wetlands, threatened ecological communities, threatened species and migratory species.

The Commonwealth publishes recovery plans and conservation advice for a number of species listed as threatened under the Commonwealth *Environment and Biodiversity Conservation Act 1999* (EPBC Act). These documents are intended to assist in preventing the decline, and enhance the recovery, of threatened species. The requirements of management plans, species recovery plans and conservation advice for threatened species are an important consideration when determining monitoring priorities and finalising monitoring designs.

Relevant protected matters will vary according to the Titleholder's EMBA and are required to be identified in Titleholder's EPs. The Joint Industry OSM Bridging Implementation Plan Template provides guidance on how the Titleholder may choose to identify relevant protected matters requirements and integrate these into the monitoring design.

10.5 RESOURCE REQUIREMENTS AND IMPLEMENTATION TIMEFRAMES

Resource requirements and implementation timeframes will vary according to the individual spill risk profile (i.e. hydrocarbon characteristics, spatial and temporal extent of spill), proximity of the spill to sensitive receptors, mobilisation constraints and logistical requirements. When determining resource needs and implementation timeframes, Titleholders will need to consider the following issues (note: this list is not exhaustive) and address their individual requirements in their Bridging Implementation Plan):

Timeframes

- Monitoring priorities (see above) – using stochastic or deterministic modelling, assess how quickly receptors may be contacted by the spill and at what probability. For example, spill modelling may show an island surrounded by important coral habitat with active turtle nesting and shorebird breeding to be contacted within 7 days of spill release at a 50% probability. Titleholders will need to determine how quickly they would need to mobilise resources to obtain any reactive baseline monitoring (if required) and conduct relevant operational and/or scientific monitoring components for that location. Note that guidance is provided in Appendix C on OMPs and SMPs that are relevant to certain receptors;
- Timeliness of information needed from operational monitoring to mobilise and initiate implementation of spill response control measures;

- Remote locations – offshore islands, shoals, reefs and remote mainland locations are likely to require self-sufficient arrangements on vessels to act as a field base and cater for field personnel and equipment. This requirement will influence number of personnel, equipment/accommodation types and implementation timeframes;
- Storage of samples – samples may need immediate freezing or refrigeration so consideration should be given to how samples will be stored from point of collection to comply with laboratory preservation and holding times; and
- Permits and access – there may be a requirement to obtain permission to access a site prior to monitoring being conducted or obtain a permit before taking flora and fauna. Additional information on permits and access is provided in Section 10.8.

Resourcing

- Summary of personnel required to implement component/s of the OMP or SMPs (i.e. number of personnel per team and number of teams) versus a summary of the total personnel available via external contracts and internal personnel availability;
- Equipment maintained and stored for OMPs;
- External contracts that would be used for implementation (e.g. marine and aviation contracts);
- Vessel and vehicle requirements – remote locations of varying water depth and metocean conditions may need a number of different vessel types (e.g. larger ‘base’ vessels and shallow water craft). Monitoring components may require certain vessel specifications, depending on the final monitoring design (e.g. cranes and winches, freshwater supplies, office space). Offshore islands may also require light ‘all-terrain’ vehicles to transport personnel and equipment;
- Training and inductions – minimum competencies for key personnel are provided in individual OMPs and SMPs. However, specific inductions and some training for support staff (e.g. shoreline clean-up support personnel) may be required prior to mobilisation;
- Chain of custody of samples – Titleholders should have an established chain of custody procedure that will also be utilised by any contracted Monitoring Providers; and
- Transportation of samples – movement of samples from monitoring locations to staging areas and then to assigned laboratories is likely to require a separate courier vessel/aircraft to limit disruption of sampling continuity and sampling frequency and to comply with laboratory preservation and holding times.

Improvement to initial implementation timeframes could be achieved by sharing resources with certain response actions (e.g. shoreline protection, oiled wildlife response).

Titleholders should consider the above issues and map out a resourcing and implementation schedule for OSM activities in their Bridging Implementation Plan. An example schedule is provided in Sections 7 and 8 of the OSM Bridging Implementation Plan Template.

10.5.1 INITIATION OF OPERATIONAL MONITORING

Operational monitoring is typically commenced prior to scientific monitoring, and timeframes for implementation⁵ will need to reflect the requirement to rapidly obtain operational monitoring data to help improve the situational awareness of the spill and inform IMT/EMT decision-making.

Titleholders will need to define timeframes for implementation of each OMP in their Bridging Implementation Plan. Timeframes will need to be linked to the Titleholder’s risk assessment process (Section 10.3) and take into consideration geographical and logistical constraints.

⁵ ‘Implementation’ of an OMP/SMP is defined as being ready, at the point of staging or departure, to mobilise for monitoring. If the Monitoring Plan is desktop-based, implementation is defined as commencing the work (e.g. computer model inputs).

The following OMPs can be implemented within hours of initiation, as it is desk-top based and requires minimal mobilisation of personnel:

- OMP: Air quality modelling

Additionally, the following OMP can provide important validation of information to the IMT/EMT, so should be implemented within 72 hours of its initiation criteria being met.

- OMP: Hydrocarbon properties and weathering behaviour at sea;

The remaining OMPs may require additional time to finalise the following information/actions in order to be implemented:

Activate OSM personnel and any support contracts (e.g. equipment)

- Select/confirm sites (upon receipt of initial situational awareness/monitoring and evaluation data. Additional sites can be added as more data is received)
- Finalise sampling technique
- Determine suitable sampling frequency
- Finalise standard operating procedures
- Allocate number of teams, personnel, equipment and supporting resource requirements
- Finalise HES documentation prior to mobilisation of field teams
- Confirm logistics (e.g. flights, accommodation, vessels)
- Commence deployment of Field Teams

The OMPs provide detailed guidance on each of the above points to aid in the rapid finalisation of these plans, however, it should be noted that for some OMPs (e.g. Marine Fauna), the provision of monitoring, evaluation and surveillance data (e.g. aerial surveillance) is required to help confirm sampling sites, which in turn can affect the selection of sampling technique and frequency. However, in stating that, monitoring personnel should not wait for comprehensive monitoring, evaluation and surveillance data to finalise OMPs. Plans can always be amended and updated as more data is presented.

10.5.2 INITIATION OF SCIENTIFIC MONITORING

SMP initiation and implementation timeframes will also need to be identified in the Titleholder's OSM Bridging Implementation Plan. It may take additional time to finalise SMPs as the following actions will need to be completed:

- Activate OSM personnel and any support contracts (e.g. equipment)
- Select/confirm sites (upon receipt of initial situational awareness/monitoring and evaluation data – additional sites can be added as more data is received)
- Finalise sampling technique
- Determine suitable sampling frequency
- Finalise standard operating procedures
- Allocate number of teams, personnel, equipment and supporting resource requirements
- Finalise HES documentation prior to mobilisation of field teams
- Confirm logistics (e.g. flights, accommodation, vessels)
- Commence deployment of Field Teams
- Gather existing baseline data and/or establish control/reference sites
- Establish benchmarks and guidelines to be used
- Confirm indicator species

- Confirm parameters and metrics

10.6 FINALISING MONITORING DESIGN

It is important to note that the OMPs and SMPs provide detailed guidance rather than a prescriptive set of procedures that must be followed. Similar to individual Titleholders existing OMPs and SMPs, monitoring personnel would be expected to finalise individual monitoring plans at the time of a spill, including standard operating procedures, sampling frequency, parameters and number of teams to deploy. This is essential to ensure the finalised monitoring plan is fit for purpose and tailored to the Titleholder's specific location and associated sensitivities, and the nature and scale of the individual spill.

This flexibility must also be extended to the methodologies proposed. The methods presented in the individual OMPs and SMPs should be considered the base methods to be used. If the OMPs and SMPs are utilised for a spill, then the monitoring providers involved should be allowed the ability to employ the latest expertise and equipment, latest sampling methods and variables to be measured.

Whilst the methods may be varied, the individual monitoring plans aim/objectives, initiation and termination criteria and deliverables should not be varied outside the formal review process outlined in Section 12. In addition, the following are considered to be the minimum requirements in the individual monitoring plans (where listed). Modification of these must be justified by individual Titleholders if they are varied:

- Data and information requirements (applicable to scientific monitoring only)
- Monitoring parameters and metrics (as applicable)
- Personnel requirements
- QA/QC requirements (as applicable)
- Data analysis and management (as applicable).

Even when the intended design has been finalised, the approach to data collection may need to be modified in-situ depending on several factors, including (but not limited to):

- Information gathered from monitoring and evaluation and the OMPs;
- The evolution, weathering, behaviour and extent of the spill;
- Weather and sea state conditions;
- Unforeseen presence of protected species at monitoring locations; and/or
- Site locations and access given unforeseen logistical and safety constraints.

The OSM Monitoring Provider Implementation Lead and Technical Managers must be qualified (with appropriate skills and experience) to design and/or redesign the monitoring programs adaptively. Personnel competencies are outlined in Table 11-1.

When finalising monitoring designs post-spill, the latest threatened species recovery plans and/or conservation advice will be reviewed to take into account any controls or restrictions that need to be implemented to prevent impacts from monitoring activities.

The Joint Industry OSM Bridging Implementation Plan Template provides a worked example of the tasks and responsibilities for finalising monitoring design.

10.7 INTERFACE BETWEEN PLANS

The OMPs and SMPs activated for a spill will depend on the spill characteristics, location and response options employed to combat the spill. In addition, information collected through one monitoring plan can initiate another monitoring plan. The plans are purposefully interrelated with sampling undertaken as part of one plan being utilised to understand impacts or spill dynamics in another.

However, monitoring is resource intensive and opportunities should be sought to identify potential competing demands, share resources and maximise efficiencies between monitoring components wherever possible. If Titleholders map out their implementation schedule (Section 7 of the Bridging Implementation Plan) then they will gain a better understanding of which monitoring components are likely to be required and when. Titleholders can then determine resourcing requirements for the initial stages of monitoring and how resources may be scaled over time, similar to mapping response capability in OPEPs. For example, Titleholders may only have two vessels contracted and able to mobilise to location within 48 hours of notification. Titleholders would need to determine which monitoring components each vessel could conduct, their frequency of sampling and sampling locations. There are many logistical considerations in mapping out implementation timeframes and this is typically best achieved in a workshop environment to help partition resources between competing demands.

