Barossa Development Oil Pollution Emergency Plan

PROJECT / FACILITY	Barossa Development
REVIEW INTERVAL	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s Managerial/Technical/Site	Approver
0	Senior Oil Spill Response Coordinator	Team Leader – Barossa HSE	Manager – HSE Offshore Division

Any hard copy of this document, other than those identified above, are uncontrolled. Please see the Santos Offshore Document Management System for the latest revision.

Distribution	Oil Pollution Emergency Plan	
	Electronic	Hardcopy
Intranet – Emergency Preparedness	link only	
Manager – HSE Offshore Division	link only	
Drilling Superintendent	link only	
Drilling Supervisor	link only	
Senior Oil Spill Response Coordinator	link only	
Santos Company Site Representative (CSR)	link only	
IMT Room – Perth office		● x 4
AMOSC	●	
DoT	●	
AMSA	●	
OSRL	●	

Contents

List of tables

List of figures

List of acronyms

Abbreviation	Description
AIS	automatic identification system
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMP	Australian Marine Park
AMSA	Australian Marine Safety Authority
APASA	Asia-Pacific Applied Sciences Associates
APPEA	Australian Petroleum Production & Exploration Association
API	American Petroleum Institute
BAOAC	Bonn Agreement Oil Appearance Codes
CHARM	chemical hazard and risk management
CMT	Crisis Management Team
CSR	company site representative
DBCA	Department of Biodiversity, Conservation and Attractions
DEPWS	Department of Environment, Parks and Water Security
DFAT	Department of Foreign Affairs and Trade
DISER	Department of Industry, Science, Energy and Resources
DMIRS	Department of Mines, Industry Regulation and Safety
DoT	Department of Transport
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environment Regulation
EMBA	environment that may be affected
EP	Environment Plan
ER	emergency response
FOB	forward operating base
FPSO/ FSO	Floating Production Storage and Offloading /Floating Storage and Offloading
GIS	geographic information system
GPS	global positioning system
HMA	Hazard Management Agency
HR	human resources
IAP	Incident Action Plan
ICC	incident command centre
IMT	Incident Management Team
IR	industrial relations

Abbreviation	Description
IRT	Incident Response Team
LOWC	loss of well control
MARPOL	International Convention for the Prevention of Pollution from Ships
MEECC	Maritime Environmental Emergency Coordination Centre
MEER	Maritime Environmental Emergency Response
MNES	matters of national environmental significance
MODU	mobile offshore drilling unit
MoU	Memorandum of Understanding
MSA	Master Services Agreement
MSP	monitoring service providers
NEBA	net environmental benefit analysis
NOPSEMA	National Offshore Petroleum Safety and Environment Management Authority
NT	Northern Territory
NT IC	Northern Territory Incident Controller
NT IMT	Northern Territory Incident Management Team
NTOWRP	Northern Territory Oiled Wildlife Response Plan
OPEP	Oil Pollution Emergency Plan
OPGGS(E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSC	on-scene commander
OSRL	Oil Spill Response Limited
OSTM	oil spill trajectory modelling
OWR	oiled wildlife response
PS	People Support
SCP	Source Control Plan
SFRT	Subsea First Response Toolkit
SHP-MEE	State Hazard Plan for Maritime Environmental Emergencies
SIMA	spill impact mitigation assessment
SMP	Scientific Monitoring Plans
SMPC	State Marine Pollution Coordinator
SMPEP	Shipboard Marine Pollution Emergency Plan
SOPEP	Shipboard Oil Pollution Emergency Plans
TMPC	Territory Marine Pollution Coordinator
TRP	Tactical Response Plan
VOC	volatile organic compound

Abbreviation	Description
VOO	vessels of opportunity
VPO	Vice President Offshore Upstream WA
WA	Western Australia
WAOWRP	Western Australian Oiled Wildlife Response Plan
WOMP	Well Operation Management Plan
WSP	waste service provider
WWC	wild well control

1 Quick reference information

<table>
<tr><th>Parameter</th><th colspan="2">Description</th><th>Further information</th></tr>
<tr><td>Petroleum Activity</td><td colspan="2">Barossa development</td><td>Environment Plan (EP) for each activity</td></tr>
<tr><td>Location</td><td colspan="2">Bonaparte Basin in Commonwealth waters approximately 300 km north-northwest of Darwin</td><td>EP for each activity</td></tr>
<tr><td>Petroleum title/s (Blocks)</td><td colspan="2">NT/L1 (Production Licence)</td><td>N/A</td></tr>
<tr><td>Facilities/vessels</td><td colspan="3">Refer to EP and Oil Pollution Emergency Plan (OPEP) Addendum for each activity</td></tr>
<tr><td>Water depth</td><td colspan="2">204–376 m</td><td>N/A</td></tr>
<tr><td>Worst-case spill scenarios</td><td colspan="3">Refer to OPEP Addendum for activity</td></tr>
<tr><td>Hydrocarbon properties</td><td>MDO:
Density at 25 °C = 829 kg/m3
Dynamic viscosity = 4 cP @ 25° C
API Gravity = 37.6°
Wax content = 1%
Pour point = -14 °C
Oil property classification = Persistent (medium)</td><td>Barossa condensate:
Density at 16 °C = 782 kg/m3
Dynamic viscosity = 1.35 cP @ 10° C
API Gravity = 50.6°
Wax content = 3.6%
Pour point = -6 °C
Volatile components = 93%
Oil property classification = non-persistent (Group I)</td><td>Appendix A: Hydrocarbon characteristics and behaviour</td></tr>
<tr><td>Weathering potential</td><td>MDO is a mixture of volatile and persistent hydrocarbons with low viscosity. It will spread quickly and thin out to low thickness levels, thereby increasing the rate of evaporation. Up to 60% will generally evaporate over the first two days. Approximately 5% is considered ‘persistent’, which are unlikely to evaporate and will decay over time.</td><td>Barossa condensate is a low viscosity, non-persistent hydrocarbon that if spilt on the sea surface, would rapidly spread and thin out resulting in a large surface area available for evaporation.
The fate of the condensate will depend greatly on the proportion that reaches the surface after rising through the water column. Hence, discharge conditions will have a strong influence on exposure risks for surrounding resources.</td><td>Appendix A: Hydrocarbon characteristics and behaviour</td></tr>
<tr><td>Protection priorities</td><td colspan="3">Refer to OPEP Addendum for activity</td></tr>
</table>

2 First-strike response actions

The initial response actions to major oil spill incidents will be undertaken by the relevant Vessel Master or the Offshore Installation Manager, depending on the nature of the incident (vessel or MODU based).

If the spill is related to the MODU, the Rig Offshore Installation Manager (hereafter referred to as the On-Scene Commander or OSC) will be notified, or in the case of a support vessel, the Vessel Master will be notified.

Following those initial actions undertaken by the On-Scene Commander or Vessel Master to ensure the safety of personnel on the vessel or MODU and to control the source of the spill, the Santos Company Site Representative will assess the situation based on:

- What has caused the spill?
- Is the source under control?
- What type of hydrocarbon has been spilled?
- How much has been spilled?

For spills from support vessels, initial response actions to major incidents are under the direction of the Vessel Master and in accordance with vessel-specific procedures (e.g., Shipboard Oil Pollution Emergency Plans (SOPEPS)).

Response information contained within this OPEP is concerned primarily with a large scale (Level 2/3) hydrocarbon spill where the Perth-based Incident Management Team (IMT) and Santos Crisis Management Team (CMT) are engaged for support and implementation of response strategies. Level 1 spills are managed through on-site response and IMT is available to assist with regulatory requirements/notifications and support as required. Therefore, the immediate response actions listed in **Table 2-1** are relevant for any spill. Once sufficient information is known about the spill, the Incident Commander will classify the level of the spill. If the spill is classified as a Level 1 spill, then the actions related to Level 2/3 spills do not apply, unless specified by the Incident Commander.

Table 2-1: First-strike activations

When (indicative)	Activations		Who
	Objective	Action	
All spills			
Immediate	Manage the safety of personnel	Implement site incident response procedures (MODU Operator's Emergency Response Plan and Santos MODU Operator Emergency Response Bridging Plan) or vessel-specific procedures, as applicable	On-Scene Commander/Vessel Master
Immediate	Control the source using site resources, where possible	Control the source using available onsite resources (MODU/vessel) Refer to source control plan – **Section 9**	On-Scene Commander/Vessel Master
30 minutes of incident being identified	Notify Santos Offshore Duty Manager/Incident Commander	Verbal communication to Offshore Duty Manager/Incident Commander's duty phone	On-Scene Commander via Company Site Representative
As soon as practicable	Obtain as much information about the spill as possible	Provide as much information to the IMT (Incident Commander or delegate) as soon as possible	On-Scene Commander via Company Site Representative
60 minutes	Gain situational awareness and begin onsite spill surveillance	If spill reaches marine waters gain further situational awareness by undertaking surveillance of the spill from vessel or MODU Refer to Monitor and Evaluate Plan – **Section 9.2**	On-Scene Commander via Company Site Representative Incident Commander
Refer timeframes Go to **Section 6**	Make regulatory notifications within regulatory timeframes	Activate the External Notifications and Reporting Procedures – **Section 6**	Initial notifications by Environment Unit Leader/Safety Officer – **Table 6-1**
Level 2/3 spills (in addition to actions above)			
Immediately once notified of spill (to Incident Commander)	Activate IMT, if required	Notify IMT	Offshore Duty Manager/Incident Commander

<table>
<tr><th rowspan="2">When (indicative)</th><th colspan="2">Activations</th><th rowspan="2">Who</th></tr>
<tr><th>Objective</th><th>Action</th></tr>
<tr><td colspan="4">IMT actions (0 to 48 hours)</td></tr>
<tr><td rowspan="2">Within 90 minutes from IMT callout</td><td>Set-up IMT room</td><td>Refer to IMT tools and checklists for room and incident log set-up</td><td>Incident Commander
IMT Data Manager</td></tr>
<tr><td>Gain situational awareness and set incident objectives, strategies and tasks</td><td>Begin reactive Incident Action Planning process
Go to Section 8
Review First-strike Activations (this table)</td><td>Incident Commander
Planning Section Chief</td></tr>
<tr><td>Refer timeframes
Section 6</td><td>Make regulatory notifications as required
Notify and mobilise/put on standby external oil spill response organisations and support organisations, as required</td><td>Go to Section 6</td><td>Initial notifications by Environment Unit Leader/Safety Officer
Oil Spill Response Organisations (Australian Marine Oil Spill Centre [AMOSC] and Oil Spill Response Ltd [OSRL]) activation by designated call-out authorities (Incident Commanders/Duty Managers)</td></tr>
<tr><td>Refer timeframes
Section 10</td><td>Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making</td><td>Vessel Surveillance (Section 10.1)
Aerial Surveillance (Section 10.2)
Tracking Buoys (Section 10.3)
Oil Spill Trajectory Modelling (Section 10.4)
Initial Oil Characterisation (Section 10.6)
Operational Water Quality Monitoring (Section 10.7)</td><td>IMT Operations Section Chief
IMT Logistics Section Chief/Supply Unit Leader
IMT Environment Unit Leader</td></tr>
</table>

When (indicative)	Activations		Who
	Objective	Action	
Activate on Day 1 for applicable scenarios	Source control support to stop the release of hydrocarbons into the marine environment. **Degree of IMT support will be scenario-dependent**	Go to **Section 9**	IMT Operations Section Chief (Relief Well Team Leader as appropriate to scenario) IMT Logistics Section Chief/Supply Unit Leader
Activate on Day 1 for applicable scenarios Refer **Section 11**	Reduce exposure of wildlife to floating oil through mechanical dispersion	Activate the Mechanical Dispersion Plan Go to **Section 11**	IMT Operations Section Chief IMT Logistics Section Chief/Supply Unit Leader
Day 1	Identify environmental sensitivities at risk and conduct operational Net Environmental Benefit Analysis (NEBA)	Review situational awareness and spill trajectory modelling Review applicable response strategies and begin operational NEBA (**see activity-specific OPEP Addendum**)	IMT Environment Unit Leader
Day 1	Develop forward operational base/s to support forward operations	Begin planning for forward operations base as per Forward Operations Plan. **Appendix M: Forward operations guidance**	IMT Operations Section Chief IMT Logistics Section Chief/Supply Unit Leader
Day 1	Ensure the health and safety of spill responders	Identify relevant hazards controls and develop hazard register Begin preparation Site Health and Safety Management requirements Refer Oil Spill Response Health and Safety Management Manual (SO-91-RF-10016)	IMT Safety Officer
If/when initiated Refer **Section 12**	Prevent or reduce impacts to wildlife	Activate the Oiled Wildlife Response Plan Go to **Section 12**	IMT Environment Unit Leader IMT Operations Section Chief IMT Logistics Section Chief/Supply Unit Leader

When (indicative)	Activations		Who
	Objective	Action	
If/when initiated Refer **Section 13**	Safely transfer, transport and dispose of waste collected from response activities.	Activate the Waste Management Plan. Go to **Section 13**	IMT Operations Section Chief IMT Logistics Section Chief/Supply Unit Leader
If/when initiated Refer **Section 14**	Assess and monitor impacts from spill and response	Activate the Scientific Monitoring Plan Go to **Section 14**	IMT Environment Unit Leader IMT Logistics Section Chief/Supply Unit Leader IMT Operations Section Chief

When (indicative)	Activations		Who
	Objective	Action	
IMT Actions (48+ hours)			
Ongoing	+ For ongoing incident management – indicatively 48 + hours – a formal incident action planning process is to be adopted to continue with spill response strategies identified above. An Incident Action Plan (IAP) is to be developed for each successive operational period. + Santos will maintain control for those activities for which it is the designated Control Agency/Lead IMT. + Depending on the specifics of the spill, Australian Maritime Safety Authority (AMSA), the Northern Territory (NT) IMT, and/or Western Australia (WA) Department of Transport (DoT) may be relevant Control Agencies (see **Section 4.2**). + Where another control agency has taken control of aspects of the response, Santos will provide support to that Control Agency. Santos' support to the NT IMT (for a spill that impacts the NT shoreline) and the DoT (for a WA State waters response) is detailed in **Sections 4.6.2 and 4.6.3**, respectively.		Control agency IMT Santos to provide the following roles to DoT Maritime Environmental Emergency Coordination Centre (MEECC) / IMT for WA State waters response (see **Table 5-5**): + CMT Liaison Officer + Deputy Incident Controller + Deputy Intelligence Officer + Deputy Planning Officer + Environment Support Officer + Deputy Public Information Officer + Deputy Logistics Officer + Deputy Waste Management Coordinator + Deputy Finance Officer + Deputy Operations Officer + Deputy Division Commander. Roles similar to the above may also be provided to the NT IMT for NT waters response, if applicable.

3 Introduction

3.1 Purpose

This Oil Pollution Emergency Plan (OPEP) outlines the emergency management arrangements and oil spill response options for the following activities associated with the Barossa Development:

+ drilling and completions
+ subsea umbilicals
+ risers and flowlines installation
+ moorings installation
+ hook-up and commissioning.

This OPEP is an overarching document and will be supported with an OPEP Addendum for each activity.

This overarching OPEP provides detail on spill management arrangements, Santos' incident management structure, external notifications and reporting, and detailed implementation information on the relevant response strategies for the listed Barossa Development activities.

Each activity has an activity specific OPEP Addendum that is to be used in conjunction with this OPEP. Each Addendum provides the following information specific to each activity, including:

+ a description of the activity specific spill profile
+ applicable response strategies
+ net environmental benefit analysis (NEBA)
+ spill response 'as low as reasonably practicable' (ALARP) assessment.

This OPEP addresses the requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environmental) Regulations 2009 (OPGGS (E) Regulations)). It is also consistent with the National Plan for Maritime Environmental Emergencies (AMSA, 2020), the NT Oil Spill Contingency Plan (NT DoT, 2014) and the Western Australian (WA) State Hazard Plan for Maritime Environmental Emergencies (WA DoT, 2020a).