When results and outputs from various OMPs are evaluated together, a dynamic map can be created to understand the spill dynamics and weathering over time. Operational plans can also be utilised alongside each other to build a picture of sensitive receptors that are likely to be affected by the spill to inform the spill response. Outputs from the scientific monitoring plans may also be used alongside each other to assist in understanding broader cause and effect impacts of the spill at a habitat or ecosystem level.

10.8 PERMITS AND ACCESS REQUIREMENTS

To conduct monitoring of some receptors and within some areas, permits may need to be obtained from the relevant State/Territory and/or Commonwealth jurisdictional authority, other operators/proponents, or landholders (private and/or Traditional). Permit and access requirements apply to Marine Parks, Marine Protected Areas, restricted heritage areas, operational areas of industrial sites, defence locations and managed fisheries but in some cases they may apply to all waters. Access permits for individual landholders may be specific to that landholder (e.g. pastoral lease holders).

Titleholders will need to refer to the relevant Australian Marine Park Management Plan for specific requirements for marine parks and marine protected areas, which will need to be addressed in their Bridging Implementation Plan. However, generally actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act may be conducted in all zones in an Australian Marine Park (Ref. 25).

Table 10-2 provides guidance on the relevant jurisdictional authority for various receptors and relevant permitting information for Commonwealth, Western Australian and Northern Territorial receptors. The process for obtaining permits and addressing access requirements will need to be confirmed by the Titleholder in their Bridging Implementation Plan. Titleholders will also be required to outline who will be responsible for obtaining any necessary permits and access requirements for their selected monitoring activities.

Titleholders must have provision in their Bridging Implementation Plan and/or OPEP for notifications to be made to the Director of Parks Australia in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park. Where practicable, this notification should be made prior to any response action being undertaken. In addition, activities (including monitoring) should be conducted in accordance with the relevant accepted EP.

If permits are likely to be required in any area, at the onset of initiation, the OSM Implementation Lead (or other designated role in the Titleholder's Bridging Implementation Plan) should be responsible for contacting the relevant jurisdictional authority and/or asset manager and arrange for the pre-issuing of 'blanket' sampling permits to avoid the typical lead times when applying for permits through normal channels. Permits depend on the type of sampling to be undertaken and on the jurisdictions within the response area. Alternatively, permits could be sought pro-actively prior to any spills, where possible.

Table 10-2: Jurisdictional Authorities for Various Receptors and Permitting Information

Receptor	Jurisdictional Authority	Permitting information ⁶
Permits for monitoring fauna	State/Territory government department with jurisdiction for fauna Department of Agriculture, Water and the Environment (DoAWE)	Any interactions involving nationally listed threatened fauna may require approval from DoAWE (http://www.environment.gov.au/biodiversity/threatened/permits) WA – appropriate permits can be found at: https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities?showall=&start=4 NT – permits can be found at: https://nt.gov.au/environment/animals/wildlife-permits/permits-take-interfere-with-wildlife
State/Territory Marine Protected Areas; Fish Habitat Protection Areas	State/Territory government department with jurisdiction for parks and wildlife State/Territory government department with jurisdiction for fisheries	No specific permitting requirements exist for monitoring in WA marine protected areas, but additional information is available at: https://www.dpaw.wa.gov.au/management/marine , https://www.dpaw.wa.gov.au/management/marine/marine-parks-and-reserves , and https://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biodiversity/Marine-Protected-Areas/Pages/default.aspx No specific permitting requirements exist for monitoring in NT fish protection areas, but zones are described here: https://nt.gov.au/marine/recreational-fishing/when-and-where-to-fish/reef-fish-protection-areas
Ramsar wetland	Commonwealth Department of Environment and Energy	Additional information on Ramsar wetlands and how they are protected as a matter of national environmental significance under the EPBC Act is available at https://www.environment.gov.au/epbc/what-is-protected/wetlands
Australian (Commonwealth) Marine Parks	Parks Australia	Permit and licence application information for Marine Protected Areas (including monitoring) can be found at: https://onlineservices.environment.gov.au/parks/australian-marine-parks and https://onlineservices.environment.gov.au/parks/australian-marine-parks/permits Additional information on permitting requirements in Australian Marine Parks can be obtained through Parks Australia via email marineparks@environment.gov.au or phone 1800 069 352 Information on permits to access biological resources in Commonwealth areas can be found at: http://www.environment.gov.au/topics/science-and-research/australias-biological-resources/access-biological-resources-commonwealth

⁶ Information presented in this table is relevant to WA, NT, and Commonwealth jurisdictions. Titleholders operating within other jurisdictions will need to investigate permitting requirements in those jurisdictions.

Receptor	Jurisdictional Authority	Permitting information ⁶
State/Territory Managed Fisheries	State/Territory government department with jurisdiction for fisheries	No specific permitting requirements exist for WA Fisheries, but additional information is available at: https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Pages/default.aspx No specific permitting requirements exist for NT Fisheries, but additional information is available at: https://dpir.nt.gov.au/fisheries
Commonwealth Managed Fisheries	Australian Fishing Management Authority	Commonwealth Managed Fisheries (scientific permit for research/monitoring in an Australian Fishing Zone) https://www.afma.gov.au/fisheries-services/fishing-rights-permits
Indigenous Cultural Heritage	State/Territory government department with jurisdiction for indigenous heritage	Entry access permits to Aboriginal Lands in WA: https://www.wa.gov.au/service/aboriginal-affairs/aboriginal-heritage-conservation/apply-permit-access-or-travel-through-aboriginal-land Aboriginal heritage sites in WA: https://www.wa.gov.au/service/aboriginal-affairs/aboriginal-cultural-heritage/search-aboriginal-sites-or-heritage-places Indigenous heritage information in NT: https://nt.gov.au/leisure/arts-culture-heritage/visit-a-cultural-or-heritage-site/indigenous-heritage-information
Defence/ restricted military area	Department of Defence	Unexploded Ordnances (mapping information): https://www.defence.gov.au/UXO/default.asp Maritime military firing practice and exercise areas: https://www.hydro.gov.au/factsheets/FS_Navigation-Firing_Practice_and_Exercise_Areas.pdf
Industry (e.g. operational zone of offshore oil or gas platform)	Operating company	Safety zones (up to 500 m from outer edge of well or equipment): https://www.nopsema.gov.au/safety/safety-zones/
Shipwrecks	State/Territory or Commonwealth government department with jurisdiction for maritime cultural heritage/archaeology	Underwater heritage protected zones (Commonwealth): www.environment.gov.au/heritage/underwater-heritage/protected-zones NT protected zones: https://nt.gov.au/leisure/arts-culture-heritage/visit-a-cultural-or-heritage-site/maritime-heritage

10.9 OPERATIONAL MONITORING INFORMING RESPONSE DECISION-MAKING

10.9.1 OPERATIONAL MONITORING TO INFORM RESPONSE ACTIVITIES

Operational monitoring informs planning and decision-making for the effective and timely implementation of response operations. This is a direct requirement of the OPGGS (Environment) Regulations 2009 (Part 2, Division 2.3, Regulation 14 (8AA)) – The oil pollution emergency plan must include adequate arrangements for responding to and monitoring oil pollution, including the following: (d) the arrangements and capability in place for monitoring oil pollution to inform response activities). Therefore, it is important for a Titleholder's OPEP and/or OSM Bridging Implementation Plan to outline their arrangements for recording, communicating and using operational monitoring data during a response.

These arrangements will vary according to each Titleholder's Incident Management Structure (e.g. Incident Command System [ICS] versus Australasian Inter-Service Incident Management System [AIIMS]), whether or not they rely entirely on external monitoring providers and if/how they use NEBA/SIMA, Incident Action Plans (IAPs) and tactical plans in their IMT/EMT.

In situ OMP data are typically recorded by field teams, checked by the Field Team Lead and communicated back to the Situation Unit Lead/Intelligence Unit or Planning Section Chief via field reporting forms, debriefs and reports. Laboratory analysis reports should also be directed to the same position.

If the Situation Unit Lead/Intelligence Unit receives this data, it is then their responsibility to understand who in the IMT/EMT requires this data. Typically this would be the Planning Section/Unit who may provide the data directly to the OSM Management Team for rapid analysis. This analysis would then be used to inform the Common Operating Picture (managed by the Situation Unit Lead/Intelligence Unit) and would be used by the Environment Unit Lead during development of the operational NEBA/SIMA. The NEBA/SIMA would in turn help inform the IAP or tactical plans as developed by the Planning Section/Unit for the current or next operating period. The flow of the above information should be identified in the OSM Bridging Implementation Plan.

Table 10-3 provides an outline of the types of data generated from each OMP and how this data may be used by the IMT/EMT during the response.

Titleholders will need to outline their process for how OMP data will be recorded, communicated and used to inform response activities. A worked example is provided in Section 18 of the OSM Bridging Implementation Plan Template.

Table 10-3: Data Generated from each OMP and how IMT/EMT may use this in Decision-making

Operational Monitoring Plan	Data generated ⁷	How data may be used by IMT/EMT
Hydrocarbon properties and weathering behaviour at sea	Hydrocarbon physical characteristics (e.g. viscosity, asphaltene content, fingerprinting, weathering ratios of hydrocarbon chains)	Changes to the hydrocarbon properties will affect the window of opportunity for particular responses and the associated logistical requirements of these responses, such as use of chemical dispersants, recovery and pumping equipment suitability, hydrocarbon storage and hydrocarbon disposal requirements
Shoreline clean-up assessment	Assessment of shoreline character; assessment of shoreline oiling; recommendations for response activities; post-treatment surveys	Confirmation of shoreline character, habitats and fauna present which may influence protection priorities and selection of response tactics (e.g. no mechanical recovery if turtles are known to be nesting); oil deposition and/or removal rate for a shoreline sector will help determine effectiveness of relevant tactics (e.g. shoreline protection and/or clean-up operations); shoreline clean-up assessment teams provide ground truthing of sites that are not possible via satellite imagery, therefore the IMT/EMT can rely on recommendations from shoreline clean-up assessment teams (e.g. flagging access issues, suitable tactics, likely resourcing needs)
Surface chemical dispersant effectiveness and fate	Visual observations of dispersant efficacy; concentration of hydrocarbons in water column (see also water quality assessment)	Determine the effectiveness of dispersant application in removing oil from sea surface and how dispersed oil is being distributed through the water column. This information can be used in NEBA/SIMA to help decide if dispersants are being effective at protecting high value receptors (NEBA/SIMA to evaluate any trade-offs between receptors)
Water quality assessment	Distribution of oil in water column and change in hydrocarbon concentrations (e.g. total recoverable hydrocarbons, Benzene, toluene, ethylbenzene, xylene and naphthalene compounds (BTEXN), Polycyclic aromatic hydrocarbons (PAH)), physio-chemical parameters and dispersant detection	Confirm spatial extent of spill and verify spill modelling and surveillance data; extent of spill can in turn influence location of other OMP and SMP monitoring components and sites

⁷ Summary only. For additional detail, please refer to individual OMPs. Also note data outputs will be reliant on finalised monitoring design.