3.2 Objectives

The aim of this OPEP is to provide detailed guidance to Santos' IMT, so that it will direct its response effort with the aim of preventing long-term significant environmental impacts by safely limiting the adverse environmental effects from an unplanned release of hydrocarbons to the marine environment to a level that is ALARP. This will be achieved through the implementation of the various strategies and spill response mechanisms presented throughout this OPEP. Through their implementation, Santos will:

+ initiate spill response immediately following a spill
+ establish source control as soon as reasonably practicable to minimise the amount of oil being spilt into the environment
+ assess the spill characteristics and understand its fate in order to be able to make informed and clear response decisions
+ monitor the spill to identify the primary marine and coastal resources requiring protection

- remove as much oil as possible from the marine environment while keeping environmental impacts from the removal methods to ALARP
- reduce the impacts of the remaining floating and stranded oil to ALARP
- respond to the spill using efficient response strategies that do not damage the environment themselves
- comply with all relevant environmental legislation when implementing this OPEP
- conduct all responses safely without causing harm to participants
- monitor the impacts from a spill until impacted habitats have returned to baseline conditions
- remain in a state of 'Readiness' at all times for implementation of this OPEP by keeping resources ready for deployment, staff fully trained and completing response exercises as scheduled
- keep stakeholders informed of the status of the hydrocarbon spill response to aid in the reduction of social and economic impacts.

3.3 Area of operation

The Barossa development is located within permit area NT/L1 within Commonwealth waters of the Bonaparte Basin in Australia.

The operational area is located within Commonwealth waters in the Timor Sea, approximately 140 km north of the Tiwi Islands and 300 km north-northwest of Darwin.

Section 3 of the Barossa Development Drilling and Completions Environment Plan (BAD-200 0003) includes a comprehensive description of the existing environment.

3.4 Interface with internal documents

In addition to this OPEP, a number of other Santos documents provide guidance and instruction relevant to spill response, including:

- Incident Command and Management Manual (SO-00-ZF-00025)
- Barossa Development Drilling and Completions Environment Plan (BAD-200 0003)
- Barossa Development OPEP Addendum: Drilling and Completions (BAA-200 0316)
- MODU Operator's Emergency Response Plan
- Santos-MODU Operator Emergency Response Bridging Plan
- Incident Response Telephone Directory (SO-00-ZF-00025.020)
- Refuelling and Chemical Management Standard (QE-91-IQ-00098)
- Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001)
- Well Specific Source Control Plan(s)
- Oil Pollution Waste Management Plan (QE-91-IF-10053)
- Oil Spill Response Health and Safety Manual (SO-91-RF-10016)
- Santos Oiled Wildlife Framework Plan (SO-91-BI-20014)
- Oil Spill Scientific Monitoring Plan (EA-00-RI-10099)

- Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162)
- Oil Spill Scientific Monitoring Baseline Data Review (QE-00-BI-20001)
- Santos Offshore Division Incident and Crisis Management Training and Exercise Plan (SO-92-HG-10001)
- Santos Offshore Division Oil Spill Response Readiness Guideline (SO-91-OI-20001).

3.5 Interface with external documents

Information from the following external documents have been used or referred to within this plan:

- AMOSPlan – Australian Industry Cooperative Spill Response Arrangements
  - details the cooperative arrangements for response to oil spills by Australian oil and associated industries.
- Offshore Petroleum Incident Coordination Framework
  - provides overarching guidance on the Commonwealth Government's role and responsibilities in the event of an offshore petroleum incident in Commonwealth waters.
- National Plan for Maritime Environmental Emergencies and National Marine Oil Spill Contingency Plan
  - sets out national arrangements, policies and principles for the management of maritime environmental emergencies. The plan provides for a comprehensive response to maritime environmental emergencies regardless of how costs might be attributed or ultimately recovered.
- Territory Emergency Plan
  - describes the NT approach to emergency and recovery operations, the governance and coordination arrangements, and roles and responsibilities of agencies (go to https://pfes.nt.gov.au/sites/default/files/uploads/files/2021/NTES_Territory_Emergency_Plan_2021.pdf).
- Northern Territory (NT) Oil Spill Contingency Plan
  - outlines the approach to management of marine oil pollution that are the responsibility of the NT Government (the NTOSCP is currently being revised in 2021).
- NT Oiled Wildlife Response Plan (NTOWRP)
  - an industry prepared plan, which is designed to ensure timely mobilisation of appropriate resources (equipment and personnel) in the event of an incident affecting wildlife NT waters.
- HazPlan – SHP-MEE – Western Australia State Hazard Plan for Maritime Environmental Emergencies
  - details the management arrangements for preparation and response to a marine pollution incident occurring in State waters.
- WA DoT Oil Spill Contingency Plan
  - defines the steps required for the management of marine oil pollution responses that are the responsibility of the DoT.
- DoT's Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (go to: DoT's Offshore Petroleum Industry Guidance Note – Marine Oil pollution: Response and Consultation Arrangements)

- Western Australia Oiled Wildlife Response Plan
  - defines the steps, personnel, equipment and infrastructure required for the management of wildlife in an oil pollution response. Each region has a Regional Oiled Wildlife Response Plan that gives further details on sensitivities and available resources.
- Shipboard Oil Pollution Emergency Plans
  - under International Convention for the Prevention of Pollution from Ships (MARPOL) Annex I requirements, all vessels of over 400 gross tonnage are required to have a current SOPEP. The SOPEP includes actions to be taken by the crew in the event of an oil spill including steps taken to contain the source with equipment available onboard the vessel.
- OSRL Associate Agreement
  - defines the activation and mobilisation methods of OSRL spill response personnel and equipment allocated under contract.
- Australian Government Coordination Arrangements for Maritime Environmental Emergencies:
  - provides a framework for the coordination of Australian Government departments and agencies in response to maritime environmental emergencies.

3.6 Document review

In line with regulatory requirements, this document shall be reviewed, updated and submitted to NOPSEMA every five years from date of acceptance.

The document may be reviewed and revised more frequently, if required, in accordance with the Santos Management of Change Procedure (EA-91-IQ-10001). This could include changes required in response to one or more of:

- when major changes have occurred that affect oil spill response coordination or capabilities
- changes to the Environment Plan that affect oil spill response coordination or capabilities (e.g., a significant increase in spill risk)
- following routine testing of the OPEP if improvements or corrections are identified
- after a Level 2/3 spill incident.

The extent of changes made to the OPEP and resultant requirements for regulatory resubmission will be informed by the relevant Commonwealth regulations; i.e., the OPGGS (E) Regulations.

4 Spill management arrangements

4.1 Response levels and escalation criteria

Santos uses a tiered system of three incident response levels consistent with the National Plan for Maritime Environmental Emergencies (National Plan) (AMSA, 2020) and the WA State Hazard Plan for Maritime Environmental Emergencies (SHP- MEE) (WA DoT, 2020a). Spill Response Levels help to identify the severity of an oil spill incident and the level of response required to manage the incident and mitigate environmental impacts. Incident response levels are outlined within the Santos Incident Command and Management Manual (SO-00-ZF-00025) and further detailed in **Table 4-1** for hydrocarbon spills.

Table 4-1: Santos oil spill response levels

Level 1	
An incident which will not have an adverse effect on the public or the environment which can be controlled by the use of resources normally available onsite without the need to mobilise the Santos IMT or other external assistance.	
Oil is contained within the incident site. Spill occurs within immediate site proximity. Discharge in excess of permitted oil in water (OIW) content (15 ppm). Incident can be managed by the On-site Incident Response Team (IRT) and its resources.	Source of spill has been contained. Oil is evaporating quickly and no danger of explosive vapours. Spill likely to naturally dissipate. No media interest/not have an adverse effect on the public.
Level 2	
An incident that cannot be controlled by the use of onsite resources alone and requires external support and resources to combat the situation; or **An incident that can be controlled onsite but which may have an adverse effect on the public or the environment.**	
Danger of fire or explosion. Possible continuous release. Concentrated oil accumulating in close proximity to the site or vessel. Potential to impact other installations.	Level 1 resources overwhelmed, requiring additional regional resources. Potential impact to sensitive areas and/or local communities. Local/national media attention/may adversely affect the public or the environment.
Level 3	
An incident which has a wide-ranging impact on Santos and may require the mobilisation of external state/territory, national or international resources to bring the situation under control.	
Loss of well integrity. Actual or potentially serious threat to life, property, industry. Major spill beyond site vicinity. Significant shoreline environmental impact.	Level 2 resources overwhelmed, requiring international assistance. Level 3 resources to be mobilised. Significant impact on local communities. International media attention.

4.2 Jurisdictional authorities and control agencies

The responsibility for an oil spill is dependent on location and spill origin. The National Plan for Maritime Environmental Emergencies (AMSA, 2020) sets out the divisions of responsibility for an oil spill response. Definitions of control agency and jurisdictional authority are as follows:

+ Control agency: the organisation assigned by legislation, administrative arrangements or within the relevant contingency plan, to control response activities to a maritime environmental emergency. Control agencies have the operational responsibility of response activities but may have arrangements in place with other parties to provide response assistance under their direction.
+ Jurisdictional authority: the agency which has responsibility to verify that an adequate spill response plan is prepared and, in the event of an incident, that a satisfactory response is implemented. The jurisdictional authority is also responsible for initiating prosecutions and the recovery of clean-up costs on behalf of all participating agencies.

Table 4-2 provides guidance on the designated control agency and jurisdictional authority for Commonwealth and state/territory waters and for vessel and facility spills.

To aid in the determination of a vessel versus a petroleum activity / facility spill, the following guidance is adopted:

+ A vessel is a ship at sea to which to which the *Navigation Act 2012* applies. Defined by Australian Government Coordination Arrangements for Maritime Environmental Emergencies (AMSA, 2017) as a seismic vessel, supply or support vessel, or offtake tanker.
+ A petroleum activity including a fixed platform, FPSO/FSO, MODU, subsea infrastructure, or a construction, decommissioning and pipelaying vessel. As defined by Schedule 3, Part 1, Clause 4 and Volume 2, Part 6.8, Section 640 of the OPGGSA 2006.

Table 4-2: Jurisdictional and control agencies for hydrocarbon spills

Jurisdictional boundary	Spill source	Jurisdictional authority	Control agency		Relevant documentation
			Level 1	Level 2/3	
Commonwealth waters (three to 200 nautical miles from territorial/ state sea baseline)	Vessel[1]	AMSA	AMSA		Vessel SOPEP National Plan Barossa Development OPEP
	Petroleum activities[2]	NOPSEMA	Titleholder		Barossa Development OPEP
Northern Territory (NT) waters (territorial sea baseline to three nautical miles and some areas around offshore atolls and islands)	Vessel	Department of Environment, Parks and Water Security (DEPWS)	Vessel owner	NT IMT	Vessel SOPEP Barossa Development OPEP NT Oil Spill Contingency Plan (2014)
	Petroleum activities	DEPWS	Titleholder[3]		Barossa Development OPEP NT Oil Spill Contingency Plan (2014)
NT shorelines	Vessel	DEPWS	Vessel owner	NT IMT	Barossa Development OPEP NT Oil Spill Contingency Plan (2014)
	Petroleum activities	DEPWS	Titleholder	NT IMT[4]	Barossa Development OPEP NT Oil Spill Contingency Plan (2014)

[1] Vessels are defined by Australian Government Coordination Arrangements for Maritime Environmental Emergencies (AMSA, 2017) as a seismic vessel, supply or support vessel.

[2] Includes a 'facility', such as a fixed platform, FPSO/FSO, MODU, subsea infrastructure, or a construction, decommissioning and pipelaying vessel. As defined by Schedule 3, Part 1, Clause 4 of the OPGGSA 2006.

[3] Titleholder will be the control agency but will request approval of IAPs from the NT IC.

[4] NT IMT will be the control agency but will be supported by the titleholder (additional support from AMOSC if required).

Jurisdictional boundary	Spill source	Jurisdictional authority	Control agency		Relevant documentation
			Level 1	Level 2/3	
Western Australian (WA) state waters (State waters to three nautical miles and some areas around offshore atolls and islands)	Vessel	WA Department of Transport (DoT)	WA DoT	WA DoT	Vessel SOPEP State Hazard Plan: Maritime Environmental Emergencies Oil Spill Contingency Plan (OSCP) (WA DoT 2015) Barossa Development OPEP
	Petroleum activities	WA DoT	Titleholder	WA DoT	Barossa Development OPEP State Hazard Plan: Maritime Environmental Emergencies (WA DoT 2020a)
International waters	Petroleum activities	Relevant foreign authority	Santos will liaise with the Australian Government Department of Foreign Affairs and Trade (DFAT) in the event that an oil spill may enter international waters. Santos will work with DFAT and the respective governments to support response operations.		
	Vessel				

4.3 Petroleum activity spill in Commonwealth waters

For an offshore petroleum activity spill in Commonwealth waters, the jurisdictional authority is National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA). NOPSEMA is responsible for the oversight of response actions to pollution events from offshore Petroleum Activities, in areas of Commonwealth jurisdiction. During a spill incident, NOPSEMA's role will be to implement regulatory processes to monitor and secure compliance with the *OPGGS Act 2006* and OPGGS (E) Regulations, including the issuing of directions as required, and investigate accidents, occurrences and circumstances involving deficiencies in environment management.

Under the OPGGS (E) Regulations and the *OPGGS Act 2006*, the petroleum titleholder (i.e., Santos) is responsible for responding to an oil spill incident as the control agency in Commonwealth waters, in accordance with its OPEP.

Santos is responsible as control agency unless NOPSEMA identifies a requirement to delegate control. In this situation, control agency responsibility may be delegated to AMSA who will assume control of the incident and respond in accordance with AMSA's National Plan. In such an occurrence, Santos would assume a Support Agency role and make available all necessary resources to support AMSA in AMSA's performance of their control agency responsibilities.

4.4 Vessel spills

AMSA manages the National Plan for Maritime Environmental Emergencies (AMSA, 2020) and is the control agency for all vessel-based spills in the Commonwealth jurisdiction. This includes vessels undertaking seismic surveys and associated supply or support vessels.

WA Department of Transport (DoT) manages the State Hazard Plan for Maritime Environmental Emergencies (WA DoT, 2020a) and is the control agency for all level 2/3 vessel-based spills in WA waters. Similarly, the Northern Territory Government's Incident Management Team (IMT) would assume the control agency role for level 2/3 vessel-based spills in NT waters.

In all circumstances, the Vessel Master is responsible for implementing source control arrangements detailed in the vessel specific SOPEP.

Once initial notifications to the control agency are made, Santos shall maintain direct contact with the control agency and act as a supporting agency throughout the response. This includes providing essential services, personnel, material or advice in support of the control agency. In addition, Santos will be required to implement monitoring activities as outlined in the Monitor and Evaluate Plan (**Section 9.2**) and Scientific Monitoring Plan (**Section 14**).

4.5 Cross-jurisdictional spills

4.5.1 Cross-jurisdictional petroleum activity spills

If a level 2/3 petroleum activity spill crosses jurisdictions between Commonwealth and State/Territory waters, the jurisdictional authority remains true to the source of the spill (i.e., NOPSEMA for Commonwealth waters; DoT for State waters; and NT IMT for Territory Waters).

Where a level 2/3 spill originating in Commonwealth waters moves into State waters two Control Agencies will exist: DoT and the petroleum titleholder (Santos), each with its own IMT and Lead IMT responsibilities. The arrangements between DoT and Santos for sharing resources and coordinating a response across both Commonwealth and State waters are further detailed in **Section 4.6**.

Santos will remain the control agency for Level 2/3 spills originating in Commonwealth waters that move into Territory waters.

4.5.2 Cross-jurisdictional vessel spills

If a level 2/3 vessel spill crosses jurisdictions between Commonwealth and Territory/State waters, two Jurisdictional Authorities will exist (AMSA for Commonwealth waters; and NT IMT for Territory Waters; or DoT for WA State waters). Control agency responsibilities will be determined by NT Government/DoT and AMSA, with Santos providing all necessary resources (including personnel and equipment) as a supporting agency, as detailed in **Section 4.6**.

4.6 Integration with government organisations

4.6.1 Australian Maritime Safety Authority

Upon notification of an incident involving a ship, AMSA will assume control of the incident and response in accordance with AMSA's Marine Pollution Response Plan. AMSA's Marine Pollution Response Plan is the operational response plan for the management of ship-source incidents. AMSA is to be notified immediately of all ship-source incidents through RCC Australia (Santos Incident Response Telephone Directory (SO-00-ZF-00025.020)).

A memorandum of understanding (MoU) has been established between Santos and AMSA, outlining respective roles and responsibilities when responding to vessel-sourced marine pollution incidents and petroleum activity related marine pollution incidents.

AMSA manages the National Plan for Maritime Environmental Emergencies, Australia's key maritime emergency contingency and response plan. All resources under the National Plan are available to Santos through request to AMSA under the arrangements of the MoU.

For any oil pollution event, Santos agrees to notify AMSA immediately in the interests of facilitating the most efficient and effective response to the incident.

4.6.2 Northern Territory – NT Government

If a level 2/3 spill arises which has potential to enter Territory waters, Santos must notify the Regional Harbourmaster and the NT Pollution Response Hotline (DEPWS) which will provide the communication link to the Territory Marine Pollution Coordinator (TMPC), who will establish an NT Incident Controller (NT IC) as the ongoing point of contact.

Notification to the TMPC and Regional Harbourmaster is to be completed as soon as practicable (within the first 24 hours of spill occurring or sooner) which will allow sufficient time to accurately determine the predicted time of any potential shoreline impact. The TMPC will appoint an NT IC.

Santos will commence coordination with the NT IC, mobilising resources and personnel into Darwin.

For level 2/3 vessel spills that cross from Commonwealth waters into Territory waters, AMSA will remain control agency for Commonwealth waters and the NT Government (via NT Incident Management Team (IMT)) will be the control agency for NT waters.

The NT IMT with advice from NT Environment, Scientific and Technical advisors will work with AMSA (and support from Santos, if requested) to confirm protection priorities and undertake an operational NEBA to determine the most appropriate response in Territory waters.

If a level 2/3 facility spill reaches the Northern Territory shoreline, the NT IMT will be the control agency for the shoreline.

The NT IMT will be established in Darwin and consist of staff from across NT Government. The NT IMT will be supported by existing NT emergency response arrangements[5] and Santos, as supporting agency. Additional support, if required, will be provided under the provisions of the *NT Emergency Management Act 2013*, through the Territory Emergency Management Council and the NT Government Functional Groups.

At the request of the TMPC, Santos will be required to provide all necessary resources, including personnel and equipment, to assist the NT IMT in performing duties as the Control Agency. This may include the provision of personnel to work within the NT IMT located in Darwin, to assist response activities such as shoreline protection, with the required numbers to be determined based on the nature and scale of the spill and response requirements at the time.

The Territory Emergency Management Council will delegate responsibilities associated with wildlife and activities in National parks, reserves and Territory marine parks. Direct coordination will be managed through the designated NT Government Functional Group.

Relevant guidance to support an oiled wildlife response in the event of an oil spill is outlined in the Northern Territory Oiled Wildlife Response Plan (NTOWRP) (AMOSC, 2019) (**Section 12.1**), the plan is designed to ensure timely mobilisation of appropriate resources (equipment and personnel) in the event of an incident affecting wildlife in NT waters.

4.6.3 Western Australia – Department of Transport

In the event that a level 2/3 Marine Oil Pollution Incident enters, or has potential to enter, State waters, the Hazard Management Agency (HMA) (DoT Director General or proxy) will take on the role as the SMPC and DoT will take on the role as a Control Agency.

For any oil spill entering or within WA State waters/shorelines, DoT as the Control Agency is the ultimate decision maker regarding identification and selection of protection priorities. DoT will utilise its internal processes which typically include:

+ evaluation of situational awareness information, including all surveillance, monitoring and visualisation data provided by the Titleholder
+ evaluation of resources at risk including use of the WA Oil Spill Response Atlas and any other relevant WA/Commonwealth government databases or other information sources
+ evaluation of shoreline types, habitat types and seasonality of environmental, socio-economic and cultural values and sensitivities
+ consultation with the State Environmental Scientific Coordinator and other relevant State and Federal government departments with environmental responsibilities
+ consultation with other relevant oil spill agencies, including the AMSA Environment, Science and Technology network or any other experts as necessary.

All information is utilised in a NEBA/SIMA type process, to determine protection priorities and response strategies.

DoT will adjust/amend their internal processes to suit the spill situation at the time.

[5] NT Emergency Response arrangements in accordance with the NT Government – Territory Emergency Plan (April 2019)

Santos will notify the DoT Maritime Environmental Emergency Response (MEER) unit as soon as reasonably practicable (within 2 hours of spill occurring) if an actual or impending spill occurs within or may impact WA State waters. On notification, the HMA will activate their MEECC and the DoT IMT.

For petroleum activity oil spills entering State waters (i.e., across jurisdictions) both Santos and DoT will be Control Agencies. Santos will work in partnership with DoT during such instances, as outlined within the DoT's Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (WA DoT, 2020b), available online: DoT's Offshore Petroleum Industry Guidance Note – Marine Oil pollution: Response and Consultation Arrangements.

Santos will conduct initial response actions in State waters as necessary in accordance with its OPEP and continue to manage those operations until formal handover of incident control is completed. Appendix 1 within DoT's Offshore Petroleum Industry Guidance Note (WA DoT 2020b) provides a checklist for formal handover.

For a cross-jurisdictional response, there will be a Lead IMT (DoT or Santos) for each spill response activity, with DoT's control resting primarily for State waters activities.

Appendix 2 within DoT's Offshore Petroleum Industry Guidance Note (WA DoT 2020b) provides guidance on the allocation of a Lead IMT to response activities for a cross jurisdictional spill.

To facilitate coordination between DoT and Santos during a cross jurisdictional response, a Joint Strategic Coordination Committee will be established. The Joint Strategic Coordination Committee will be jointly chaired between the SMPC and a nominated senior representative of Santos and will ensure alignment of objectives and provide a mechanism for de-conflicting priorities and resourcing requests.

For a cross jurisdictional response Santos will be responsible for ensuring adequate resources are provided to DoT as Control Agency, initially 11 personnel to fill roles in the DoT IMT or FOB (see **Section 5.2**) and operational personnel to assist with those response strategies where DoT is the Lead IMT. Concurrently DoT will also provide two of their personnel to the Santos IMT as described in **Table 5-4**. Santos' CMT Liaison Officer and the Deputy Incident Controller are to attend the DoT Fremantle Incident Command Centre (ICC) as soon as possible after the formal request has been made by the SMPC. It is an expectation that the remaining initial cohort will attend the DoT Fremantle ICC no later than 8am on the day following the request being formally made to Santos by the SMPC.

Figure 4-1 shows the organisational structure of Santos incident management personnel within Santos IMT and embedded within DoT's MEECC/IMT.

Figure 4-2 shows the overall cross jurisdictional organisational structure referenced from the SHP-MEE.

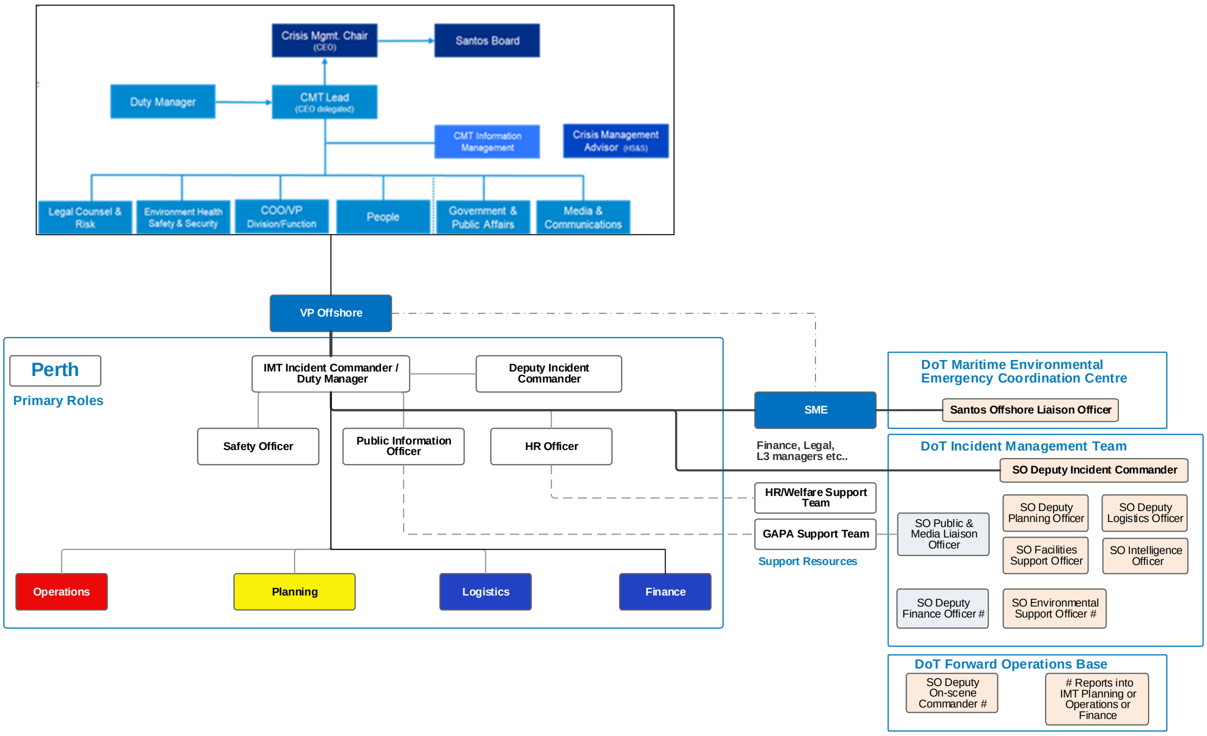


Figure 4-1: Santos cross jurisdictional incident management structure for Commonwealth waters Level 2/3 facility oil pollution incident entering WA State waters

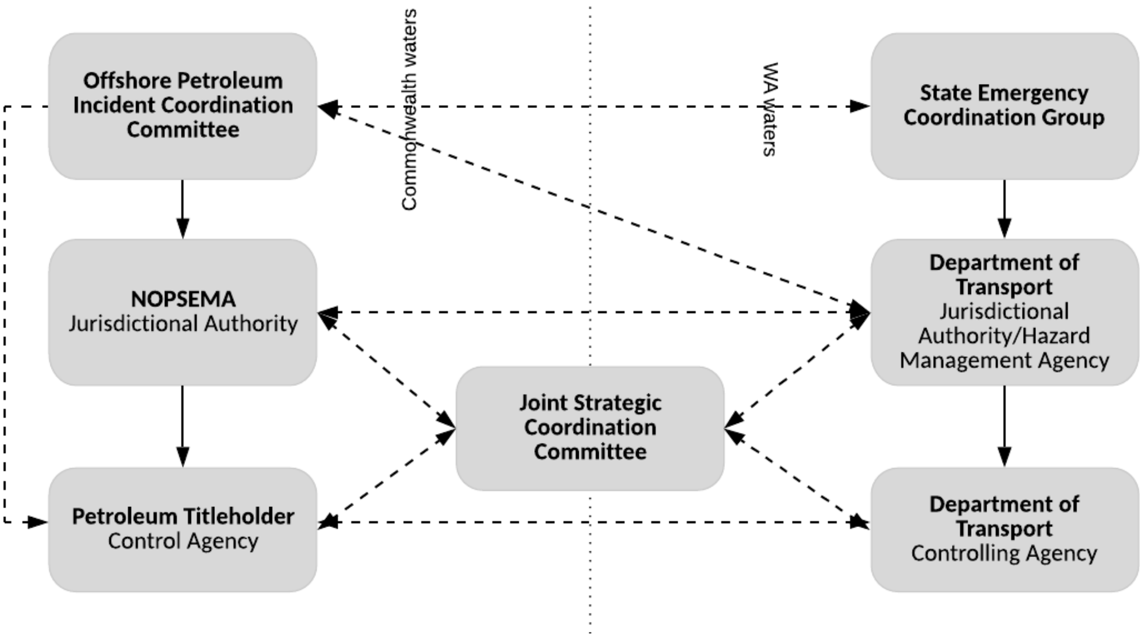


Figure 4-2: Overall control and coordination structure for offshore petroleum cross-jurisdiction incident

4.6.4 Western Australian Department of Biodiversity, Conservation and Attractions

The Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) has responsibilities associated with wildlife and activities in national parks, reserves and State marine parks. The *Biodiversity Conservation Act 2016* (WA) is the legislation that provides DBCA with the responsibility and Statutory Authority to treat, protect and destroy wildlife. In State waters, DBCA is the jurisdictional authority for Oiled

Wildlife Response (OWR), providing advice to the control agency (DoT). The role of DBCA in an OWR is outlined in the Western Australian Oiled Wildlife Response Plan (WAOWRP) and regional sub-plans.

For a level 2/3 petroleum spill that originates within or moves into State waters, DoT will be the control agency responsible for overall command of an oiled wildlife response. Santos will provide all necessary resources (equipment and personnel primarily through AMOSC membership) to DoT to facilitate this response.

For matters relating to environmental sensitivities and scientific advice in State waters DBCA may provide an Environmental Scientific Coordinator (ESC) to support the SMPC and/or DoT Incident Controller.

This may include advice on priorities for environmental protection, appropriateness of proposed response strategies and the planning and coordination of scientific monitoring for impact and recovery assessment.

4.6.5 Department of Foreign Affairs and Trade

In the event of a spill predicted to migrate into neighbouring countries Exclusive Economic Zones, Santos will notify the Department of Foreign Affairs and Trade (DFAT) who will in turn notify the affected government(s) and engage the preferred methods for Santos to respond in order to minimise the impacts to ALARP. In most cases, NOPSEMA, Department of Industry, Science, Energy and Resources (DISER) and DFAT will form an inter-agency panel; the Australian Government Control Crisis Centre, who may request AMSA to coordinate the response operations across the trans-national boundary. Santos remains willing to respond as per the direction of the affected government(s) and designated Control Agency, following approvals established between DFAT and the affected countries government.

4.6.6 Department of Industry, Science, Energy and Resources

DISER will be the lead Commonwealth Agency for the provision of strategic oversight and Commonwealth government support to a significant offshore petroleum incident (including oil spill incidents). DISER will be notified by NOPSEMA of a significant oil pollution incident and under the Offshore Petroleum Incident Coordination Framework will stand up the Offshore Petroleum Coordination Committee as the mechanism to provide Commonwealth strategic advice and support to the incident. To facilitate information between the petroleum titleholder IMT and Offshore Petroleum Incident Coordination Committee, Liaison Officer/s will be deployed from DISER to the petroleum titleholder IMT.

For incidents that are classified at a greater level than Significant (i.e., crisis level), a whole of government crisis committee will be formed under the Australian Government Crisis Management Framework to provide strategic advice and support and the Offshore Petroleum Incident Coordination Committee will not be convened, although DISER will remain as the lead agency.

4.7 Interface with external organisations

Santos has contracts in place enabling access to Oil Spill Response Organisations (OSROs). This support can be provided directly or remotely to aid the IMT and/or IRT.

4.7.1 Australian Marine Oil Spill Centre

Santos is a Participating Company of AMOSC and as such has access to AMOSC's Level 2/3 equipment and personnel as outlined in the AMOSPlan.

AMOSC has contracts with all its member companies to enable the immediate release of Core Group personnel to be made available for any Santos requirements, as outlined in Santos' *Master Service Contract* and *Principle and Agency Agreement* with AMOSC.