Operational Monitoring Plan	Data generated ⁷	How data may be used by IMT/EMT
Sediment quality assessment	Distribution of oil in sediment and change in hydrocarbon concentrations (e.g. Total recoverable hydrocarbons, BTEXN, PAH)	Confirm spatial extent of spill; extent of spill can in turn influence location of other OMP and SMP monitoring components and sites
Marine fauna assessment <ul style="list-style-type: none"> • Reptiles • Cetaceans (observational only) • Dugongs • Pinnipeds • Seabirds and shorebirds • Fish 	Rapid assessment of presence and distribution of marine fauna; evaluate impact of spill and response activities on fauna	Understanding of species, populations and geographical locations at greatest risk from spill impacts. IMT/EMTs can use this information to help qualify locations with highest level of protection priority (e.g. dugong nursery area is at risk of high contact therefore dispersant use closest to spill source may be a preferred option); understanding the impacts of spill response activities can help IMT/EMTs to modify or terminate activities if they are assessed as creating more harm than the oil alone (e.g. large shoreline clean-up teams and staging areas may disturb shorebird nesting resulting in adults abandoning chicks)
Air quality modelling (responder health and safety)	Modelled outputs of airborne hydrocarbons, gases and chemicals and their predicted distribution	Determine safe distances from spill source for response personnel; determine the presence and persistence of volatile organic compounds to know if response areas are safe for personnel

10.9.2 OPERATIONAL MONITORING OF IMPACTS FROM RESPONSE ACTIVITIES

Implementation of spill response options have the potential of introducing impacts to receptors, as described in detail in the relevant EP. Operational monitoring is required to provide the IMT/EMT with information on any impacts detected from response activities, so that the IMT/EMT can make informed decisions regarding whether activities should commence, continue, continue with variations or cease. It should be noted that response activities may result in impacts where there is no oil (e.g. shoreline clean-up staging sites, vessel movements) and this should also be considered in the selection of monitoring sites.

Table 10-4 lists potential impacts from the relevant response options. It also outlines the OMPs and SMPs that are relevant for detecting potential impacts from the listed response options.

Titleholders need to outline the process for monitoring potential impacts from response activities in their OSM Bridging Implementation Plan. A worked example is provided in Section 18 of the OSM Bridging Implementation Plan Template.

Table 10-4: Potential Impacts from Response Activities and Relevant Monitoring Plan

Potential impact	Response activity	Relevant OMP/SMP for monitoring impacts
Physical presence	<ul style="list-style-type: none"> • Source control • Surface dispersant application • Containment and recovery • Shoreline protection and deflection • Shoreline clean-up • Oiled wildlife response (including pre-emptive capture and deterrence e.g. hazing) 	<ul style="list-style-type: none"> • OMP: Shoreline clean-up assessment • OMP: Marine fauna assessment • SMP: Intertidal and coastal habitat assessment • SMP: Seabirds and shorebirds • SMP: Marine mega-fauna assessment – Reptiles • SMP: Marine mega-fauna assessment – Whale sharks, cetaceans and dugongs • SMP: Benthic habitat assessment • SMP: Social impact assessment
Physical disturbance (ground and seabed)	<ul style="list-style-type: none"> • Source control • Shoreline protection and deflection • Shoreline clean-up • Oiled wildlife response 	<ul style="list-style-type: none"> • OMP: Shoreline clean-up assessment • OMP: Marine fauna assessment – Seabirds and shorebirds • OMP: Marine fauna assessment – Dugongs • SMP: Intertidal and coastal habitat assessment • SMP: Seabirds and shorebirds • SMP: Benthic habitat assessment • SMP: Marine mega-fauna assessment – Reptiles • SMP: Marine mega-fauna assessment – Whale sharks, cetaceans and dugongs • SMP: Heritage features assessment
Water quality decline	<ul style="list-style-type: none"> • Source control • Surface dispersant application • Containment and recovery • Shoreline protection and deflection • Shoreline clean-up 	<ul style="list-style-type: none"> • OMP: Water quality assessment • OMP: Sediment quality assessment • SMP: Water quality impact assessment • SMP: Sediment quality impact assessment

Potential impact	Response activity	Relevant OMP/SMP for monitoring impacts
	<ul style="list-style-type: none"> Oiled wildlife response 	<ul style="list-style-type: none"> SMP: Intertidal and coastal habitat assessment SMP: Benthic habitat assessment
Sediment quality decline	<ul style="list-style-type: none"> Source control Surface dispersant application Containment and recovery Shoreline protection and deflection Shoreline clean-up Oiled wildlife response 	<ul style="list-style-type: none"> OMP: Water quality assessment OMP: Sediment quality assessment OMP: Shoreline clean-up assessment SMP: Water quality impact assessment SMP: Sediment quality impact assessment SMP: Intertidal and coastal habitat assessment SMP: Benthic habitat assessment
Lighting impacts to fauna	<ul style="list-style-type: none"> Source control Shoreline clean-up 	<ul style="list-style-type: none"> OMP: Marine fauna assessment – Seabirds and shorebirds OMP: Marine fauna assessment – Reptiles SMP: Seabirds and shorebirds SMP: Marine fauna assessment – Reptiles SMP: Marine fish and elasmobranch assemblages assessment
Noise impacts to fauna	<ul style="list-style-type: none"> Source control Monitoring, evaluation and surveillance Surface dispersant application Containment and recovery Shoreline protection and deflection Shoreline clean-up Oiled wildlife response (including pre-emptive deterrence e.g. hazing) 	<ul style="list-style-type: none"> OMP: Marine fauna assessment – Seabirds and shorebirds OMP: Marine fauna assessment – Reptiles SMP: Seabirds and shorebirds SMP: Marine fauna assessment – Reptiles SMP: Marine mega-fauna assessment – Whale sharks, cetaceans and dugongs
Vessel strike to fauna	<ul style="list-style-type: none"> Source control Monitoring, evaluation and surveillance (vessel) Surface dispersant application (vessel) Containment and recovery Shoreline protection and deflection Oiled wildlife response 	<ul style="list-style-type: none"> OMP: Marine fauna assessment – Reptiles OMP: Marine fauna assessment – Dugongs OMP: Marine fauna assessment – Cetaceans OMP: Marine fauna assessment – Fish SMP: Seabirds and shorebirds SMP: Marine fauna assessment – Reptiles SMP: Marine mega-fauna assessment – Whale sharks, cetaceans and dugongs

10.9.3 OPERATIONAL MONITORING OF EFFECTIVENESS OF CONTROL MEASURES AND TO ENSURE EPS ARE MET

Titleholders will need to outline in their OSM Bridging Implementation Plan how they will use operational monitoring data to determine the effectiveness of the response control measures and to ensure that environmental performance standards for the implementation of control measures are met. This is a requirement of OPGGS (Environment) Regulations 2009, Part 2, Division 2.3, Regulation 14 (8AA) – The oil pollution emergency plan must include adequate arrangements for responding to and monitoring oil pollution, including the following: (c) the arrangements and capability that will be in place for monitoring the effectiveness of the control measures and ensuring that the environmental performance standards for the control measures are met.

Environmental performance standards vary greatly between Titleholders, however the outcomes of operational monitoring should allow Titleholders to confirm that the required levels of performance of their response control measures are being met (e.g. when, where and how response resources are being deployed and response options implemented).

As ultimately responsible for the IAPs, the Planning Section Chief continually assesses the effectiveness of the response options throughout the response to determine if the response options can be continued, escalated, terminated, or if controls need to be put in place to manage impacts of the response activities (Section 10.9.2). Operational monitoring data provides the information necessary to support that decision-making.

Titleholders will need to ensure that their OSM Bridging Implementation Plan has considered any possible linkages between spill response control measures, their resultant performance standards and how operational monitoring will provide information to confirm that the performance standards are being met. Worked examples are provided in the OSM Bridging Implementation Plan Template.

10.10 DATA MANAGEMENT AND REPORTING

The following reporting to Titleholders is required as a minimum and will need to be undertaken by the OSM Services Provider/s or any internal teams tasked with implementing OMPs/SMPs:

- Any OMP's implemented during a response will have simple reporting requirements (e.g. activities undertaken, HES performance and survey progress). Reports will need to be sent through to the IMT on a daily basis (or more frequently as requested by the IMT). OMP reporting will not be peer reviewed. No final reporting is required for OMPs. However, information from OMPs may feed into certain SMP draft and final reports as appropriate.
- All sampling data and data interpretation provided in spatial data format (e.g. shape file) and/or spreadsheets as appropriate.
- Technical survey reports detailing whether the termination criteria have been reached, including recommendations for future monitoring. Where possible, reports will compare monitoring results for hydrocarbons/chemicals against reference/baseline data or benchmark levels. Reporting should also include the spatial assessment of the distribution of hydrocarbons/chemicals over time.
- Where possible, reporting should also include an assessment of the performance of the response options against the environmental performance objectives in the relevant regulatory environmental permits or other relevant environmental management documentation.
- Draft technical survey reports for SMPs will be peer reviewed by an expert panel to be approved by the Commonwealth DoAWE and/or WA Department of Biodiversity Conservation and Attractions (DBCA) (depending on jurisdiction), as appropriate. Comments from peer reviews will be addressed when finalising SMP reports.
- Scientific monitoring data and reports shall be reviewed by the OSM Implementation Lead prior to being submitted to the Titleholder's nominated representative.

- If the Titleholder has any additional specific data management requirements for OSM then these should be stated in Section 19 of the Joint Industry OSM Bridging Implementation Plan

10.11 QUALITY ASSURANCE AND QUALITY CONTROL

Robust QA/QC measures are required to instil confidence in the operational and particularly the scientific monitoring programs. The requirements for QA/QC for monitoring plans include:

- Use of chain of custody forms, procedures for sampling, data collection templates and a data management plan;
- Quality control/review steps performed on the statistical analysis and interpretation (where applicable);
- Adhering to handling, storage, holding times and transport requirements in accordance with the finalised monitoring design;
- Collection and analyses of QA/QC samples in accordance with the finalised monitoring design;
- Archiving of samples where applicable;
- Maintenance and calibrations of systems and equipment;
- Maintenance of metadata; and
- Data backup, storage and archiving.

10.12 COMMUNICATION PROTOCOLS

Communications can be separated into two categories, 1) communication protocols with OSM Service Provider/s and 2) protocols with external stakeholders. Communication protocols are individual to each Titleholder, therefore they will need to be outlined in the Titleholder's OSM Bridging Implementation Plan.

Titleholders will need to state how results of OMPs and SMPs will be discussed with relevant stakeholders. In some instances, this sharing of information is required under legislation and/or outlined in management plans. For example, if monitoring is planned to be conducted in an Australian Marine Park, the Director of Parks Australia should be notified, so far as reasonably practicable, prior to action being taken within the Marine Park. Titleholders will be required to include this notification in their EP Framework (often included in the OPEP's 'external notifications' table), as the requirement refers to all actions relating to responding to oil pollution incidents (e.g. response actions, monitoring and remediation). However, Titleholders should note that control sites may be located outside the EMBA and in such circumstances, the Titleholder will need to ensure relevant communications are conducted and permits obtained (Section 10.8) prior to undertaking activities at these sites.

Information will need to be shared with regulatory agencies/authorities (as required) and inputs received from stakeholders will need to be evaluated. Where practicable, this input should be used to refine the ongoing spill response and/or ongoing operational and/or scientific monitoring.

The Joint Industry OSM Bridging Implementation Plan Template provides a worked example of a Titleholder's communication protocols for the categories mentioned above.

10.13 ROLES AND RESPONSIBILITIES

10.13.1 MAINTENANCE OF THE OSM FRAMEWORK

Since 2017, development of the Joint Industry OSM Framework has been progressed via APPEA and the Joint Industry OSM Steering Committee, supported by independent consultants. The Steering Committee is developing a complementary Joint Industry OSM shared service arrangement. Under this arrangement the Framework will be maintained by a central organisation, referred to below as an OSM Management Entity. The terms of reference for this role are being finalised, however, under this arrangement the OSM

Management Entity would be the custodian of the Framework and the supporting OMPs and SMPs. To access this shared service, Participating Titleholders would need to sign up via a participant agreement.

Ultimately, it would create efficiencies if this Entity coordinates updates to the documents, conduct regular reviews and works with Participating Titleholders to identify areas for improvement. Additionally, the custodian could manage the contracts with specialised Monitoring Providers who would be required to finalise and then implement the monitoring plans during a response. This role could include maintaining evidence of the required monitoring capability and coordinating a regular testing schedule to demonstrate capability.

Implementation of the Joint Industry OSM Framework shared service is proposed to be separated into three phases: 1) set-up phase; 2) readiness phase; and 2) activation phase, all of which are detailed in the Scope of Work prepared specifically for this shared service. An example of the division of roles and responsibilities between Participating Titleholders, OSM Management Entity and contracted Monitoring Providers is presented in Table 10-5.

Until this shared service arrangement is fully functional, APPEA will remain custodian of the Framework and the associated supporting documents and be responsible for maintenance of this documentation.

Table 10-5: Roles and Responsibilities for the Joint Industry OSM Framework

Role	Set-up Phase Responsibilities	Readiness Phase Responsibilities	Activation Phase Responsibilities
Titleholder	<ul style="list-style-type: none"> • Prepare and obtain acceptance of Titleholder's OSM Bridging Implementation Plan • Ensure own personnel are familiar with OSM Framework, applicable OMPs, SMPs and their individual Titleholder Bridging Implementation Plan • Establish OSM arrangements/structure within their own IMT/EMT • Plan logistical arrangements to support OSM Management Entity and Monitoring Service Providers during (and after) an Incident • Nominate a representative to participate in Joint Industry OSM SteerCo 	<ul style="list-style-type: none"> • Where applicable, review and approval of other reporting or documentation presented by the OSM Management Entity • Where applicable, review and approval of annual Deliverables (e.g. OSM Services Program etc). • Participate as required in the scheduled annual OSM Services Program testing exercises 	<ul style="list-style-type: none"> • Activate OSM Management Entity • Approve OSM Management Entity and Monitoring Service Provider/s to implement and report on the relevant monitoring programs • Approve the monitoring design in consultation with the OSM Management Entity and Monitoring Service Provider/s according to the nature and scale of the spill • Provide logistical arrangements for any Incident (and post-Incident), unless otherwise agreed • Approve analysed monitoring data for use in IMT and recovery phase
OSM Management Entity	<ul style="list-style-type: none"> • Establish contracts with suitably qualified Monitoring Service Providers • Ensure Monitoring Service Providers provide all of their supporting OSM Management documents • Ensure Monitoring Service Providers prepare an Annual OSM Services and Assurance Program • Establish and maintain an activation process for OSM services and ensure that all Monitoring Service Providers are familiar with it and can respond in accordance with it • Ensure Monitoring Service Providers establish and maintain process for data presentation 	<ul style="list-style-type: none"> • Ensure that all Monitoring Service Providers are performing their contractual obligations • Maintain the Annual OSM Services and Assurance Program • Maintain data forms and processes • Maintain the document control system • Maintain HES policies and processes • Prepare and submit OSM Services Management Reporting to Steering Committee • Participate in training and exercises with individual Titleholders, as required 	<ul style="list-style-type: none"> • Due to the familiarity of the documents, there may be a role in supporting Titleholders and Monitoring Providers during implementation • Provide support to Titleholders IMT/EMT during the response phase • Accountable for packaging and readying all OSM personnel and equipment in a ready state for mobilisation to agreed location (e.g. airport, marine port) (OSM Management Entity would be required to work in close consultation with Logistics Section in Titleholder's Emergency/ Incident Management Team)

Role	Set-up Phase Responsibilities	Readiness Phase Responsibilities	Activation Phase Responsibilities
	and transfer to IMT during response phase (e.g. forms)		<ul style="list-style-type: none"> Accountable for data reporting and transfer to Titleholder in response and recovery phase
Monitoring Providers	<ul style="list-style-type: none"> Responsible for preparing new supporting OSM Management documents / templates during set up phase Prepare initial Annual OSM Services and Assurance Program Demonstrate they have the required equipment, processes, systems and trained personnel to fulfil the relevant OMPs and SMPs (as a minimum) 	<ul style="list-style-type: none"> Responsible for updating Joint Industry OSM Framework and OMP/SMP documents, as required Maintain agreed OSM capability and readiness to establish an OSM Monitoring Team within a specified timeframe Participate in workshops, conferences to represent Titleholders Provide training and awareness sessions to Titleholders, as required 	<ul style="list-style-type: none"> Finalise the monitoring design according to the nature and scale of the spill in consultation with the Titleholder OSM representative Implement the relevant monitoring program and report as required to the Titleholder OSM representative

10.13.2 RESPONSE PHASE IMPLEMENTATION

The size and composition of the OSM Management Team is likely to vary among Titleholders and according to the nature and scale of the spill. The Bridging Implementation Plan will need to provide detail on the OSM Management Team structure and be relevant to the system of incident command used by the Titleholder (either ICS or AIIMS). Section 5 of the Joint Industry OSM Bridging Implementation Plan Template provides a worked example to help Titleholders determine the structure best suited to their individual needs.

It is recommended that during spill response operations the OSM Management Team report to either the Planning Section or Operations Section in the IMT/EMT.

Table 10-6 lists the key OSM roles and responsibilities in the IMT/EMT and OSM Management Team. Titleholders will need to present the roles and responsibilities of key IMT/EMT personnel (e.g. Operations Section Chief, Planning Section Chief) in their relevant EP or OPEP.

Titleholders must clearly articulate responsibility for implementation and decision-making of scientific monitoring components during the post-response phase. A pragmatic approach would be to assign this responsibility to the same person during the response phase and post-response phase, for continuity of decision-making.

Table 10-6: Responsibilities of Key Roles in OSM Management Team

Role	Key Responsibilities
Incident Commander	<p>Ultimately accountable for the implementation of the OSM. Specific responsibilities related to the OSM include:</p> <ul style="list-style-type: none"> • Ensure OSM-specific roles are established • Integrate operational and scientific monitoring with the spill response • Ensure that OMP and SMP components are implemented according to their specific initiation criteria and within nominated response times • Ensure that the OSM Implementation Lead and Environment Unit Lead are sufficiently resourced to oversee and guide implementation of OSM activities
Environment Unit Lead (EUL)	<p>The EUL is the key position for relaying information between the IMT and the OSM Implementation Lead. Key OSM responsibilities include:</p> <ul style="list-style-type: none"> • Mobilise OSM Service Provider • Validate protection and monitoring priorities with OSM Implementation Lead • Validate strategic SIMA to generate the initial operational SIMA • Main point of contact between IMT and OSM Service Provider • Provide overarching technical advice • Analysing data received from monitoring teams (this task may be delegated to OSM Management Team) and ensuring the information is incorporated into the current/next operating period's Incident Action Plan • Advise on environmental impact from implementing monitoring • Management of scientific monitoring components once spill response operation is terminated (may be delegated once IMT/EMT is stood down following termination of response)

Role	Key Responsibilities
OSM Implementation Lead	<p>Responsible for overseeing implementation of OMP and SMP components in accordance with this Plan, specifically:</p> <ul style="list-style-type: none"> Identify the relevant OMP and SMP components that may be triggered based on the information collected during the initial response and OMP monitoring Ensure that the relevant OMP and SMPs are implemented at the appropriate times Liaise with EUL/Environment Advisor throughout monitoring period (response phase and post-response) Confirm monitoring priorities with EUL and continually re-evaluate Integrate any protected matters requirements into final monitoring designs Approve monitoring designs and monitoring plans Liaise with relevant stakeholders and regulators on monitoring design, monitoring priorities, and results
Operational Monitoring Coordinator and Scientific Monitoring Coordinator (Monitoring Provider)	<p>The Operational Monitoring Coordinator and Scientific Monitoring Coordinator are the technical leads for each monitoring type. Responsibilities include:</p> <ul style="list-style-type: none"> Assist OSM Implementation Lead in finalising the monitoring design for individual OMPs and/or SMPs Understand the data metrics collected in the event of a spill Advise the OSM Implementation Lead 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
OSM Field Operations Manager (Monitoring Provider)	<p>Responsible for the coordination of resources and developing a schedule of movements, in close consultation with the IMT/EMT Logistics Section. Key responsibilities include:</p> <ul style="list-style-type: none"> Determine locations where monitoring teams are required and resource requirements for specific locations Keep track of vessel/aerial movements associated with monitoring activities Monitor resource availability Direct communications with relevant Monitoring Coordinator and Field Team Leads Monitor and coordinate simultaneous operations
OSM Field Teams (Monitoring Provider)	<p>A Field Team includes one Field Team Lead, who is the key contact point to the relevant Monitoring Coordinator during a field deployment. The responsibilities of all Field Team members include:</p> <ul style="list-style-type: none"> 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