The mutual aid arrangements that AMOSC operates under are collaborated under the AMOSPlan. This provides the mechanism for members of AMOSC to access oil spill response capability of other members. To further enhance the mutual aid arrangements, Santos, BHPB, Chevron and Woodside have signed a memorandum of understanding (MoU) that defines the group's mutual aid arrangements. Under this MoU, Santos, BHPB, Chevron and Woodside have agreed to use their reasonable endeavours to assist in the provision of emergency response services, personnel, consumables and equipment.

4.7.2 Oil Spill Response Limited

Through an associate membership, Santos has access to spill response services from OSRL with offices in Perth, Singapore, UK and at other various locations around the globe. In the event of a level 2/3 response, Santos could access OSRL's international personnel, equipment and dispersants to supplement resources available within Australia. Santos may also call on OSRL for technical services to support its IMT.

Response equipment and personnel are allocated on a 50% of inventory basis under OSRL's Service Level Agreement.

5 Santos incident management arrangements

5.1 Incident management structure

The Santos IMT (Perth) and CMT will be activated in the event of a level 2/3 hydrocarbon spill regardless of the type of spill or jurisdiction. Santos maintains internal resources (trained personnel and equipment) across its activities that provide first strike response capability and to also support an ongoing response. Should an incident occur, the IMT Duty Manager would be notified immediately. This rostered role is on-call, filled by trained Incident Commanders and available 24 hours/day and seven days/week. The IMT Duty Manager would then activate the IMT via an automated call-out system.

As outlined in **Section 4**, control of the response may be taken over by the relevant control agency as the incident progresses. The Santos response structure to a major emergency incident is detailed in the Santos Incident Command and Management Manual (SO-00-ZF-00025). The Incident Command and Management Manual describes response planning and incident management that would operate under emergency conditions – describing how the Santos IMT operates and interfaces with the CMT and external parties.

The first priority of an escalating oil spill response to a level 2/3 spill is the formation of an IMT and establishment of an incident command centre (ICC). The ongoing involvement of the IMT and CMT will be dependent on the severity and type of spill and the obligations of Santos and other agencies/authorities in the coordinated spill response.

Santos' incident response structure relevant to a Barossa Development incident includes:

+ facility-based Emergency Response Team
+ Santos IMT – Perth based to coordinate and execute responses to an oil spill incident
+ Santos Crisis Management Team (CMT) – to coordinate and manage threats to the company's reputation and to handle Santos' corporate requirements in conjunction with the Perth based Santos – Vice President Offshore Upstream WA
+ other field-based command, response and monitoring teams for implementing strategies outlined within the OPEP.

The Santos incident response organisational structure is defined in the Incident Command and Management Manual (SO-00-ZF-00025) and in **Figure 5-1** for reference.

If the incident involves a LOWC, the Santos Source Control Branch would also be included in the incident response structure. This team would be comprised of the following sub-teams, according to the applicable source control strategies:

+ Relief Well Team
+ Subsea Intervention Team.

The Santos Source Control Branch would report directly to the Incident Commander and would be responsible for:

+ coordination of engineering safety and operational activities
+ managing source control technical personnel from third parties (e.g., Wild Well Control)
+ development of task-specific plans and procedures
+ identification and sourcing of required tools and equipment

+ approving source control components of IAPs.

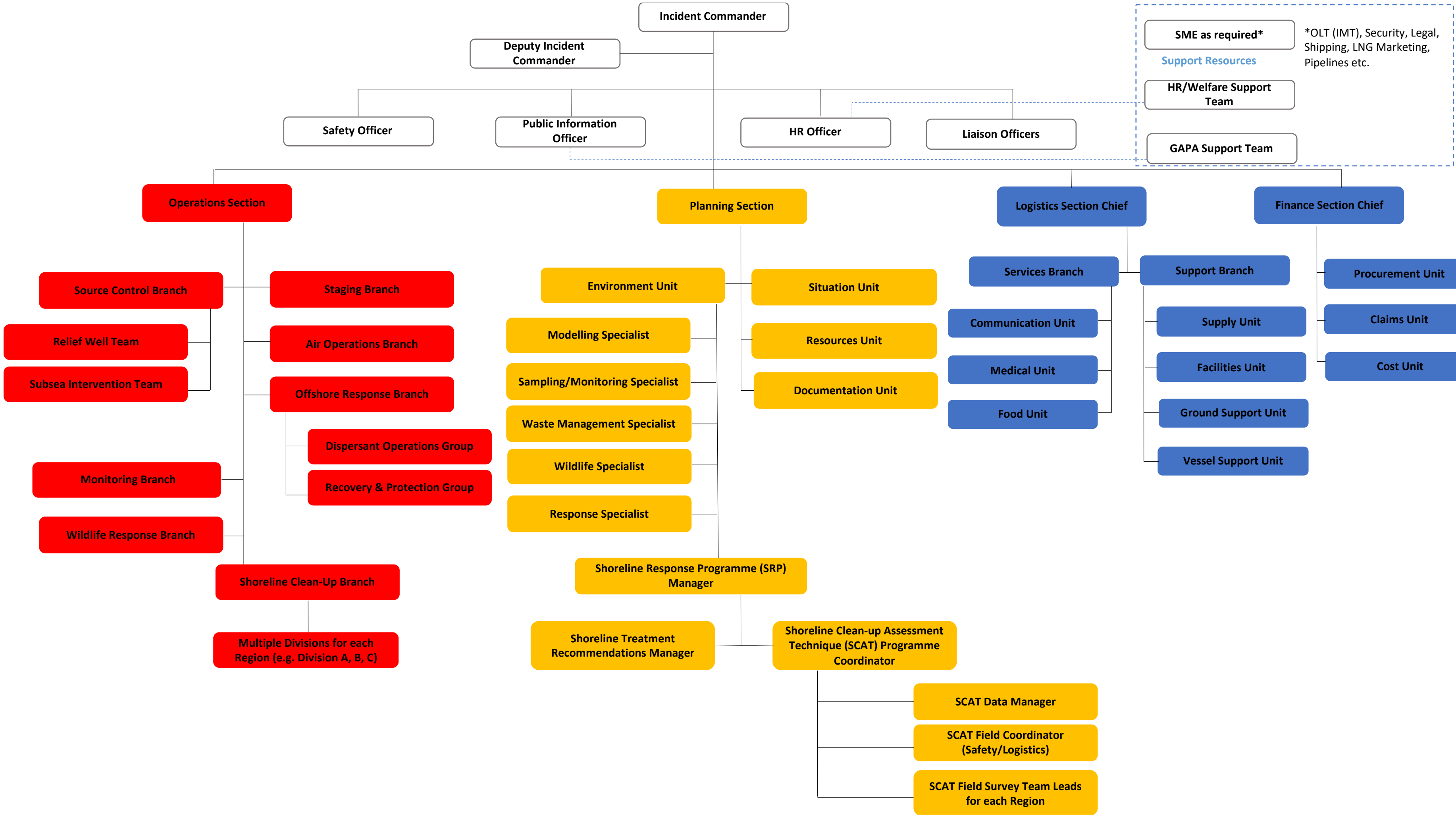


Figure 5-1: Santos' incident management team organisational structure

*Note: For a Level 2/3 facility spill whereby DoT is involved as a Control Agency, either within a single jurisdiction (State water only spills) or cross-jurisdictional (spills from Commonwealth to State waters), Santos will work in coordination with DoT in providing spill response capability. Santos' expanded organisational structure for these situations is detailed in **Section 4.6**.*

5.2 Roles and responsibilities

The following tables provide an overview of the responsibilities of the Santos CMT (**Table 5-1**), IMT (**Table 5-2**), and field-based response team members in responding to an incident (**Table 5-3**).

Also provided are the roles and responsibilities of Santos personnel required to work within DoT's organisational structure (**Table 5-5**), where DoT has responsibilities for spill response as a Control Agency, as per DoT's Offshore Petroleum Industry Guidance Note – Marine Oil pollution: Response and Consultation Arrangements.

DoT will provide a Liaison Officer/Duty Incident Commander and the Santos IMT in a coordinated response, as outlined for reference (**Table 5-4**).

The details on IMT resourcing requirements for roles identified in **Table 5-2** and **Table 5-5** to manage the response in the event of a worst-case discharge scenario and demonstration of the resourcing capacity available for Santos to meet those requirements are described in **Appendix M**.

Table 5-1: Roles and responsibilities in the Santos Crisis Management Team

Santos CMT Role	Main Responsibilities
Crisis Management Chair (CEO)	The CM Chair (Santos Chief Executive Officer) is responsible for the following: + Leads crisis management direction + Provides governance and oversight of CMT operations. + Provides enterprise and strategic direction to the CMT for the resolution of the crisis event. + Delegates the CM Lead role and accountability to the appropriate ExCom designee. + Engage with the CM Lead to endorse the crisis resolution plan. + Liaise with the Santos Board and strategic stakeholders. + Provide the full extent of the company's resources to bring about a resolution and recovery from the crisis impact.
CMT Lead/ Duty Manager	The CM Lead is responsible for: + Determine the need for establishing a Level 3 response and for activating the CMT. + Determine which / if any CMSTs are mobilized. + Leading the crisis resolution process. + Ensures internal and external notifications to key stakeholders. + Uses the crisis resolution process to determine enterprise level impacts (potential or actual) and strategic objectives. + Ensures a crisis resolution plan is developed and direct the CMT functions to implement strategies, action plans and tasks. + Determines when it is appropriate to conclude the crisis response and stand down all or a portion of the CMT.

Santos CMT Role	Main Responsibilities
CMT Information Management	The CMT Information Managers directly support the CMT as follows: + Support the CMT during crisis management operations. + Sets up the crisis management room, assist with set-up of communications, video conferences and information transfer within the CMT. + Advises on CMT operating processes and available resources. + Assisting with reserving break out rooms for the CMT functions and CMSTs. + Ensuring CMT crisis resolution forms are used and displayed on the monitors. + Provides incident action plan information when an IMT is established. + Monitoring and managing the welfare needs of the CMT.
Crisis Management Advisor	The CMT Management Advisor is responsible for the following: + Provides CMT process guidance and advice to CMT Lead, Function Leads, and CMST. + Supports and facilitates the crisis resolution planning process. + Acts as the liaison between the CMT and IMT. + Work with CMT Information Managers to manage roster and handovers for extended CMT operations. + Schedules and facilitates post crisis debriefs and after-action reviews.: The CMT Advisor will support the CMT Lead as follows: + Facilitates CMT activation requirements with the CMT Lead. + Assists the CMT Lead in maintaining an ongoing assessment of incident potential and analysis of stakeholder impacts. + Advises the CMT Lead on CMT structure and requirements for CMST engagement. + Coordinates tasks delegated by CMT Lead. + Provide tools to the CMT Lead for review and crisis assessment meetings.
CMT Core Function Leads	CMT Core Function Leads include Leads for the following areas: + Legal Counsel and Risk, + Environment Health Safety and Security, + COO/VP Division/ Function, + People, + Government and Public Affairs, + Media and Communications The CMT Core Function Leads are responsible for the following: + Participate and contribute to the crisis resolution planning process. + Each Function Lead shall determine critical communications pertaining to their area. + Mobilize and coordinate activities of the function CMST. + Advise the CMT Lead on strategic impacts, threats and mitigation created by the crisis event. + Develop and execute strategies to meet objectives endorsed by the CM Chair. + Provide support and resources via the CMST to divisional IMTs. + Ensures critical actions, decisions or points of strategic criticality are included in the CMT log. + Participates in the crisis management debrief and after-action reviews.

Santos

Table 5-2: Roles and responsibilities in the Santos Incident Management Team

Santos Management/ IMT Role	Main Responsibilities
Vice President Offshore (VPO) Upstream WA	+ Depending on the level of the incident, the VPO (and/or their delegate) will act as the primary liaison to the CMT Duty Manager. + On the activation of the IMT, the VPO is advised by the Incident Commander.
Incident Commander	+ Incident Commander is responsible for the overall management of the incident. Will set response objectives and strategic directions and oversee the development and implementation of Incident Action Plans.
Safety Officer	+ Safety Officer is responsible to develop and recommend measure for assuring personnel safety and to assess and/or anticipate hazardous and unsafe situations. Safety Officer may have specialists as necessary.
Public Information Officer	+ Public Information Officer is responsible for developing and releasing information about the incident to media, incident personnel and to appropriate agencies and organisations
Human Resources Officer	+ HR Officer is responsible for advising and assisting the Incident Commander, Command Staff and Section Chiefs on any HR related aspects of an incident.
Operations Section Chief	+ The Operation Section Chief leads the Operations Section within the IMT and is responsible for the management of all tactical operations directly applicable to the primary assignments. The Operations Section Chief activates and supervises operational elements in accordance with the IAP and directs its execution.
Source Control Branch Director	+ The Source Control Branch Director will be responsible for the implementation of the Source Control Plan (Source control planning and response guideline -DR-00-OZ-20001). The Source Control Branch Director will activate and supervise source control elements in accordance with the Incident Action Plan and direct its execution.
Relief Well Team Leader	+ The Relief Well Team Leader is responsible for the management and coordination of relief well design and operations. The Relief Well Team Leader coordinates the development of the drilling plans and procedures, secures resources and manages relief well operations to ensure the relief well reaches its target.
Subsea Intervention Team Leader	+ The Subsea Intervention Team Leader is responsible for subsea intervention activities including initial site survey, debris clearance, subsea dispersant application, direct BOP intervention and Capping Stack installation.
Staging Branch Director	+ The Staging Branch Director is responsible for supervising the Staging Area Managers as well as coordinating their activities including assigning Staging Area Managers, receiving, maintaining, checking in/out, storing and distributing resources.
Air Operations Branch Director	+ The Air Operations Branch Director is ground-based and is primarily responsible for the coordination of the air operations section (ICS 220) of the IAP and for providing logistical support to incident aircraft.

Santos Management/ IMT Role	Main Responsibilities
Offshore Response Branch Director	+ The Offshore Response Branch Director is responsible for leading the offshore response activities including dispersant application, protection, containment and recovery activities on water. Depending on the size and nature of the incident, various, groups, teams and task forces will be implemented including Dispersants Operations Group, Recovery & Protection Group, etc. + The Recovery & Protection Group is responsible for the deployment of containment and diversion/protection booming and managing on water recovery operations in the designated locations in compliance with the IAP. + The Dispersant Operations Group is responsible for coordinating all aspects of dispersant operations. For aerial applications, the Group works closely with the Air Operations Branch.
Monitoring Branch Director	+ Working closely with the Environmental Unit, the Monitoring Branch Director will be responsible for implementing the operational and scientific monitoring plans required based on the nature and scale of the incident.
Oiled Wildlife Response Branch Director	+ Working with relevant state authorities, the Oiled Wildlife Response Branch Director will be responsible for implementing the OWR plan for the incident including the deployment of equipment and personnel required.
Shoreline Clean-up Branch Director	+ The Shoreline Clean-up Branch Director is responsible for leading all shoreline response activities working closely with the Shoreline Response Program Manager and shoreline clean-up supervisors and various locations.
Planning Section Chief	+ Planning Section Chief will lead the Planning Section within the IMT and is responsible for the collection, evaluation, dissemination and use of incident information and maintaining status of assigned resources.
Situation Unit Lead	+ The Situation Unit Leader is responsible for collecting, processing, and organizing incident information relating to escalation, mitigation or intelligence activities taking place in an incident. The Situation Unit will be responsible for preparing future projections of incident growth, maps, and intelligence information.
Resources Unit Lead	+ The Resource Unit Leader is responsible for maintaining the status of all assigned tactical resources and personnel at an incident. The Resource Unit will oversee the check-in of all tactical resources and personnel, maintaining a status-keeping system indicating current location and status of all the resources.
Documentation Unit Lead	+ The Documentation Unit Lead us responsible for maintenance of accurate, up-to-date incident files including Incident Action Plans. Incident reports, communication logs, situation status reports, etc.
Environment Unit Leader	+ The Environment Unit Leader is responsible for environmental matters associated with the response, including strategic assessment, modelling, surveillance and environmental monitoring and permitting.
Technical Specialists	+ Certain incidents may require the use of Technical Specialists who have specialised knowledge or expertise. Technical Specialists may function within the Planning Section or be assigned wherever their services are required. Santos will activate Technical Specialists, based on the requirements of the incident, through a range of arrangements and this may include, Modelling Specialist, Operational/Scientific Monitoring Specialist, Response Technology Specialist, Waste Management Specialist, etc.