11 CAPABILITY

11.1 CAPABILITY ARRANGEMENTS

To ensure Titleholders meet OPGGS (Environment) Regulations 2009 (Part 2, Division 2.3, Regulation 14 (8AA)), they will be required to detail the arrangements and capability in place within their own organisation and with external providers, for monitoring activation and implementation. This will need to be outlined in their Bridging Implementation Plan and include:

- Details of nominated positions/personnel to call. This may cross reference to a contacts directory which is updated regularly and includes contact details of internal and external personnel
- Agreed timeframes for activation with external providers
- Agreed process for activation with external providers (worked example provided in Section 12 of the OSM Bridging Implementation Plan Template)
- Roles and responsibilities between the Titleholder and external provider for activation and implementation (worked examples provided throughout Part B of the OSM Bridging Implementation Plan Template).
- Process for finalising monitoring designs (additional detail provided in Section 10.6 and worked example in Section 15 of the OSM Bridging Implementation Plan Template.).
- Minimum team numbers for initial actions and how capability can be built upon over time
- Minimum competencies for personnel (additional detail provided in Section 11.3)
- Process for inductions and training personnel (note that some operational monitoring field based roles could cater for personnel who receive a brief training course and are supervised on the job by more experienced personnel)
- Logistical arrangements, including nominating analytical laboratories, identifying vessel and aviation contracts to assist with monitoring platforms, equipment location and lead times for delivery, and identifying diving support services (if required)
- Any communication, data management, data transfer methods and reporting protocols with the external provider/s that vary from those provided in Sections 10.10 to 10.12
- Stand down process (worked example provided in Section 22 of the OSM Bridging Implementation Plan Template).

11.2 PERSONNEL AND EQUIPMENT

The OMPs and SMPs list the equipment and personnel required to implement each monitoring plan. In addition, Titleholders will be required to outline in their Bridging Implementation Plan the arrangements of how the equipment requirements for their selected OMPs and SMPs will be met (e.g. through contracted monitoring providers and/or independent external equipment providers). Guidance and worked examples are provided in Section 9 of the OSM Bridging Implementation Plan Template.

11.3 TRAINING AND COMPETENCY

Implementation of OSM requires skilled professionals with specific competencies. This includes an OSM Management Team and multiple field teams who implement individual monitoring plans. Example team structures are shown in Section 6 of the OSM Bridging Implementation Plan. The roles and responsibilities of key positions are listed in Table 10-6.

Table 11-1 provides minimum competencies for the key OSM Management Team roles.

It is important to note that Titleholders should involve their most experienced monitoring personnel (internal or external personnel) in the early stages of monitoring, so that they are able to contribute to the finalisation of the monitoring design for the triggered OMPs and SMPs.

Table 11-1: Competencies Required for Key OSM Roles

Role	Competencies
Environment Unit Lead (Titleholder) ⁸	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • > 10 years' experience in environmental management • PMAOMIR320 or PMAOMIR322 – Manage Incident Response Information; or ICS 100 and ICS 200; or IMO2 Oil Spill Management Course or similar accredited course • Participation in one incident management exercise every two years • Operational and Scientific Monitoring Plan Awareness Training
OSM Implementation Lead (Titleholder)	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • > 10 years' experience in environmental management • PMAOMIR320 or PMAOMIR322 – Manage Incident Response Information; or ICS 100 and ICS 200; or IMO2 Oil Spill Management Course or similar accredited course • Participation in one incident management exercise per year • Operational and Scientific Monitoring Plan Awareness Training, including understanding of how to activate external OSM providers
Operational Monitoring Coordinator and Scientific Monitoring Coordinator (Monitoring Provider)	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • > 5 years' experience in environmental management • PMAOMIR320 or PMAOMIR322 – Manage Incident Response Information; or ICS 100 and ICS 200; or IMO2 Oil Spill Management Course or similar accredited course • Participation in one incident management exercise per year • Operational and Scientific Monitoring Plan Awareness Training • Working knowledge of processes to engage additional support contracts and personnel (if required)
OSM Field Operations Manager (Monitoring Provider)	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • >5 years' experience in relevant scientific field
OSM Field Teams (Monitoring Provider)	<ul style="list-style-type: none"> • Refer to Appendix D

⁸ If the appointed EUL does not meet this competency requirement, then for OSM decision-making and implementation they must be supported by another person who does meet this level of competency and can sign off each Operational and Scientific Monitoring IAP Sub-plan and approve finalised OMPs and SMPs. This may include someone appointed via Monitoring Service Provider or mutual aid (e.g. another Titleholder).

11.4 TESTING RESPONSE ARRANGEMENTS

Titleholders have a requirement to test the operational readiness of their response arrangements for monitoring, to meet OPGGS (Environment) Reg. 14 (8A) and (8B). This can include drills, audits and exercises to test arrangements such as resource requirements, implementation timeframes and logistics. This information must be presented in the Titleholder's EP Framework, either in the OPEP, EP or OSM Bridging Implementation Plan. A worked example is provided in Section 9.3 of the Joint Industry OSM Bridging Implementation Plan Template.

12 REVIEW

The OSM Joint Industry Framework shall initially be reviewed biennially, from the date of the Regulatory Advice Statement being issued and incorporate improvements from various continuous improvement sources. After 4 years (two revisions), the OSM Joint Industry Framework shall undergo a comprehensive review every 5 years.

The document may be reviewed and revised more frequently, if required by APPEA or NOPSEMA.

13 REFERENCES

Ref. No.	Description
1.	International Tanks Owners Pollution Federation Limited (2011) Fate of Marine Oil Spills: Technical Information Paper 2, London
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14 ABBREVIATIONS AND ACRONYMS

Abbreviation/Acronym	Definition
AIIMS	Australasian Inter-Service Incident Management System
ALA	Atlas of Living Australia
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance. A collection of statistical models, and their associated procedures, in which the observed variance is partitioned into components due to different explanatory variables. In its simplest form, ANOVA gives a statistical test of whether the means of several groups are all equal.
ANZECC	Australian and New Zealand Environment and Conservation Council
AODN	Australian Oceans Data Network
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BACI	Before-After, Control-Impact statistical design
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene compounds
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBCA	Western Australian Department of Biodiversity Conservation and Attractions
DoAWE	Commonwealth Department of Agriculture, Water and the Environment
EMBA	Environment that May Be Affected
EMT	Emergency Management Team
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPS	Environmental Performance Standard
EUL	Environment Unit Lead
GIS	Geographic Information System
HES	Health, Environment, and Safety
IAP	Incident Action Plan
ICS	Incident Command System
I-GEMS	Industry-Government Environmental Metadata System
IMT	Incident Management Team
ITOPF	International Tanker Owners Pollution Federation Ltd
IvC	Impact versus Control
LCL	Lower Control Limit
MBACI	Multiple Before–After, Control–Impact statistical design

Abbreviation/Acronym	Definition
MES	Monitoring, Evaluation, and Surveillance
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (Australia)
NT	Northern Territory
OMP	Operational Monitoring Plan
OPEP	Oil Pollution Emergency Plan
OPGGS	Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009
OSM	Operational and Scientific Monitoring
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbon
PERMANOVA	Permutational Multivariate Analysis of Variance
QA/QC	Quality Assurance / Quality Control
SD	Standard Deviation
SIMA	Spill Impact Mitigation Assessment
SMART	Special Monitoring of Applied Resource Technologies
SMP	Scientific Monitoring Plan
UCL	Upper Control Limit
WA	Western Australia
WAMSI	Western Australian Marine Science Institution

APPENDIX A JOINT INDUSTRY OSM FRAMEWORK MINIMUM STANDARDS

‘Minimum standards’ refer to those items that the OSM Framework sets as its minimum standard (e.g. personnel competencies, finalisation of monitoring designs)

‘Commitments’ refer to those items the Titleholder will need to individually address in their OSM Bridging Implementation Plans.

If Titleholders wanted to deviate from the minimum standards then they would be required to indicate in their bridging implementation plans which ones they are not committing to and the justification behind it.

MINIMUM STANDARDS

Minimum standard	Section No. (if relevant)
Titleholders that apply this Framework will implement, as a minimum, the OMPs listed in Table 5-1 where initiation criteria for each of these studies are met.	5
Titleholders that apply this Framework will implement, as a minimum, the SMPs listed in Table 6-1 where initiation criteria for each of these studies are met.	6
The implementation of the spill response control measures will be subject to continual review during a response to determine if a strategy should commence, continue, continue with variations or cease.	5
Control measures will be identified to manage the impacts and risks of implementing a spill response (e.g. locations where surface dispersants can be deployed, restrictions on disturbance of sensitive shorelines by shoreline responders etc).	5
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 will be adopted: <ul style="list-style-type: none"> 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. 	6
The Monitoring Design information in each SMP will be considered by the Monitoring Provider in the review and finalisation of the monitoring design, including sampling techniques and standard operating procedures.	6
Finalisation of monitoring designs are considered to be a key decision in the OSM process and will need to be approved by personnel holding the competencies outlined in Table 11-1	6