Santos Management/ IMT Role	Main Responsibilities
Shoreline Response Programme (SRP) Manager	+ The SRP Manager reports to the Environment Unit Leader and is responsible for managing shoreline response. + Provides input to Planning and Operations Section Chiefs on shoreline response program to minimize shoreline impacts and SCAT program.
SCAT Programme Coordinator	+ SCAT Program Coordinator is the primary point of contact, through SRP Manager, within the IMT for all SCAT activities. + SCAT Program Coordinator act as the project manager for SCAT program and will design and direct the SCAT program for any incidents. + SCAT Program Coordinator will implement and manage the day-today activities for the SCAT program including establishing good management practices and safety protocols for the field teams, chairing SCAT Field Survey Team briefings and debriefings and producing daily and weekly summaries of field reports.
SCAT Field Coordinator	+ SCAT Field Coordinator works with SCAT Program Coordinator to develop daily missions and rolling strategy for the field teams and to provide the necessary logistics and equipment support as required.
SCAT Data Manager	+ SCAT Data Manager reports to the SCAT Program Coordinator and is responsible for processing field data, quality assurance, data storage and dissemination within the IMT, and for providing the SCAT Field Survey Teams with the maps and data required to conduct their missions.
Shoreline Treatment Recommendations (STR) Manager	+ The STR Manager is responsible for the preparation of the Shoreline Treatment Recommendations (STRs). + STR Manager will work with the Environment Unit to obtain reconnaissance information to assess priority areas for initial SCAT surveys and gain approval for land access where appropriate. + STR Manager ensures all approvals are obtained (e.g., concerning any endangered species, cultural, historical resources, etc.) prior to undertaking shoreline activities. + STR Manager will work with the Environment Unit's Technical Specialists, subject matter experts and stakeholders to ensure that their requirements and constraints are incorporated into shoreline treatment recommendations. + STR Manager will work with the Operations Section to obtain advice on the feasibility, practicality and effectiveness of potential treatment strategies and tactics. + STR Manager will track the progress of approved STRs to generate and update progress reports.
Logistics Section Chief	+ Logistics Section Chief is responsible for providing facilities, services and materials in support of the incident. The Logistics Section Chief participates in the development and implementation of the Logistics Section of the IAP.
Services Branch Director	+ Service Branch Director, when activated is under the supervision of the Logistics Section Chief and is responsible for the management of all service activities for the incident including the operations of the Communications, Medical and Food Units.
Support Branch Director	+ Support Branch Director, when activated, is under the supervision of Logistics Section Chief and is responsible for the development and implementation of logistics plan in support of the IAP. The Support Branch supervises the operations of the Supply, Facilities, Ground Support and Vessel Support Units.

Santos

Santos Management/ IMT Role	Main Responsibilities
Finance Section Chief	+ Finance Section Chief is responsible for all the financial, administrative and cost analysis aspects of the incident and for supervising members of the Finance Section.
Procurement Unit Lead	+ Procurement Unit Leader us responsible for administering all financial matters pertaining to vendor contracts and leases. The Procurement Unit Leader will execute all procurements in accordance with the policies and procedures of Santos.
Claims Unit Lead	+ The Claims Unit Leader is responsible for the management and direction of all administrative matters pertaining to compensation and claims related matters for any incident.
Cost Unit Lead	+ The Cost Unit is responsible for collecting all cost data and providing cost estimated and any cost saving recommendations for the incident.

Table 5-3: Roles and responsibilities in the field-based response team

Field-based position	Main responsibilities
On-Scene Commander	+ Assess facility-based situations/incidents and respond accordingly. + Single point of communications between facility/site and IMT. + Communicate the incident response actions and delegates actions to the Incident Commander. + Manage the incident in accordance with Facility Incident Response Plan, Third Party Incident Response Plan, and/or activity specific Oil Spill Contingency Plan or Oil Pollution Emergency Plan. + Coordinate medical evacuations as required. + Refer to the Facility Incident Response Plan for detailed descriptions of roles and responsibilities.
Company Site Representative	+ Notify the Perth based Incident Commander of oil spills. + Coordinate onsite monitoring of oil spill and ongoing communication with Incident Commander.
Facility Incident Response Team (IRT)	+ Manage the incident in accordance with Facility Incident Response Plan, Third Party Incident Response Plan, and/or activity specific Oil Spill Contingency Plan or OPEP. + Coordinate forward operations response teams and activities for on-asset incidents + Refer to the facility Incident Response Plan for detailed descriptions of roles and responsibilities within the IRT.
Medical Evacuation Team	+ Manage all medical and transportation requirements related to injured personnel to an appropriate medical facility. + Refer to the Medical Evacuation Procedure (QE-91-IF-00020) for detailed descriptions of roles and responsibilities within the Medical Evacuation Team.
Off-Asset Oil Spill Response Teams	+ Respond to oil spills at sea to minimise the impacts to as low as reasonably practicable. + Refer to activity specific Oil Spill Contingency Plans (OSCP) and OPEP for detailed descriptions of roles and responsibilities within the Off-Asset Oil Spill Response Team.
Source Control Branch	+ Respond to incidents involving well loss of containment to stop the flow of oil to sea. + Refer to the Santos Source Control Planning and Response Guideline (DR-00-OZ-20001) for detailed descriptions of roles and responsibilities within the Source Control Branch.
Oiled Wildlife Response Team	+ Respond to oiled wildlife incidents to minimise the impacts to wildlife. + Refer to the Western Australia Oiled Wildlife Response Plan (WAOWRP) or Northern Territory Oiled Wildlife Response Plan (NTOWRP) for detailed descriptions of roles and responsibilities within the Oiled Wildlife Response Team.
Scientific Monitoring Teams	+ Monitor the impacts and recovery to sensitive receptors from an oil spill and associated response actions. + Refer to the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162) for detail on Scientific Monitoring Team roles and responsibilities.

Table 5-4: Department of Transport roles embedded within Santos' CMT/IMT (note these roles may also come from NT Government in the event of a response in NT waters)

DoT roles embedded within Santos' CMT/IMT	Main responsibilities
DoT Liaison Officer (before DoT assuming role of Control Agency) **Deputy Incident Controller – State Waters (after DoT assumes role of control agency)**	+ Facilitate effective communications between DoT's State Marine Pollution Coordinator (SMPC)/SMEEC/the Incident Controller and Santos' appointed CMT Leader/Incident Commander. + Provide enhanced situational awareness to DoT of the incident and the potential impact on State waters. + Assist in the provision of support from DoT to Santos. + Facilitate the provision of technical advice from DoT to Santos' Incident Commander as required.
Media Liaison Officer	+ Provide a direct liaison between the Santos Media team and DoT IMT Media team. + Facilitate effective communications and coordination between the Santos and DoT media teams. + Assist in the release of joint media statements and conduct of joint media briefings. + Assist in the release of joint information and warnings through the DoT Information and Warnings team. + Offer advice to the Santos Media Coordinator on matters pertaining to DoT and wider Government media policies and procedures.

Table 5-5: Santos personnel roles embedded within the WA State Maritime Environmental Emergency Coordination Centre/Department of Transport Incident Management Team (note similar roles may also be provided to support the NT IMT in the event of a response in NT waters)

Santos roles embedded within the State MEECC/ DoT IMT	Main responsibilities
CMT Liaison Officer[6]	+ Provide a direct liaison between the Santos CMT and the State MEECC. + Facilitate effective communications and coordination between the Santos CMT Leader and the SMPC. + Offer advice to SMPC on matters pertaining to Santos' crisis management policies and procedures.
Deputy Incident Controller	+ Provide a direct liaison between the DoT IMT and the Santos IMT. + Facilitate effective communications and coordination between the Santos Incident Commander and the DoT Incident Controller. + Offer advice to the DoT Incident Controller on matters pertaining to the Santos incident response policies and procedures. + Offer advice to the Safety Coordinator on matters pertaining to Santos' safety policies and procedures particularly as they relate to Santos employees or contractors operating under the control of the DoT IMT.
Deputy Intelligence Officer	+ As part of the DoT Intelligence Team, assist the Intelligence Officer in the performance of their duties in relation to situation and awareness. + Facilitate the provision of relevant modelling and predications from the Santos IMT. + Assist in the interpretation of modelling and predictions originating from the Santos IMT. + Facilitate the provision of relevant situation and awareness information originating from the DoT IMT to the Santos IMT. + Facilitate the provision of relevant mapping from the Santos IMT. + Assist in the interpretation of mapping originating from the Santos IMT. + Facilitate the provision of relevant mapping originating from the Santos IMT.
Deputy Planning Officer	+ As part of the DoT Planning Team, assist the Planning Officer in the performance of their duties in relation to the interpretation of existing response plans and the development of incident action plans and related sub-plans. + Facilitate the provision of relevant IAP and sub-plans from the Santos IMT. + Assist in the interpretation of the Santos OPEP from Santos. + Assist in the interpretation of the Santos IAP and sub-plans from the Santos IMT. + Facilitate the provision of relevant IAP and sub-plans originating from the DoT IMT to the Santos IMT. + Assist in the interpretation of Santos' existing resource plans. + Facilitate the provision of relevant components of the resource sub-plan originating from the DoT IMT to the Santos IMT. (Note this individual must have intimate knowledge of the relevant Santos OPEP and planning processes).

[6] The role described as the *Santos Liaison Officer (CMT)* in **Figure 4-1**.

Santos roles embedded within the State MEECC/ DoT IMT	Main responsibilities
Environment Support Officer	+ As part of the Intelligence Team, assist the Environment Coordinator in the performance of their duties in relation to the provision of environmental support into the planning process. + Assist in the interpretation of the Santos OPEP and relevant Tactical Response Plan (TRPs). + Facilitate in requesting, obtaining and interpreting environmental monitoring data originating from the Santos IMT. + Facilitate the provision of relevant environmental information and advice originating from the DoT IMT to the Santos IMT.
Deputy Public Information Officer[7]	+ As part of the Public Information Team, provide a direct liaison between the Santos Media team and DoT IMT Media team. + Facilitate effective communications and coordination between Santos and DoT media teams. + Assist in the release of joint media statements and conduct of joint media briefings. + Assist in the release of joint information and warnings through the DoT Information & Warnings team. + Offer advice to the DoT Media Coordinator on matters pertaining to Santos' media policies and procedures. + Facilitate effective communications and coordination between Santos and DoT Community Liaison teams. + Assist in the conduct of joint community briefings and events. + Offer advice to the DoT Community Liaison Coordinator on matters pertaining to Santos community liaison policies and procedures. + Facilitate the effective transfer of relevant information obtained from the Contact Centre to the Santos IMT.
Deputy Logistics Officer	+ As part of the Logistics Team, assist the Logistics Officer in the performance of their duties in relation to the provision of supplies to sustain the response effort. + Facilitate the acquisition of appropriate supplies through Santos' existing OSRL, AMOSC and private contract arrangements. + Collects Request Forms from DoT to action via the Santos IMT. (Note this individual must have intimate knowledge of the relevant Santos logistics processes and contracts).
Deputy Waste Management Coordinator	+ As part of the Operations Team, assist the Waste Management Coordinator in the performance of their duties in relation to the provision of the management and disposal of waste collected in State waters. + Facilitate the acquisition of appropriate services and supplies through Santos' existing private contract arrangements related to waste management. + Collects Waste Collection Request Forms from DoT to action via the Santos IMT.

[7] In the event of an incident, access to media and communications response strategy and a comprehensive stakeholder list inclusive of all potentially relevant stakeholders, including indigenous organisations are contained via Santos' internal intranet site for use by CMT/IMT members

Santos roles embedded within the State MEECC/ DoT IMT	Main responsibilities
Deputy Finance Officer	+ As part of the Finance Team, assist the Finance Officer in the performance of their duties in relation to the setting up and payment of accounts for those services acquired through Santos' existing OSRL, AMOSC and private contract arrangements. + Facilitate the communication of financial monitoring information to Santos to allow them to track the overall cost of the response. + Assist the Finance Officer in the tracking of financial commitments through the response, including the supply contracts commissioned directly by DoT and to be charged back to Santos.
Deputy Operations Officer	+ As part of the Operations Team, assist the Operations Officer in the performance of their duties in relation to the implementation and management of operational activities undertaken to resolve an incident. + Facilitate effective communications and coordination between the Santos Operations Section and the DoT Operations Section. + Offer advice to the DoT Operations Officer on matters pertaining to Santos' incident response procedures and requirements. + Identify efficiencies and assist to resolve potential conflicts around resource allocation and simultaneous operations of Santos and DoT response efforts.
Deputy Division Commander (FOB)	+ As part of the Field Operations Team, assist the Division Commander in the performance of their duties in relation to the oversight and coordination of field operational activities undertaken in line with the IMT Operations Section's direction. + Provide a direct liaison between Santos' Forward Operations Base/s (FOB/s) and the DoT FOB. + Facilitate effective communications and coordination between Santos FOB Operations Commander and the DoT FOB Operations Commander. + Offer advice to the DoT FOB Operations Commander on matters pertaining to Santos' incident response policies and procedures. + Assist the Safety Coordinator deployed in the FOB in the performance of their duties, particularly as they relate to Santos employees or contractors. + Offer advice to the Senior Safety Officer deployed in the FOB on matters pertaining to Santos' safety policies and procedures.

5.3 Cost recovery

As required under Section 571(2) of the OPGGS Act 2006, Santos has financial assurances in place to cover any costs, expenses and liabilities arising from carrying out its petroleum activities, including major oil spills. This includes costs incurred by relevant control agencies (e.g., DoT) and third-party spill response service providers.

5.4 Training and exercises

The IMT undertake workshops, desktop studies and an activation exercise, as per the Santos Offshore Division Incident Crisis Management Training and Exercise Plan (SO-92-HG-10001), to familiarise the IMT members with roles and responsibilities, OPEP arrangements and the functions and process contained within an OPEP.

All activities undertaken are recorded in the Santos EHS Toolbox, with the key recommendations recorded and tracked.

5.4.1 Incident management team training and exercises

Santos provides training to its personnel to fill all required positions within the IMT.

Competency is maintained through participation in regular response exercises and workshops. Exercise and training requirements for Santos' IMT members are summarised in **Table 5-6**.

Table 5-6: Training and exercise requirements for incident management team positions

IMT Role	Exercise	Training
Incident Commander Operations/Source Control Branch Director	One Level 3 exercise annually or two Level 2 exercises annually[1]	+ PMAOMIR320 + PMAOMIR418 + AMOSC – IMO3 Oil Spill Command and Control
Planning Section Chief Logistics Section Chief Environment Unit Leader		+ PMAOMIR320 + AMOSC – IMO2 Oil Spill Management Course
Safety Officer Supply Team Leader GIS Team Leader Data Manager HR/Welfare Team Leader		+ PMAOMIR320 + AMOSC – Oil Spill Response Familiarisation Training

1: All IMT members are required to participate in at least one Level 3 exercise every two years

5.4.2 Oil spill responder training

Santos has an internal capability of trained oil spill responders who can be deployed in the field in a spill response and has access to external, trained spill responder resources (**Table 5-7**).

Table 5-7: Spill responder personnel resources

Responder	Role	Training	Available Number
Santos AMOSC Core Group Responders	Santos personnel trained and competency assessed by AMOSC as the AMOSC Core Group. Deployed by IMT for spill response operations.	AMOSC Core Group Workshop (refresher training undertaken every two years). AMOSC – IMO1 Oil Spill Operators Course	12
Santos Facility Emergency Response Teams	Present at Facility for first-strike response to incidents.	Internal Santos training and exercises as defined in each facility's Emergency Response Plan OSC to have AMOSC – Oil Spill Response Familiarisation Training.	One Incident Response (IR) team per operational facility per shift

Responder	Role	Training	Available Number
Santos Aerial Observers	Undertake aerial surveillance of spill. Deployed by IMT in the aerial surveillance aircrafts.	AMOSC – Aerial Surveillance Course (refresher training undertaken tri-annually).	7
AMOSC Core Group Oil Spill Responders	Industry personnel as the AMOSC Core Group, available to Santos under the AMOSPlan. For providing incident management (IMT) and operations (field response) assistance.	AMOSC Core Group Workshop (refresher training undertaken every two years). AMOSC – IMO1 Oil Spill Operators Course and/or IMO2 Oil Spill Management Course	As defined in Core Group Member Reports[8] Target to maintain at least 84 members (Ref.: AMOSC Core Group Program and Policies)
OSRL Oil Spill Response Personnel	Oil Spill Response Ltd professionals, providing technical, incident management and operational advice and assistance available under Santos-OSRL contract.	As per OSRL training and competency matrix.	18
AMOSC Oil Spill Response Specialists	Professionals, providing technical, incident management and operational advice and assistance available under Santos-AMOSC contract.	As per AMOSC training and competency matrix.	8
Oiled Wildlife Response Roles	Refer **Section 12** and **Appendix I**		
Monitoring Service Provider: Monitoring Coordination Team (MCT) and Scientific Monitoring Plan Teams	Monitoring Coordination Team (MCT). Scientific Monitoring Plan Teams: + Technical Advisers + Field Team Leader + Field Team Member.	As defined in the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162).	Capability defined in Monthly Capability Reports MCT – five personnel Scientific Monitoring Plan Teams 12+ per team
Level 1 Oiled Wildlife Responders (Workforce Hire)	Provide oiled wildlife support activities under supervision.	No previous training required; on the job training provided.	Nominally over 1,000
Shoreline clean-up personnel (Workforce Hire)	Manual clean-up activities under supervision.		

[8] An average of 47 personnel plus 16 AMOSC staff members available as of September 2021.

In addition to the resources listed in **Table 5-7**, the following resources are available for spill response and may be activated by the relevant Control Agency:

+ National Plan: National Response Team – Trained oil spill response specialists, including aerial observers, will be deployed under the direction of AMOSC and the IMT in a response. The National Response Team is trained and managed in accordance with the National Response Team Policy, approved by the National Plan Strategic Coordination Committee (AMSA, 2013b).
+ NT Oil Spill Contingency Plan (NT OSCP): NT Response Team are available to assist under the jurisdiction of the NT IMT. NT Response Team members remain trained and accredited in line with the NT OSCP.
+ WA State Hazard Plan for Maritime Environmental Emergencies (SHP-MEE): State Response Team (SRT) – Oil pollution response team available to assist under the jurisdiction of the DoT in State waters. SRT members remain trained and accredited in line with the State Hazard Plan (SHP-MEE) requirements.

In the event of a spill, the trained spill responders listed in **Table 5-7** would be required to undertake various roles in key spill response operations, including operational monitoring, shoreline protection, shoreline clean-up, oiled wildlife response and scientific monitoring.

In the event of a spill, Team Leader roles for protection and deflection and shoreline clean-up would be filled through Santos' AMOSC Core Group Responders and then industry Core Group Responders.

5.5 Response testing arrangements and audits

Santos has oil spill response testing arrangements and auditing programmes in place which are detailed within the Santos Offshore Oil Spill Response Readiness Guideline (SO-91-OI-20001). Testing of key response provider arrangements may be done as part of larger exercises or as standalone tests where the capability and availability of resources through the response provider are assessed against the performance requirement.

5.5.1 Testing arrangements

Santos employs a range of tests to ensure that the various response arrangements function as required. These tests include:

1. Review
2. Audit
3. Equipment Checks/ Deployments
4. Desktop Exercise
5. Level 2/3 IMT Exercise.

The above tests and the testing schedule are detailed in full within the Santos Offshore Oil Spill Response Readiness Guideline (SO-91-OI-20001); an excerpt of the testing arrangements plan is provided in **Figure 5-2**. Objectives are set for the various tests identified for each of the response arrangements. The effectiveness of response arrangements against these objectives are assessed using pre-identified Key Performance Indicators (KPIs).

#	Response Arrangements & Critical Components	Type of Test	Schedule	Objectives	KPIs
1	**Source Control**				
	Source Control a) Relief Well Drilling - Access to MODU	Review - MODU Register	Once per month for the duration of drilling campaign	Identify suitable MODU that can be utilized in the event of a Source control incident requiring a relief well	Document the identified suitable MODU by: •Name •MODU Type •Location •Contract Status
	Source Control b) Well Capping - Access to Capping Stack	Review - Contract/Agreement	Annually (when drilling activity is occurring)	To confirm access to capping stack for well capping	Review to confirm access to Capping Stack through maintenance of service provision contract
	Source Control c) Access to Source Control Emergency Response Personnel	Desktop Exercise	Annually (when drilling activity is occurring)	To check arrangements for access to Well Control Specialists from WWC as per Source Control Planning and Response Guideline DR-00-OZ-20001	Confirmation (email) from WWC that listed Well Control specialists can be made available and will be mobilized within 72 hours of a notification
	Source Control d) Vessel Fuel Tank Rupture - SOPEP	Review - Plan	Prior to vessel arrival in field	To confirm that each vessel within the field has an approved SOPEP in place	Review to confirm approved SOPEP in place for vessels
2	**Operational Monitoring**				
	Operational Monitoring - Vessel Surveillance a) Access to vessels	Review - Contract/Agreement	Annually	To confirm access to vessels for surveillance	Review to confirm Master Service Agreements (MSAs) with vessel providers to gain access to vessels
	Operational Monitoring - Aerial Surveillance a) Access to aircrafts	Review - Contract/Agreement	Annually	To confirm access to aircrafts for surveillance	Review to confirm Master Service Agreements (MSAs) with aircraft providers to gain access to aircrafts for surveillance
	Operational Monitoring - Aerial Surveillance b) Access to trained aerial observers	Review - Contract/Agreement	Annually	To confirm access to trained aerial observers	Review to confirm access to trained aerial observers through; •Trained Santos personnel or •AMOSC Member Contract or •OSRL Associate Member Contract

Figure 5-2: Excerpt of testing arrangement plan, taken from Santos Offshore Oil Spill Response Readiness Guideline (SO-91-OI-20001)

All testing activities are documented, and all reports generated will be saved in Santos's EHS Toolbox system and any actions, recommendations or corrective actions identified are assigned a responsible party for completion and tracked to closure. The status of completion is tracked through the 'Action module' in the EHS Toolbox and communicated widely through monthly EHS KPI reporting.

5.5.2 Audits

Oil spill response audits will follow the Santos Assurance Management Standard (SMS-MS15.1) and are scheduled as per the Santos Assurance Schedule (E-910HA-20002). Audits will help identify and address any deficiencies in systems and procedures. At the conclusion of the audit, any opportunities for improvement and corrective actions (non-conformances) will be formally noted and discussed, with corrective actions developed and accepted. In some cases, audits may conclude with potential amendments to the OPEP.

The deployment readiness and capability of AMOSC's oil spill response equipment and resources in Geelong and Fremantle are audited every two years under the direction of AMOSC's participating members. The intent is to provide assurances to Santos and associated members about AMOSC's ability to respond to an oil spill incident as per the methods and responsibilities defined in OPEPs and AMOSC's Service Level Statement.

The deployment readiness and capability of OSRL's oil spill response equipment and personnel are audited every two years by the Emergency & Oil Spill Coordinator. The intent of this audit is to provide assurances to

Santos of OSRL's ability to respond to an oil spill incident as per the methods and responsibilities defined in Santos' OPEPs and OSRL's SLA.

6 External notifications and reporting requirements

For oil spill incidents, the OSC (of the MODU or Company Site Representative) will notify the Perth-based IMT for delegation of further notifications to relevant regulatory authorities and for further spill response assistance for level 2/3 spills.

6.1 Regulatory notification and reporting

The Incident Commander (IC) is to delegate the following regulatory reporting requirements. Typical delegated parties will be the Safety Officer and the Environment Unit Leader.

Contact details for the Regulatory agencies outlined in **Table 6-1** are provided within the Incident Response Telephone Directory (SO-00-ZF-00025.020).

Table 6-1 outlines the external regulatory reporting requirements specifically for oil spill incidents outlined within this OPEP in Commonwealth, State and Territory jurisdictions, noting that regulatory reporting may apply to smaller Level 1 spills that can be responded to using onsite resources as well as larger level 2/3 spills. There are also additional requirements for Vessel Masters to report oil spills from their vessels under relevant marine oil pollution legislation (e.g., MARPOL). This includes, where relevant, reporting oil spills to AMSA (Rescue Coordination Centre) and WA DoT (MEER unit) and the NT Government.

State/Territory water notifications to WA DoT/ NT Regional Harbourmaster/DEPWS will apply to spills in State/Territory waters or spills originating in Commonwealth waters and moving to State/Territory waters.

The Incident Response Telephone Directory (SO-00-ZF-00025.02) contains a more detailed list and contact details for incident response support and is updated every six months with up-to-date revisions available within the IMT room and online (intranet procedures and emergency response pages).

6.2 Activation of external oil spill response organisations and support agencies

Table 6-2 outlines notifications that should be made to supporting agencies to assist with spill response activities outlined within this plan. This list contains key OSROs that have pre-established roles in assisting Santos in an oil spill response. It is not an exhaustive list of all providers that Santos may use for assisting an oil spill response.

The Incident Response Telephone Directory (SO-00-ZF-00025.02) contains a more detailed list and contact details for incident response support and is updated every six months with up-to-date revisions available within the IMT room and online (intranet procedures and emergency response pages).

6.3 Environmental performance

Table 6-3 lists the environmental performance standards and measurement criteria for external notifications and reporting.

Table 6-1: External notification and reporting requirements (Commonwealth, state/territory and international waters)

Agency or Authority	Type of notification/ timing	Legislation/guidance	Reporting requirements	Responsible person/group	Forms
NOPSEMA reporting requirements for Commonwealth water spills					
NOPSEMA (Incident Notification Office)	Verbal notification within two hours Written report as soon as practicable, but no later than three days	*Petroleum and Greenhouse Gas Storage Act 2006* Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 (as amended 2020)	A spill associated with the activity in Commonwealth waters that has the potential to cause moderate to significant environmental damage[1]	Notification by IMT Environment Unit Leader (or delegate)	Incident reporting requirements: https://www.nopsema.gov.au/environmental-management/notification-and-reporting/
National Offshore Petroleum Titles Administrator (NOPTA) (Titles Administrator)	Written report to NOPTA within seven days of the initial report being submitted to NOPSEMA	Guidance Note (N-03000-GN0926) Notification and Reporting of Environmental Incidents	Spill in Commonwealth waters that is reportable to NOPSEMA	Notification by IMT Environment Unit Leader (or delegate)	Provide same written report as provided to NOPSEMA
AMSA Rescue Coordination Centre (RCC)[2]	Verbal notification within two hours of incident Written POLREP form, within 24 hours on request from AMSA	MARPOL	Santos to notify AMSA of any marine pollution incident[1]	Notification by IMT Environment Unit Leader (or delegate)	Not applicable
Commonwealth Department of Agriculture, Water and the Environment (DAWE) (Director of monitoring and audit section)	Email notification as soon as practicable	*Environment Protection and Biodiversity Conservation Act 1999*	If Matters of National Environmental Significance (MNES) are considered at risk from a spill or response strategy, or where there is death or injury to a protected species	Notification by IMT Environment Unit Leader (or delegate)	Not applicable

Agency or Authority	Type of notification/ timing	Legislation/guidance	Reporting requirements	Responsible person/group	Forms
Parks Australia (24-hour Marine Compliance Duty Officer)	Verbal notification as soon as practicable To include: + titleholder details + time and location of the incident (including name of marine park likely to be affected) + proposed response arrangements as per the OPEP (e.g., dispersant, containment, etc.) + confirmation of providing access to relevant monitoring and evaluation reports when available; and + contact details for the response coordinator.	*Environment Protection and Biodiversity Conservation Act 1999*	An oil spill which occurs within a marine park or are likely to impact on an Australian Marine Park	Notification by IMT Environment Unit Leader (or delegate)	Not applicable
Australian Fisheries Management Authority (AFMA)	Verbal phone call notification within 24 hours of incident	For consistency with DPIRD Fisheries notification	Reporting of marine oil pollution[1] Fisheries within the environment that may be affected (EMBA) Consider a courtesy call if not in exposure zone	Notification by IMT Environment Unit Leader (or delegate)	Not applicable

Santos

Agency or Authority	Type of notification/ timing	Legislation/guidance	Reporting requirements	Responsible person/group	Forms
If spill is heading towards NT waters					
NT Regional Harbourmaster	Verbal notification Follow up with POLREP as soon as practicable after verbal notification	Northern Territory Oil Spill Contingency Plan. As per Territory legislation (i.e., *Marine Pollution Act 1999*)	All actual or impending spills in NT waters, regardless of source or quantity Notify if spill has the potential to impact wildlife in Territory waters (to activate the Oiled Wildlife Coordinator)	Notification by IMT Environment Unit Leader (or delegate)	POLREPs to be emailed to rhm@nt.gov.au (Regional Harbourmaster) Instructions for submitting POLREPs (including a POLREP Template) are provided on the NT Government webpage: https://nt.gov.au/marine/marine-safety/report-marine-pollution
NT Department of Environment, Parks and Water Security (DEPWS) (Pollution Response Hotline; Environmental Operations)	Verbal notification as soon as practicable Written report to be provided as soon as practicable after the incident, unless otherwise specified by the Minister	Northern Territory Oil Spill Contingency Plan. As per State legislation (i.e., *Marine Pollution Act 1999*)	All actual or impending spills in NT waters	Notification by IMT Environment Unit Leader (or delegate)	Marine Pollution Reports (POLREPs) are to be emailed to pollution@nt.gov.au (Environmental Operations) Instructions for submitting POLREPs (including a POLREP Template) are provided on the NT Government webpage : https://nt.gov.au/marine/marine-safety/report-marine-pollution

Agency or Authority	Type of notification/ timing	Legislation/guidance	Reporting requirements	Responsible person/group	Forms
NT Department of Primary Industry and Fisheries (DPIF)	Verbal notification, timing not specified	Not applicable	Fisheries within the EMBA Consider a courtesy call if not in exposure zone	Notification by IMT Environment Unit Leader (or delegate)	Not applicable
If spill is heading towards WA waters					
Department of Mines, Industry Regulation and Safety (DMIRS) (Petroleum Environment Duty Officer)	Verbal phone call within two hours of incident being identified Follow up written notification within three days	Guidance Note on Environmental Non-compliance and Incident Reporting	All actual or impending spills in State waters	Notification by IMT Environment Unit Leader (or delegate)	Environmental and Reportable Incident/ Non-compliance Reporting Form http://www.dmp.wa.gov.au/Environment/Environment-reports-and-6133.aspx
WA Department of Transport (WA DoT)[2] (MEER Duty Officer)	Verbal notification within two hours Follow up with Pollution Report (**Appendix C**) as soon as practicable after verbal notification If requested, submit Situation Report (**Appendix D**) within 24 hours of request	*Emergency Management Regulations 2006* State Hazard Plan: Maritime Environmental Emergencies Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements	Santos to notify of actual or impending Marine Pollution Incidents (MOP) that are in, or may impact, State waters Emergency Management Regulations 2006 define MOP as an actual or impending spillage, release or escape of oil or an oily mixture that is capable of causing loss of life, injury to a person or damage to the health of a person, property or the environment[1]	Notification by IMT Environment Unit Leader (or delegate) MEER Duty Officer contacted per Incident Telephone Directory	WA DoT POLREP (**Appendix C**): https://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-PollutionReport.pdf WA DoT SITREP (**Appendix D**): https://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-SituationReport.pdf

Agency or Authority	Type of notification/ timing	Legislation/guidance	Reporting requirements	Responsible person/group	Forms
Department of Biodiversity Conservation and Attractions (State Duty Officer)	Verbal notification within two hours	Western Australian Oiled Wildlife Response Plan	Notify if spill has the potential to impact or has impacted wildlife in State waters (to activate the Oiled Wildlife Adviser)	Notification by IMT Environment Unit Leader (or delegate)	Not applicable
Department of Primary Industry and Regional Development (DPIRD) Fisheries	Verbal phone call notification within 24 hours of incident	As per consultation with DPIRD Fisheries	Reporting of marine oil pollution[1] Notify if spill has the potential to impact or has impacted fisheries in State waters	Notification by IMT Environment Unit Leader (or delegate)	Not applicable
If spill is heading towards international waters					
Department for Foreign Affairs and Trade (DFAT) (24-hour consular emergency centre)	Verbal phone call notification within 8 hours, if the spill is likely to extend into international waters Follow up with email outlining details of incident	Not applicable	Notify DFAT that a spill has occurred and is likely to extend into international waters Inform DFAT of the measures being undertaken to manage the spill NOPSEMA, DISER and DFAT will form an inter-agency panel; the Australian Government Control Crisis Centre	Notification by IMT Environment Unit Leader (or delegate)	Email details of incident to sea.law@dfat.gov.au

1: For clarity and consistency across Santos regulatory reporting requirements, Santos will meet the requirement of reporting a marine oil pollution incident by reporting oil spills assessed to have an environmental consequence of moderate or higher in accordance with Santos' environmental impact and risk assessment process outlined in Section 5 of the EPs.