Minimum standard	Section No. (if relevant)
<p>If benchmarks are relevant in the scientific studies, they will be selected taking into consideration guideline values that have already been established (e.g. Ref. 7, Ref. 8, Ref. 9, Ref. 10) or if appropriate, follow the process as outlined in Water Quality Australia (Ref. 7) or, if in Western Australia, the Environmental Protection Authority (EPA) Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (Ref. 11) to develop a relevant benchmark value with appropriate statistical power.</p> <p>Benchmark values will also need to take into consideration levels of protection. Levels of protection are defined as the degree of protection afforded based on ecosystem condition (Ref. 7). When finalising monitoring design, the levels of protection for that jurisdiction will need to be investigated. Water Quality Australia (Ref. 7) lists the following levels of protection:</p> <ul style="list-style-type: none"> • High ecological/conservation value —99% species protection • Slightly to moderately disturbed system —95% species protection • Highly disturbed system —90 or 80% species protection <p>Western Australia has a localised approach to levels of ecological protection, outlined in its EPA Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (Ref. 11). In addition, Western Australia has also identified (through public consultation) and mapped levels of ecological protection for the Pilbara Region from the Exmouth Gulf to Cape Keraudren. EPA Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (Ref. 11) will be consulted when investigating levels of protection.</p>	6
<p>Post-spill, the OSM Implementation Lead will be required to approve reactive baseline data requirements, determine if control sites are required and determine the number of samples and sampling sites as part of finalising the monitoring designs for each SMP.</p>	7
<p>Where possible and practicable, baseline data used will match the methods and parameters used in OMPs and SMPs. This will require Titleholders to examine baseline data sets they plan to use for operational and scientific monitoring. This assessment will need to be addressed as part of their Bridging Implementation Plan. The Bridging Implementation Plan Template provides detailed guidance on this review process.</p>	7
<p>The OSM Implementation Lead will be required to select the most suitable survey approaches and finalise monitoring designs for each SMP, according to the individual circumstances of the spill.</p>	8
<p>The OSM Bridging Implementation Plan will form part of the environmental management document framework for offshore petroleum activities and will need to be integrated with the activity's EP and OPEP.</p>	10.1
<p>In addition, Titleholders electing to use this Framework will need to consult with key stakeholders (i.e. Jurisdictional Authority for receptor, appointed State/Territory Environment and Science Coordinator) and monitoring service providers (including subject matter experts, where available) regarding monitoring priorities at the time of the spill (taking into account situational awareness information).</p>	10.3
<p>Whilst the methods may be varied, the individual monitoring plans aim/objectives, initiation and termination criteria and deliverables should not be varied outside the formal review process outlined in Section 12. In addition, the following are considered to be the</p>	10.6

Minimum standard	Section No. (if relevant)
<p>minimum requirements in the individual monitoring plans (where listed). Modification of these must be justified by individual Titleholders if they are varied:</p> <ul style="list-style-type: none"> • Data and information requirements (applicable to scientific monitoring only) • Monitoring parameters and metrics (as applicable) • Personnel requirements • QA/QC requirements (as applicable) • Data analysis and management (as applicable). 	
<p>The OSM Monitoring Provider Implementation Lead and Technical Managers must be qualified (with appropriate skills and experience) to design and/or redesign the monitoring programs adaptively. Personnel competencies are outlined in Table 11-1.</p>	10.6
<p>When finalising monitoring designs post-spill, the latest threatened species recovery plans and/or conservation advice will be reviewed to take into account any controls or restrictions that need to be implemented to prevent impacts from monitoring activities.</p>	10.6
<p>The following reporting to Titleholders is required as a minimum and will need to be undertaken by the OSM Services Provider/s or any internal teams tasked with implementing OMPs/SMPs:</p> <ul style="list-style-type: none"> • Any OMPs implemented during a response will have simple reporting requirements (e.g. activities undertaken, HES performance and survey progress). Reports will need be sent through to the IMT on a daily basis (or more frequently as requested by the IMT). OMP reporting will not be peer reviewed. No final reporting is required for OMPs. However, information from OMPs may feed into certain SMP draft and final reports as appropriate. • All sampling data and data interpretation provided in spatial data format (e.g. shape file) and/or spreadsheets as appropriate. • Technical survey reports detailing whether the termination criteria have been reached, including recommendations for future monitoring. Where possible, reports will compare monitoring results for hydrocarbons/chemicals against reference/baseline data or benchmark levels. Reporting should also include the spatial assessment of the distribution of hydrocarbons/chemicals over time. • Where possible, reporting should also include an assessment of the performance of the response options against the environmental performance objectives in the relevant regulatory environmental permits or other relevant environmental management documentation. • Draft technical survey reports for SMPs will be peer reviewed by an expert panel to be approved by the Commonwealth DoAWE and/WA DBCA (depending on jurisdiction), as appropriate. Comments from peer reviews will be addressed when finalising SMP reports. • Scientific monitoring data and reports shall be reviewed by the OSM Implementation Lead prior to being submitted to the Titleholder's nominated representative. 	10.10

Minimum standard	Section No. (if relevant)
<p>The requirements for QA/QC for monitoring plans include:</p> <ul style="list-style-type: none"> • Use of chain of custody forms, procedures for sampling, data collection templates and a data management plan; • Quality control/review steps performed on the statistical analysis and interpretation (where applicable); • Adhering to handling, storage, holding times and transport requirements in accordance with the finalised monitoring design; • Collection and analyses of QA/QC samples in accordance with the finalised monitoring design; • Archiving of samples where applicable; • Maintenance and calibrations of systems and equipment; • Maintenance of metadata; and • Data backup, storage and archiving. 	10.11
Table 11-1 provides minimum competencies for the key OSMP Management Team roles.	11.3
The OSM Joint Industry Framework shall initially be reviewed biennially, from the date of the Regulatory Advice Statement being issued and incorporate improvements from various continuous improvement sources. After 4 years (two revisions), the OSM Joint Industry Framework shall undergo a comprehensive review every 5 years.	12

COMMITMENTS

Commitment	Section No. (if relevant)
Titleholders will need to provide access/login details or a link to where I-GEMS can be accessed (i.e. Contacts Directory) in their Bridging Implementation Plan.	7
(In reference to baseline relevance: There are operational and scientific monitoring components that are suited to pre-impact/reactive baseline monitoring, although this is not the case for all receptors, especially if a more detailed understanding of natural variability is required to assess the extent of oil spill impacts.) In this case, more detailed baseline planning will need occur and consideration should be given to the relevance of baseline data (including metrics and parameters) used in EPs and its relationship to the data required for the OSM	7
If there is insufficient time to obtain reactive baseline data then Titleholders will need to consider whether additional baseline data are required to be collected .	7
The OSMP Bridging Implementation Plan will form part of the environmental management document framework for offshore petroleum activities and will need to be integrated with the activity's EP and OPEP. Titleholders will be required to provide the following information to demonstrate they meet the regulatory requirements associated with OSMP implementation. (Refer to Section 10.1 for detailed inclusions)	10.1
If a Titleholder choses to adopt the Joint Industry OSM Framework, they will remain responsible for demonstrating its applicability and relationship to their activity.	10.1
Titleholders will need to undertake the following actions to support their Bridging Implementation Plan: <ul style="list-style-type: none"> Assign OSMP roles and responsibilities (internal and external) Establish external contracts to maintain OSMP capability and readiness Determine internal and external personnel competencies and availability (to be monitored and reviewed on a regular basis) Determine equipment providers and laboratories and establish processes/contracts as required Liaise with internal logistics and supply chain departments to advise of OSMP requirements 	Table 10-1
Titleholders will be required to identify in their Bridging Implementation Plan how they have used the results of their risk assessment process, in particular the modelling results, to help determine their likely initial monitoring priorities from their list of receptors.	10.3
Titleholders will be required to outline their initial monitoring priorities in their OSM Bridging Implementation Plan.	10.3
Titleholders will need to identify their relevant thresholds in the EP or Bridging Implementation Plan.	10.3
Titleholders will be required to outline who will be responsible for completing checklist tasks in their Bridging Implementation Plan.	10.3 and 10.5

Commitment	Section No. (if relevant)
Titleholders will need to define timeframes for implementation of each OMP in their Bridging Implementation Plan. Timeframes will need to be linked to the Titleholder's risk assessment process (Section 10.3).	10.5.1
SMP initiation and implementation timeframes will also need to be identified in the Titleholder's OSM Bridging Implementation Plan	10.5.2
Titleholders will need to refer to the relevant Australian Marine Park Management Plan for specific requirements for marine parks and marine protected areas, which will need to be addressed in their Bridging Implementation Plan. (Guidance will be provided in Framework)	10.8
Specific access and permit requirements will need to be confirmed by the Titleholder in their Implementation Bridging Plan. Titleholders will also be required to outline who will be responsible for obtaining any necessary permits and access requirements for their selected monitoring activities. (Guidance provided in Framework)	10.8
Titleholders must have provision in their Bridging Implementation Plan and/or OPEP for notifications to be made to the Director of Parks Australia in the event of an oil pollution incident that occurs within, or may impact upon, an Australian Marine Park.	10.8
Titleholders will need outline their process for how OMP data will be recorded, communicated and used to inform response activities.	10.9.1
Titleholders need to outline the process for monitoring potential impacts from response activities in their OSM Bridging Implementation Plan.	10.9.2
Titleholders will need to outline in their Bridging Implementation Plan how they will use operational monitoring data to determine the effectiveness of the response control measures and to ensure that environmental performance standards for the implementation of control measures are met.	10.9.3
Titleholders will need to ensure that their OSM Bridging Implementation Plan has considered any possible linkages between spill response control measures, their resultant performance standards and how operational monitoring will provide information to confirm that the performance standards are being met.	10.9.3
Titleholders will need to state how results of OMPs and SMPs will be discussed with relevant stakeholders.	10.12
Information will need to be shared with regulatory agencies/authorities (as required) and inputs received from stakeholders will need to be evaluated. Where practicable, this input should be used to refine the ongoing spill response and/or ongoing operational and/or scientific monitoring.	10.12
The Bridging Implementation Plan will need to provide detail on the OSM Management Team structure and be relevant to the system of incident command used by the Titleholder (either ICS or AIIMS).	10.13.2
Titleholders must clearly articulate responsibility for implementation and decision-making of scientific monitoring components during the post-response phase in their Bridging Implementation Plan	10.13.2

Commitment	Section No. (if relevant)
To ensure Titleholders meet OPGGS (Environment) Regulations 2009 (Part 2, Division 2.3, Regulation 14 (8AA)), they will be required to detail the arrangements and capability in place within their own organisation and with external providers, for monitoring activation and implementation.	11.1
Titleholders will be required to outline in their Implementation Bridging Plan the arrangements of how the equipment requirements for their selected OMPs and SMPs will be met.	11.2
Titleholders have a requirement to test the operational readiness of their response arrangements for monitoring, to meet OPGGS (Env) Reg. 14 (8A). This can include drills, audits and exercises to test arrangements such as resource requirements, implementation timeframes and logistics. This information must be presented in the Titleholder's EP Framework, either in the OPEP, EP or OSM Bridging Implementation Plan.	11.4

APPENDIX B SCIENTIFIC MONITORING DESIGN

Data collection depends on several constraints (as outlined below), including but not limited to, the type and location of hydrocarbon spill, and site locations and access given logistical and safety constraints. Therefore, the designs recommended in each Scientific Monitoring Plan 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 Scientific Monitoring Plans 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).