2: Santos reporting requirements only listed. For oil spills from vessels, Vessel Masters also have obligations to report spills from their vessels to AMSA Rescue Coordination Centre (RCC) and, in State waters, WA DoT MEER.

Table 6-2: List of spill response support notifications

Organisation	Indicative timeframe	Type of communication	Resources available	Activation instructions	Santos person responsible for activating
AMOSC Duty Manager	As soon as possible but within two hours of incident having been identified	Verbal Service Contract	Santos is a Participating Company in AMOSC and can call upon AMOSC personnel and equipment (including oiled wildlife). Under the AMOSPlan, Santos can also call upon mutual aid from other trained industry company personnel and response equipment AMOSC's stockpiles of equipment include dispersant, containment, recovery, cleaning, absorbent, oiled wildlife and communications equipment. Equipment is located in Geelong, Fremantle, Exmouth and Broome	**Step 1.** Obtain approval from Incident Commander to mobilise AMOSC. **Step 2.** Notify AMOSC that a spill has occurred. Put on standby as required – activate if spill response escalates in order to mobilise spill response resources consistent with the AMOSPlan. **Step 3.** E-mail confirmation and a telephone call to AMOSC will be required for mobilisation of response personnel and equipment, and callout authorities will be required to supply their credentials to AMOSC. A signed service contract must also be completed by a call out authority and returned to AMOSC before mobilisation.	IMT Environment Unit Leader (or delegate) will notify AMOSC (upon approval from Incident Commander)
Aviation Service Provider	Within two hours of incident having been identified	Verbal	Helicopters/pilots available for aerial surveillance. Contract in place	Phone call.	IMT Logistics Section Chief (or delegate)
Duty Officers/ Incident Commanders (Woodside, BHP, Chevron)	Within two hours of incident having been identified	Verbal	Mutual aid resources (through AMOSC mutual aid arrangement)	Phone call.	Incident Commander (or delegate)

Organisation	Indicative timeframe	Type of communication	Resources available	Activation instructions	Santos person responsible for activating
Toll – Freight and Logistics	Within two hours of incident having been identified	Verbal	Assistance with mobilising equipment and loading vessels	Phone call.	IMT Logistics Section Chief (or delegate)
Waste Service Provider/s	As required for offshore and shoreline clean-up activities	Verbal	Santos has contract arrangements in place with Waste Service Providers to take overall responsibility to transport and dispose of waste material generated through clean-up activities	Phone call to the Primary Contact Person. In the event the Primary Contact Person is not available, the Secondary Contact Person will be contacted.	IMT Logistics Section Chief (or delegate)
Astron	Scientific Monitoring Plan initiation criteria are met (**Appendix J**)	Verbal and written	Astron has been contracted by Santos to provide Standby Services for Scientific Monitoring Plans (SMPs) 1 to 11. This includes provision of personnel and equipment. Astron annually reviews the SMPs for continual improvement	**Step 1.** Obtain approval from Incident Commander to activate Astron for Scientific Monitoring. **Step 2.** Verbally notify Astron followed by the submission of an Activation Form (Environment Unit Leader Folder) via email. **Step 3.** Provide additional details as requested by the Astron Monitoring Coordinator on call-back. **Step 4.** Astron initiates Scientific Monitoring Activation and Response Process.	IMT Environment Unit Leader (or delegate)
Intertek Geotech (WA) Environmental Services and Ecotoxicology	When characterisation of oil is activated (**Section 10.6**)	Verbal	Oil analysis including gas chromatography/mass spectrometry fingerprinting	Phone call.	IMT Environment Unit Leader (or delegate)

Organisation	Indicative timeframe	Type of communication	Resources available	Activation instructions	Santos person responsible for activating
Oil Spill Response Limited, OSRL Duty Manager	Within two hours of incident having been identified	Verbal OSRL Mobilisation Authorisation Form	Santos has a Service Level Agreement with OSRL, which includes the provision of support functions, equipment and personnel to meet a wide range of scenarios At minimum OSRL will provide technical support to the IMT and place resources on standby Further details available on the OSRL webpage	**Step 1**. Contact OSRL Duty Manager in Singapore and request assistance from OSRL. **Step 2**. Send notification to OSRL as soon as possible after verbal notification. **Step 3**. Upon completion of the OSRL incident notification form, OSRL will plan and place resources on standby.	Designated call-out authorities (including Incident Commanders)
RPS Group	As soon as possible but within two hours of incident having been identified	Verbal and written	Santos has an agreement in place with RPS Group to allow rapid marine hydrocarbon spill modelling capability to be activated at any time during activities, which will be undertaken for any spill greater than Level 1. AMOSC can also run modelling on behalf of Santos, if required, as part of contracting arrangements with RPS Group	Contact RPS Group Duty Officer.	IMT Environment Unit Leader (or delegate)

Organisation	Indicative timeframe	Type of communication	Resources available	Activation instructions	Santos person responsible for activating
Wild Well Control (WWC)	Within four hours of a loss of well control incident having been identified	Loss of well control only Verbal	Well intervention services; under contract	**Step 1**. Following Santos management confirmation of a loss of well control (LOWC), Relief Well Team Leader is to call the Wild Well Control 24-hour emergency hotline number to notify WWC of the incident. **Step 2**. As soon as practical after initial notification and once the scale of the subsea loss of containment is confirmed, an emergency mobilisation authorisation form (saved in ECM) must be filled out, signed off by the authorised Santos Manger sent through to WWC. The form is located on the Santos Intranet Procedures Index under Emergency Procedures (http://ausintranet.enerylimited.com/dept_data/Procedure_data/index.htm). Email as directed by WWC point of contract provided by the emergency hotline attendant.	Relief Well Team Leader

Table 6-3: Environmental performance – external notification and reporting

Environmental performance outcome	Make notifications and reports within regulatory and defined timeframes.		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
External notifications and reporting plan	**Response preparedness**		
	Santos Incident Response Telephone Directory (SO-00-ZF-00025.020)	Incident Response Telephone Directory is revised every six months	Document revision history
	OPEP communications test	OPEP contact details for regulatory and service provider notifications are checked annually	Test records
	Response implementation		
	External notifications and reporting tables	External notification and reporting undertaken as per **Table 6-1** and **Table 6-2**	Incident log

7 Response strategy selection

An assessment of the applicable oil spill response strategies, priority response locations and a strategic NEBA for each of the Barossa Development activities is included in each activity-specific OPEP Addendum. The Barossa Development OPEP Addendum: Drilling and Completions (BAA-200 0316) provides this information to support the Barossa Development Drilling and Completions Environment Plan (BAD-200-0003).

7.1 Response planning thresholds

In addition to the impact assessment thresholds described in Section 7.5.4 of the Barossa Drilling and Completions EP (BAD-200 0003) response thresholds have been developed for response planning to determine the conditions that response strategies would be effective. These thresholds are provided as a guide for response planning based on case studies that have demonstrated some response strategies (e.g., chemical dispersant application) require certain oil spill thicknesses and conditions to be effective.

For example, containment and recovery effectiveness drops significantly with reduced oil thickness (McKinney and Caplis, 2017; NOAA, 2013). McKinney and Caplis (2017) tested the effectiveness of various oil skimmers at different oil thicknesses. Their results showed that the oil recovery rate of skimmers dropped significantly when oil thickness was less than 50 g/m^2.

Surface chemical dispersants are most effective on hydrocarbons that are at a thickness of 50-100 g/m^2 on the sea surface. EMSA (2010) recommends thin layers of spilled hydrocarbons should not be treated with dispersant. This includes Bonn Agreement Oil Appearance Codes (BAOAC) 1-3 (EMSA, 2010).

Response planning thresholds are provided in **Table 7-1**.

Table 7-1: Surface hydrocarbon thresholds for response planning

Hydrocarbon concentration (g/m^2)	Description
>1	Estimated minimum threshold for commencing some scientific monitoring components (see **Appendix J**)
>50	Estimated minimum floating hydrocarbon threshold for containment and recovery and surface dispersant application *Note: Containment and recovery and surface dispersant application are not applicable spill response strategies under this OPEP.*
>100	Estimated floating hydrocarbon threshold for effective containment and recovery and surface dispersant application Estimated minimum shoreline accumulation threshold for shoreline clean-up *Note: Containment and recovery, surface dispersant application and shoreline clean-up are not applicable spill response strategies under this OPEP.*

8 Incident action planning

The incident action planning process is built on the following phases:

1. Understand the situation.
2. Establish incident priorities, objectives and tasks.
3. Develop a plan (IAP).
4. Prepare and disseminate the plan.
5. Execute, evaluate and revise the plan for the next operational period.

The Santos IMT will use the IAP process to determine and document the appropriate response priorities, objectives, strategies and tasks to guide the incident response which are reviewed and updated as more information becomes available. The IMT will use an IAP for each operational period following the initial first-strike assessments, notifications, and activations undertaken.

When acting as the support agency, Santos may be requested by the control agency to develop, or support the development of, an IAP to help guide the incident response.

The Santos IAP process is built on the phases described in **Figure 8-1**.

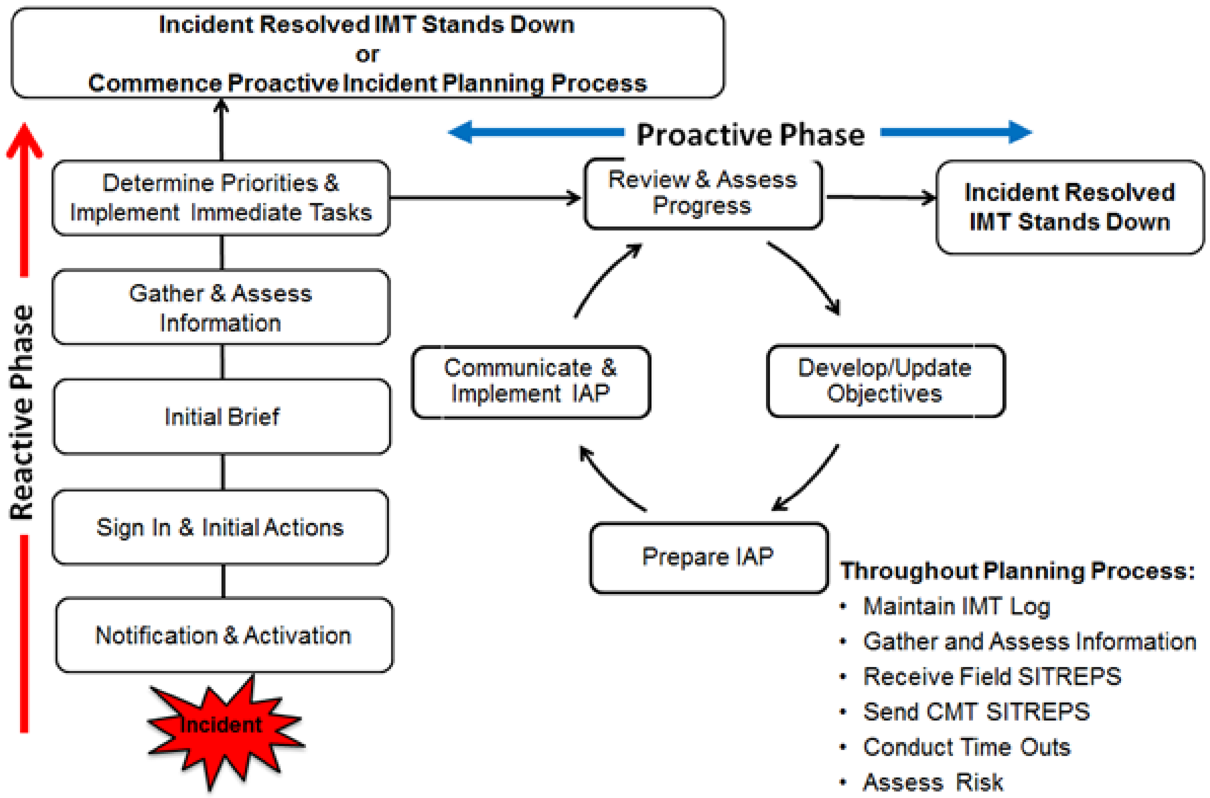


Figure 8-1: Incident action plan process

8.1.1 Reactive phase planning

The initial phase of the incident action planning process can be considered a reactive phase (indicatively lasting up to 48 hours) where information on the incident is being progressively established through reports coming in from the field. During this phase there is no formal incident action plan to follow (given the incident has just begun and details are still being established) however the OPEP (this document) has been prepared to contain all first-strike oil spill response actions required to be followed during this phase in lieu of a formal IAP.

First-strike response actions are summarised in **Section 2** and provide links to relevant oil spill strategy sections within the OPEP which contain a more detailed list of implementation actions and considerations as well as statements of performance (performances standards) that must be followed to ensure the initial response meets regulatory requirements and environmental performance outcomes.

For each credible oil spill scenario covered by this OPEP, the first-strike response actions have been informed by a pre-assessment of applicable oil spill response strategies, priority response locations and a strategic NEBA also referred to as a SIMA. This pre-planning is included in the activity specific OPEP Addendums. During the reactive phase the strategic NEBA is to be reviewed and, using the specific information gathered from the spill, operationalised into an operational NEBA. This assessment helps verify that the response strategies pre-selected for each spill scenario are providing the best environmental outcome for the incident response.

8.1.2 Developing an incident action plan

At the end of the reactive phase where the incident specifics have been determined, a more formal phase of spill response is entered whereby a documented IAP is developed to guide the incident response activities for the next operational period. An operational period is defined as the period scheduled for execution of actions specified in the IAP. The next operational period is nominally a daily period but for long running incidents may be extended further where the pace of the incident response has settled, and the level of new information has decreased.

As IAPs and response strategies are implemented their performance is monitored. The performance measurement results are fed back into the IMT to provide the IMT with greater situational awareness to enable the effective formulation of following IAPs. Those response strategies that are effective are continued or increased, while those strategies that are ineffective are scaled back or ceased.

The performance against the objectives of the IAP must be documented in the Incident log by the IMT. This provides the IMT with information required to assist in formulating the following IAP and provides evidence of Santos' response to the incident for regulatory and legal investigations that will follow the termination of the incident.