This appendix provides guidance on general survey approaches likely to apply to the Scientific Monitoring Plans:

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

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 OMP data
- Availability of appropriate control 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

The OSM Implementation Lead will be required to select the most suitable survey approaches and finalise monitoring designs for each SMP, according to the individual circumstances of the spill.

IMPACT VERSUS CONTROL APPROACH

For some locations and receptors, baseline data may not exist, may not be 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, an 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 control 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 control 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 control sites and may affect the conclusion of the assessment. Biological information may also be relevant, such as degree of sub-lethal and lethal impacts to populations. 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. The physical and biological information can therefore augment and act as additional evidence to help interpret conclusions from any IvC analyses. 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.

The suggested statistical approach for analysing the data collected using the IvC approach is a multi-factorial ANOVA (to account for nested data), including PERMANOVA and non-parametric tests, to 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 in the receptors.

GRADIENT APPROACH

The Gradient Approach **can be used in some instances where a lack of suitable control sites prohibits using a BACI or IvC Approach**. Sampling should be established along a gradient of predicted effect (based on input of data from OMPs 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 OMP or SMP 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. The Gradient Approach also provides a 'Line of Evidence' 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 take these into account when interpreting the data.

When designing a study using a Gradient Approach, relevant OMP data, SMP data (e.g. water and sediment quality), and modelling should be considered. 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 so shouldn't necessarily be discouraged.

Typically, the level of observed impact will decline at distance from the source of a hydrocarbon release, with this decline likely to be exponential (i.e. large changes close to a release that quickly decrease in severity); therefore, sampling effort can be distributed along the gradient of effect in a way that best characterises the changes in the parameter measured.

If possible, multiple (> two) sites could be sampled at each distance along the gradient (if logistics and time permit) to provide an understanding of small scale variation. Sites should also be sampled at distances where no environmental effect is predicted or observed, if possible, to characterise the full extent of the effects gradient.

The suggested statistical analysis for the Gradient Approach includes correlation analysis between impact (measurements of hydrocarbon/stress; x-axis) and measurement parameter (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.

BACI APPROACH

Where appropriate baseline data are available, consideration should be given to developing a beyond BACI monitoring program design (Ref. 13; Ref. 14) or similar extended BACI design (MBACI), which monitors a

range of control and impact sites, and can do so over time (Figure B-1). Where robust, appropriate baseline data for exposure sites are not available, pre-exposure sampling of locations that lie within the hydrocarbon spill trajectory should be prioritised to obtain baseline data prior to hydrocarbon exposure.

Exposure sites should be selected first, encompassing a representative selection of locations within the area affected by hydrocarbons. Where practicable, the monitoring program design may consider stratified sampling along environmental gradients (e.g. level of hydrocarbon exposure etc.). Comparable control sites beyond the area affected by hydrocarbons should then be selected, with monitoring conducted at all sites. Clearly obtaining control sites pre-exposure can be challenging and is heavily reliant on predicting the extent of hydrocarbon movement.

The suggested statistical analysis of data collected using the BACI approach includes a univariate or multi-factorial analysis of variance (ANOVA) and equivalent non-parametric tests, all of which will compare between treatment (impact versus reference) and time (before versus after). Components of variation may help partition a sum of squares into different sources and describe the importance of factors within tests.

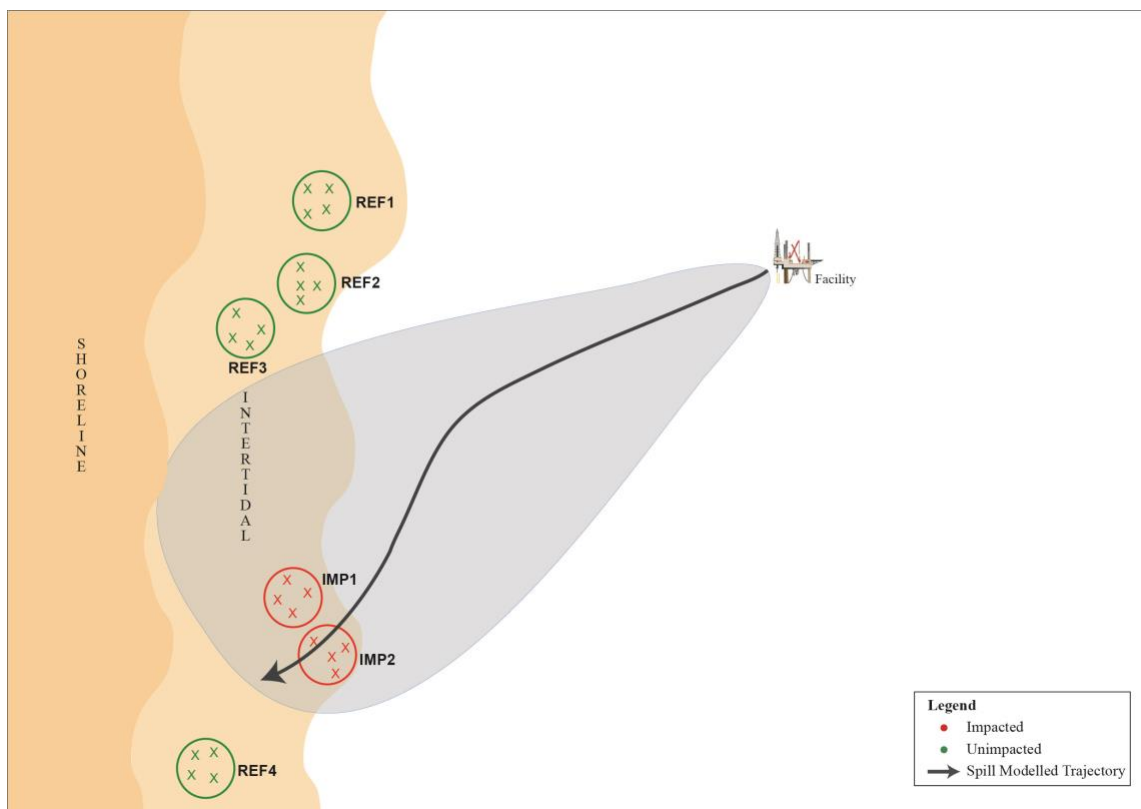


Figure B-1: Example of a MBACI design for Shoreline and/or Intertidal Communities

Notes:

- 1 A modification to the beyond BACI design, is known as an MBACI design. MBACI designs incorporate multiple impact locations, whereas beyond BACI designs include only one impact location.
- 2 The above design consists of four reference/control locations and two impact locations, with four nested sites in each. The number of replicates (e.g. quadrats or transects) per site should be set based on resourcing, and /or the results of the power analysis (if applicable).
- 3 The area affected by the spill is indicated by the grey shaded area, or the area of influence.
- 4 Design assumes the area of influence has been affected equally.

CONTROL CHART APPROACH

The Control Chart Approach is applicable in the following circumstances:

- 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 is ‘Strength of Association’ (Ref. 15), exemplified by a ‘larger decline in individuals in areas affected by hydrocarbon than in control 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 (UCL; e.g. typically 3 standard deviations [SD] above the mean), and a lower control limit (LCL; e.g. typically 3 SD below the mean), which are typically all determined from historical data (Figure B-2). The mean line can be constructed using data from i) historical data of an impact site prior to it being affected by hydrocarbons (i.e. what the mean used to be), or ii) control locations, whereby either historical or recent data are used for comparison to other sites (i.e. a control site historical data compared to impact site). Any observations outside the UCL and LCL suggest that increased variation has been observed that are inconsistent with other data and may post a simple way to detect change in a system.

In addition, if ongoing data collection is possible following a potential impact, the Control Chart Approach can be used to examine the direction of change and whether this is consistent or inconsistent with other data. These data and interpretation may 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 knowledge of natural variability in a given parameter whether from historical sources or similar sites/locations. Control Chart Approach can be a powerful tool for detecting impacts for systems that are naturally highly variable.

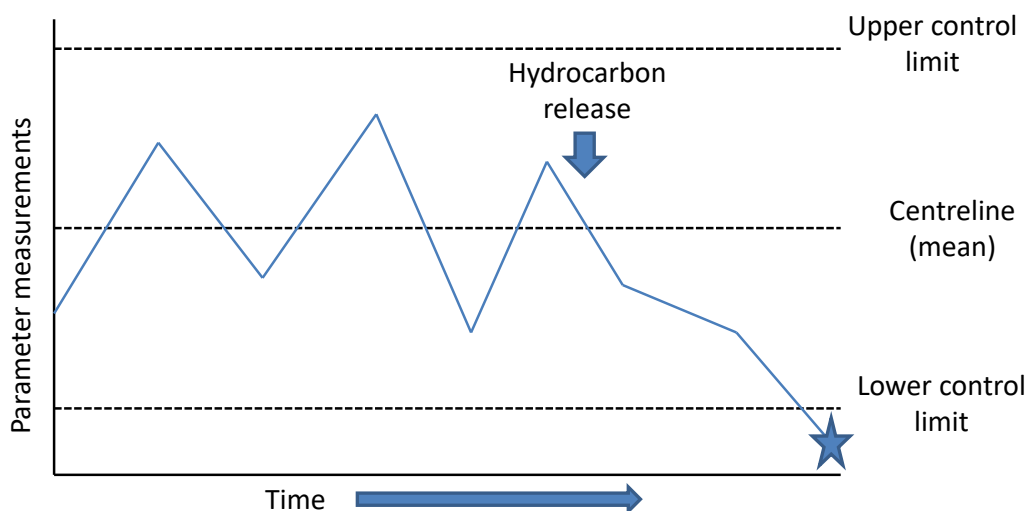


Figure B-2: Example Control Chart showing Centreline (mean), Upper Control Limit (3 SD above mean), Lower Control Limit (3 SD below mean), and Measurements

Note: The star represents a measurement beyond the likely anticipated variation, which needs to be investigated.

The statistical approach for Control Charts is:

- Calculate the historical/akin site mean for the centreline
- Calculate the upper and lower control limits from historical/akin site data, e.g. typically 3 SD above and below the mean (Ref. 16)
- Calculate the mean (ongoing) for an impact site to compare against the control chart.

LINES OF EVIDENCE APPROACH

The Lines of Evidence Approach is applicable in the following circumstances:

- Can be combined with any of the above monitoring 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 control sites exist.

When a sampling design is suboptimal, or if conclusions from more formal tests are inconclusive, a 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. 17), which does not necessarily imply causation. Each causal argument may be weak when considered independently but combined they may provide strong circumstantial evidence and support for a conclusion (Ref. 17).

This approach was originally developed in medicine (Ref. 15) but has been used more recently in ecological studies (Ref. 17 to Ref. 21). Causal criteria have been developed for categorizing arguments from studies on disease on humans (Ref. 15), and these can be applied to ecological arguments (Ref. 15). 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. 17; Ref. 20).

Table B-1: Hills' (Ref. 15) Causal Criteria and Description in the Context of Ecological Impact Assessment

Causal Criterion	Description
Strength of association	A large proportion of individuals are affected in the impact area relative to control 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 B-1 before the survey is undertaken (see Ref. 17 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 should be based on the 'weight of evidence' from examining multiple Lines of Evidence. Example generalised Lines of Evidence descriptions are provided in Table B-2. These should be modified and tailored to individual SMPs, as required and each parameter investigated.

Table B-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 control areas	Similar declines in individuals in areas affected by hydrocarbon and control areas

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
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)
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
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

EFFECT SIZE AND POWER

A critical aspect of monitoring program design is to determine the number of samples required to achieve the objectives of the program. The variability inherent in natural systems gives rise to statistical uncertainty, which can be controlled by sampling an appropriate number of representative sites and taking an appropriate number of replicate samples at each site (Ref. 22). Power is calculable for univariate designs where change occurs in one direction. Multivariate designs are more complicated given change can occur in any number of directions.

Insufficient site and sample replication can bias findings of monitoring programs in one of two ways. Type I errors are effectively false positive outcomes (a cause for concern when it is in fact not warranted) and Type II errors give rise to a 'false sense of security' when it is concluded that there is no effect when, in fact, there is one. Monitoring program design should aim to minimise Type I and Type II error rates and at the same time maximise cost effectiveness and scientific rigour (Ref. 22).

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.

The statistical power of a test is mostly driven by sample size, e.g. the number of sites sampled or the number of replicates within a site. Other factors driving the power of a test include:

- 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).

Free packages such as [G-Power](#), developed by the University of Dusseldorf, provide a useful platform for straightforward tests (utilising fully random or fully fixed factor designs), but are typically inadequate for more complex, mixed model designs, including those of the BACI family, for which Monte Carlo simulations are needed (Ref. 23). Monitoring Providers should consult experienced statisticians to ensure power assessments are undertaken correctly and at the right level of the design i.e. the interaction term of interest (in an ANOVA context).

Monitoring Providers should aim to achieve power of 0.8 for the chosen effect size. The effect size should relate to the study's objectives and should be set at a level 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. None of this is a straightforward process, and Monitoring Providers should engage regulators and other stakeholders. Further considerations are outlined in Table B-3.

Table B-3: Considerations When Conducting Statistical Power Assessments

Power test inputs	Considerations
Effect size	<ul style="list-style-type: none"> • Natural change of varying magnitudes across temporal and spatial scales at impact and control sites make detection of small effect sizes difficult. Small changes due to impacts from an unplanned release are unlikely to be considered biologically or ecologically significant if dwarfed by large-magnitude natural variability • The effect size 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 • It may be trivial for example to aim to 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 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 variance	<ul style="list-style-type: none"> • Population variability may be estimated from data collected during previous studies (e.g. baseline), or pilot data collected in the initial days following the spill before the parameters are affected. The latter may be difficult depending on the trajectory and speed of the plume • If 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 under the OMPs
Alpha	<ul style="list-style-type: none"> • Alpha—the probability of falsely detecting a change that is not real (Type I error)—is typically set at 0.05 (5%), 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. $\alpha=0.01$), the lower the likelihood that the null hypothesis will be rejected and hence, the lower the likelihood of a conclusion that an impact has occurred • The flip-side to this is that alpha and power are inversely related: higher alpha levels (0.1 or 0.15) increase the level of making a Type I error, but increase the

Power test inputs	Considerations
	power of the test to detect an impact. Ultimately this becomes a philosophical debate, with the users weighing up the benefits of power over the increased probability of Type I error

SETTING THE SPATIAL BOUNDARIES OF THE STUDY

The spatial boundaries of a monitoring program depend 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
- Control area.

APPENDIX C VALUES AND SENSITIVITIES ADDRESSED BY OMPS AND SMPS

Receptor	Relevant OMP and SMP
Primary producers	
Corals, seagrass and macroalgae	SMP: Intertidal and coastal habitat assessment SMP: Benthic habitat assessment
Mangroves	OMP: Shoreline clean-up assessment technique SMP: Intertidal and coastal habitat assessment
Invertebrate communities	
Infauna, filter feeders and other sessile and mobile benthic invertebrates	SMP: Intertidal and coastal habitat assessment SMP: Benthic habitat assessment
Marine habitats	
Water quality	OMP: Oil properties and weathering behaviour at sea OMP: Water quality assessment OMP: Sediment quality assessment OMP: Surface chemical dispersant effectiveness and fate SMP: Water quality impact assessment
Sediment quality	OMP: Water quality assessment OMP: Sediment quality assessment SMP: Sediment quality impact assessment
Benthic habitats	SMP: Benthic habitat assessment
Shoreline and intertidal habitats	OMP: Shoreline clean-up assessment technique SMP: Intertidal and coastal habitat assessment
Marine fauna	
Seabirds and shorebirds	OMP: Shoreline clean-up assessment technique SMP: Seabirds and shorebirds
Marine megafauna	OMP: Shoreline clean-up assessment technique OMP: Marine fauna assessment SMP: Marine mega-fauna SMP: Fish impact assessment
Socio-economic	
Commercial Fisheries and Aquaculture	SMP: Water quality impact assessment SMP: Commercial and recreational fisheries impact assessment
Recreational Fisheries	SMP: Water quality impact assessment SMP: Commercial and recreational fisheries impact assessment

APPENDIX D SMP FIELD TEAM COMPETENCIES

Table D-1: Competencies of SMP Field Teams

SMP	Monitoring personnel	Competencies
Water quality impact assessment	1 team leader	<ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area >5 years' experience implementing field monitoring on relevant receptors
	1-2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >3 years' experience implementing field monitoring on relevant receptors <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >1-2 years' experience implementing field monitoring on relevant receptors
Sediment quality impact assessment	1 team leader	<ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area >5 years' experience implementing field monitoring on relevant receptors
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >3 years' experience implementing field monitoring on relevant receptors <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >1-2 years' experience implementing field monitoring on relevant receptors

SMP	Monitoring personnel	Competencies
Intertidal and coastal habitat assessment	1 team leader	<ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area >5 years' experience implementing field monitoring on relevant receptors
	1 team member	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >3 years' experience implementing field monitoring on relevant receptors <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >1-2 years' experience implementing field monitoring on relevant receptors
Seabirds and shorebirds	Aerial survey: 2 observers per aircraft	<ul style="list-style-type: none"> Experienced marine fauna aerial-observer, with experience using proposed sampling equipment and as a Marine Fauna Observer (MFO)
	Vessel-based survey: 1 team leader	<ul style="list-style-type: none"> Experienced ornithologist with >5 years' experience implementing field monitoring
	1 team member	<ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area >3 years' experience implementing field monitoring on relevant receptors
Marine mega-fauna assessment <ul style="list-style-type: none"> Reptiles Pinnipeds Whale sharks, dugongs and cetaceans 	Ground and vessel surveys: 1 team leader	<ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area >5 years' experience implementing field monitoring on relevant receptors
	2–3 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and >3 years' experience implementing field monitoring on relevant receptors <p>The remaining team member/s to possess, as a minimum:</p>

SMP	Monitoring personnel	Competencies
		<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience implementing field monitoring on relevant receptors
	Aerial survey: 2 observers per aircraft	<ul style="list-style-type: none"> • Experienced marine fauna aerial-observer, with experience using proposed sampling equipment and as a Marine Fauna Observer (MFO)
Benthic habitat assessment	1 team leader	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • >5 years' experience implementing field monitoring on relevant receptors
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >3 years' experience implementing field monitoring on relevant receptors. <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience implementing field monitoring on relevant receptors
Marine fish and elasmobranch assemblages assessment	1 team leader	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • >5 years' experience implementing field monitoring on relevant receptors • Video survey sampling experience
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >3 years' experience implementing field monitoring on relevant receptors <p>The remaining team member (if required) to possess, as a minimum:</p>

SMP	Monitoring personnel	Competencies
Fisheries impact assessment	1 team leader	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience implementing field monitoring on relevant receptors
		<ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area • >5 years' experience implementing field monitoring on relevant receptors
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >3 years' experience implementing field monitoring on relevant receptors.
		<p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience implementing field monitoring on relevant receptors
Heritage features assessment	1 team leader	<ul style="list-style-type: none"> • Bachelor degree in environmental management/science and/or archaeology from a recognised institution or equivalent tertiary study in technical area • >5 years' experience implementing field monitoring on relevant receptors
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science and/or archaeology from a recognised institution or equivalent tertiary study in technical area; and • >3 years' experience implementing field monitoring on relevant receptors. <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in environmental management/science and/or archaeology from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience implementing field monitoring on relevant receptors

SMP	Monitoring personnel	Competencies
Social impact assessment	1 team leader	<ul style="list-style-type: none"> • Bachelor degree or post-graduate qualifications in social impact from a recognised institution or equivalent tertiary study in technical area • Knowledge of socio-economic receptors of region • >5 years' experience in social and/or economic impact analysis and/or ecosystem based valuation methods
	1–2 team members	<p>One team member to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in social impact from a recognised institution or equivalent tertiary study in technical area; and • >3 years' experience in social and/or economic impact analysis and/or ecosystem based valuation methods <p>The remaining team member (if required) to possess, as a minimum:</p> <ul style="list-style-type: none"> • Bachelor degree in social impact from a recognised institution or equivalent tertiary study in technical area; and • >1-2 years' experience in social and/or economic impact analysis and/or ecosystem based valuation methods