IAP performance is monitored through IMT communication with in-field response personnel both verbally and through logs/reports/photos sent throughout the response (e.g., surveillance personnel, team leaders, laboratory chemists) who report on the effectiveness of the response strategies.

IAP forms and processes are documented in the *Incident Command and Management Manual* (SO-00-ZF-00025) and in the 'Emergency Response' folder sets at *L:\Resource\Emergency Response\Incident-Exercise Number-Name*. Begin the response by copying and saving *Incident-Exercise Number-Name* folder set with a unique incident name and Id number on the lead folder; this is the Incident log. Access subfolders to display all forms required to conduct incident action planning. Each functional position within the IMT and CMT has subfolders carrying forms and processes unique to the functional position.

8.1.3 Environmental performance

Table 8-1 lists the environmental performance standards and measurement criteria for incident action planning.

Table 8-1: Environmental performance – incident action planning

Environmental performance outcome	Manage incident via a systematic planning process		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
Incident action planning	**Response preparedness**		
	IMT Exercise and Training Plan	Incident action planning and NEBA is practiced by the IMT during exercises	Exercise records
	Response implementation		
	Incident action plan	Incident action plan is completed for each operational period and approved by the Incident Commander	Incident log Incident action plan/s
		Monitor effectiveness of response strategies being implemented and use information in the development of IAPs	Incident log Incident action plan/s
	NEBA	An operational NEBA will be undertaken for each operational period of the incident	NEBA Incident action plan

9 Source control

The initial and highest priority response to an oil spill incident following the health and safety of onsite personnel is to prevent or limit further loss of hydrocarbons to the environment.

For major hydrocarbon release incidents during Barossa development activities, the MODU Operator’s Emergency Response Plan and the Santos-MODU Operator Emergency Response Bridging Plan outline the initial actions to be taken by onsite personnel to control the source of a hydrocarbon spill and limit the volume released to the environment.

For vessels with a SOPEP, the SOPEP will provide the relevant initial actions to control the source of the spill.

For the ongoing response to a LOWC incident, the Santos Offshore Source Control Planning and Response Guideline (DR-00-ZF-20001) is to be consulted as the overarching source of information for implementing a relief well, Capping Stack and/or subsea dispersant injection response.

The sections below provide an outline of source control activities noting that the MODU Operator’s Emergency Response Plan, Vessel SOPEP and Source Control Planning and Response Guideline (DR-00-0Z-20001), where applicable, will provide a higher level of detail for specific incidents.

9.1 Vessel collision – fuel tank rupture

Table 9-1 provides the environmental performance outcome, initiation criteria and termination criteria for source control response to a fuel tank rupture. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 9-1: Vessel collision – source control environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implementation of source control methods to stop the release of hydrocarbons into the marine environment	
Initiation criteria	Notification of a spill	
Applicable hydrocarbons	**MDO**	**Barossa condensate**
	✓	✗
Termination criteria	Release of oil to the marine environment has ceased and the workplace environment is deemed environmentally safe and free of hydrocarbons	

9.1.1 Implementation guidance

Implementation guidance is summarised in **Table 9-2**. In the event MDO is released from a vessel due to a tank rupture, the relevant vessel specific procedures will be applied. For support vessel collisions, the vessel’s SOPEP will be followed to control the source, reduce the loss of hydrocarbons and prevent escalation of the incident. **Table 9-1** lists the environmental performance standards and measurement criteria for this strategy.

Table 9-2: Implementation guidance – fuel tank rupture

	Action	Consideration	Responsibility	Complete
Initial actions	The vessel's SOPEP, as applicable under MARPOL, or procedure for responding to a ruptured tank will be followed, as applicable.	Notwithstanding vessel specific procedures for source control, the following activities would be evaluated immediately for implementation, providing it is safe to do so: + Reduce the head of fuel by dropping or pumping the tank contents into an empty or slack tank. + Consider pumping water into the leaking tank to create a water cushion to prevent further fuel inventory loss. + If the affected tank is not easily identified, reduce the level of the fuel in the tanks in the vicinity of the suspected area if stability of the vessel will not be compromised. + Evaluate the transfer of fuel to other vessels. + Trim or lighten the vessel to avoid further damage to intact tanks. + Attempt repair and plugging of hole or rupture.	Vessel Master	❑

9.2 Loss of well control

Table 9-3 provides the environmental performance outcome, initiation criteria and termination criteria for controlling the source of a well leak.

Table 9-3: Loss of well control – source environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implementation of source control methods to stop the release of hydrocarbons into the marine environment	
Initiation criteria	LOWC	
Applicable hydrocarbons	**MDO**	**Barossa condensate**
	✗	✓
Termination criteria	The primary well is contained and killed to prevent any further release of hydrocarbon to the environment	

Santos identified the worst-case credible oil spill scenario for assessment as:

+ a subsea LOWC with the release of 800,000 STB (129,000 m^3) of Barossa Condensate (approximately 1,433 m^3/day or 9,015 bbl/day) over 90 days.

9.2.1 Emergency blowout preventer activation

As part of the drilling programme, a blow-out preventer (BOP) stack will be installed onto the wellhead prior to drilling of the reservoir well sections, in accordance with API Standard 53: *Well control equipment systems for drilling wells* (API, 2018). The purpose of a BOP is to provide a secondary barrier to hydrocarbons by providing a mechanical means of shutting in the well if primary well control is lost, and hydrocarbons enter the wellbore.

9.2.1.1.1 Manual activation

If primary well control actions have failed and a loss of well control incident is anticipated, or is occurring, the drilling crew will initiate emergency BOP activation procedures immediately to shut in the well as per the Van Gogh Drilling Campaign Joint Operating Manual (DR-91-MZ-20001).

The BOP choke and kill lines will be closed and the relevant BOP rams will be activated, via the BOP control panel located in the drill shack. There is an additional BOP control panel located on the MODU bridge. Available BOP rams commonly include:

+ **pipe ram:** seals the wellbore by sealing around drill pipe of a specific size
+ **variable-bore ram:** seals the wellbore by sealing around various sizes of drill pipe
+ **blind ram:** seals the wellbore when there is no tubing across the BOP
+ **blind-shear ram:** seals the wellbore by cutting through and displacing drill pipe/ tubing.

One or more of the BOP rams may be activated depending on the status of the well and the severity of the well control incident. Once a BOP ram is closed, a secondary locking mechanism activates which serves to lock the BOP ram in the closed position, even in the event of a subsequent loss of electrical or hydraulic power.

9.2.1.1.2 Automatic activation

In the event of loss of communication between the MODU and the BOP (i.e., the electrical connection between the BOP control panels on the MODU and the BOP on the wellhead is severed or damaged in some way), the BOP is designed to fail-safe close automatically on loss of signal, using stored electrical and hydraulic control power from the BOP battery and accumulators, respectively. In this situation the BOP will seal the well automatically.

9.2.1.1.3 Mobile offshore drilling unit emergency disconnect

In the event of a serious loss of well control incident where the safety of the MODU and crew are threatened, the MODU emergency disconnect system (EDS) will be activated. This will unlatch the MODU riser from the lower marine riser package (LMRP) and activate the BOP rams. The EDS is used as a 'last resort' where all other attempts at well control have been unsuccessful and the safety of the MODU and its crew is threatened to an unacceptable level.

9.2.1.1.4 Failure intervention

In the unlikely event that attempts to activate the BOP from the MODU have failed, and/or the fail-safe close operation of the BOP has malfunctioned, the BOP can be closed via ROV hot-stab intervention. Either the ROV on the MODU or an ROV from a separate support vessel can actuate the BOP in this manner. ROV deployment would commence as soon as practicable from the MODU if safe to do so. If an ROV was to be deployed from a support vessel, the IMT would immediately seek to source an ROV and suitable vessel to mobilise to the field and deploy the intervention ROV as soon as practicable. ROV operations would commence to navigate the ROV to the BOP and activate the BOP rams via a hydraulic hot-stab connection on the BOP side panel. This would serve to add hydraulic pressure to the BOP circuit from either the ROV pumps or an external hydraulic source, to enable manual close of the BOP rams to seal the well.

9.2.2 Subsea first response toolkit

If a subsea LOWC was to occur, the site would require a detailed assessment to determine the most suitable intervention methods for the incident. This may be achieved through the use of remotely operated vehicles (ROVs) (supplied by Santos via existing contractual arrangements) and the AMOSC Subsea First Response Toolkit. The SFRT includes debris clearance equipment, blowout preventer intervention equipment and ancillary tools. The SFRT also includes subsea dispersant equipment including a dedicated dispersant stockpile of Dasic Slickgone NS (500 m³).

In the event of a loss of well control incident, Santos will mobilise the AMOSC SFRT from Fremantle to Darwin for transhipment to a suitable vessel for transport to, and deployment at the incident location. The SFRT and dispersants are located at Oceaneering's facilities at Jandakot. If required, the equipment would be mobilised via road from Jandakot to Darwin. It is estimated this would take 10 hours to arrange and up to 7 days to load and transport to Darwin, depending on the destination and time of year. A suitable vessel would be acquired by Santos during this timeframe and arrive in Darwin (within 9 days of the call out). Once the equipment is loaded, the vessel will mobilise to site and be ready to commence operations by day 11-12 from call out. Specialist personnel to deploy the SFRT will be provided via Santos' contract with Oceaneering and will be available in Darwin within 72 hours (3 days). Vessel specifications are outlined in the Santos Offshore Source Control Planning and Response Guideline (DR-00-ZF-20001).

9.2.3 Relief well drilling

Relief well drilling is the primary source control strategy to control a LOWC (subsea and surface) during Barossa Development activities.

The Santos Source Control Planning and Response Guideline (DR-00-OZ-20001) outlines the overarching process for planning and mobilising personnel and equipment into the field for the purpose of drilling a relief well.

9.2.3.1 Relief well planning

Relief well planning is embedded into the Santos Drilling & Completions Management Process (DCMP). The following industry accepted guidelines have been adopted to assist relief well planning requirements:

+ SPE Calculation of Worst Case Discharge Rev 1, 2016: This is used as part of the prospect screening review to generate a credible rate for oil spill modelling, as well as providing an input for the dynamic kill modelling as part of the Well Specific Source Control Plan.
+ United Kingdom Oil and Gas Relief Well Guidelines, Issue 2, 2013: This methodology is used to confirm a well complexity analysis and tailor required content for the well specific source control plan to the appropriate level of detail.

All wells drilled during Barossa Development activities will have well specific source control plans (SCPs). SCPs will be developed as required for individual wells or as campaign specific SCPs, should a series of similar wells be drilled together or in succession. The SCP is a Santos controlled document and is encompassed in the well operation management plan (WOMP) that relates to the specific drilling activity.

All SCPs must contain relief well planning information, specifically:

+ MODU positioning assessment for relief well drilling locations
+ MODU/key equipment requirements and availability
+ relief well trajectory analysis and casing design
+ dynamic well kill hydraulic simulation results.

These reports are static reports developed before higher-risk campaign-specific activities (drilling activities). While they contain planning that would be relevant to drilling a relief well for an exploration well release (e.g., MODU positioning locations), time-variable information, such as MODU availability, is only assessed for the duration of the campaign.

To ensure Santos has current MODU availability, Santos maintains a register of MODU activity within the region and updates this on a monthly basis. The relief well rig capability register includes information about:

+ rig name
+ rig contract status (Operator and contract duration)
+ current location
+ maximum water depth capability
+ rig type (floating vs jack-up; mooring type; Rig Design/Class)
+ available drilling envelope
+ blowout preventer specifications

- blowout preventer (BOP)/lower marine riser package (LMRP) connector specifications
- mud pumps specifications/capability
- choke and kill line internal diameters
- storage capability (i.e., MDO, base-oil, brine, drill-water, potable water, bulks)
- NOPSEMA safety case (yes/no).

In order to facilitate and expedite the use of regional MODU for relief well drilling an Australian Petroleum Production & Exploration Association (APPEA) Memorandum of Understanding: Mutual Assistance is in place. This agreement provides the mechanism to facilitate the transfer of drilling units and well-site services between operators in Australian and Timor-Leste administered waters in order to respond urgently to emergency source control events.

A Safety Case Revision will be required for the relief well rig to undertake the activity; this cannot be submitted before the event. The Safety Case Revision will be based on existing documents, specifically the Safety Case Revision approved for the drilling of the original well and the Safety Case in force for the relief well rig. A Safety Case Revision would be submitted within 14 days from the well leak, however the critical path time allowed for the actual writing of the document is three days. The remaining estimated time would be used for gathering post-event data, mobilising the workforce and conducting a hazard identification. It is not practicable to reduce the critical path days with additional pre-planning as document revision, final review and approval will still be required after completing the hazard identification.

9.2.3.2 Relief well schedule

An indicative relief well drilling schedule is provided in **Table 9-4**. This is based on control of the well by 13 weeks (90 days). This period is based on indicative mobilisation durations, relief well planning and operations. It could take up to 41 days to have a MODU onsite ready to spud.

Long lead item equipment to enable a relief well to be drilled within this timeframe is currently held in the Santos inventory or has been confirmed to be available at short notice from vendors or other operators in the region.

This timeline has been assessed as ALARP based on the current controls/measures in place; however, Santos is actively working with industry to evaluate measures to improve on the ALARP response time model through the APPEA Drilling Industry Steering Committee Source Control Response Industry (SCRI) Working Group. The SCRI working group is an APPEA Drilling Industry Steering Committee initiative which has been established to drive collaboration and continuous improvement in source control emergency response planning. The Working Group will explore and act on opportunities to align and strengthen the Titleholders' source control emergency response capability through 'mutual aid' initiatives and drive continuous improvement by implementing fit-for-purpose and effective source control emergency response strategies.

Table 9-4: Schedule for mobile offshore drilling unit arriving onsite

LOWC relief well		
Task	**Duration (in days)**	**Controls**
Event reported. Begin sourcing of rig for relief well drilling operations. Concurrently, stand up relief well drilling team and activate relief well specialists.	1	+ On-site communications + Active IMT on call including Operations/Drilling Team Lead + Stood-up relief well drilling team (as per Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001) + Relief Well Drilling specialist services contract (Wild Well Control) + Regional MODU tracking + APPEA MoU: Mutual Assistance
Relief well MODU confirmed. Relief well MODU suspends operations and prepares to mobilise to relief well location. Concurrently, prepare relief well MODU Safety Case Revision and submit to NOPSEMA. Concurrently, prepare relief well design and dynamic kill plan. Prepare relief well WOMP and submit to NOPSEMA.	8	+ Active IMT + Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001) + Pre-completed campaign specific Source Control Plan complete with relief well study + Relief Well Drilling specialist services contract (Wild Well Control) + Regional MODU tracking + APPEA MoU: Mutual Assistance + Pre-verified access to relief well long lead equipment (e.g., casing and wellhead + Drilling services contracted.
Contract relief well MODU. Concurrently, continue preparations for rig mobilisation. Concurrently, NOPSEMA assessment of relief well MODU SCR and relief well WOMP. Mobilise relief well MODU to location.	32	+ Active IMT + Santos Offshore Source Control Planning and Response Guideline (DR-00-OZ-0001) + Relief Well Drilling specialist services contract (Wild Well Control)
Total days before arrival, ready to spud/commence relief well operations	41	
Drill and construct relief well and execute dynamic well kill operations	49	+ Active IMT + Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001) + Relief Well Drilling specialist services contract (Wild Well Control)
Total days from LOWC to well kill	**90**	

9.2.4 Capping stack

A Capping Stack provides a temporary means of sealing the well until a permanent well kill can be performed through either a relief well or well re-entry. It is considered a secondary source control measure.

Capping Stack compatibility varies from well to well and can also depend on the extent of the blowout and water depth. Compatibility will also vary according to technical and safety constraints, and damage to an individual well, which would only be known at the time of the spill and assessed via the SFRT and accompanying ROVs.

The installation of a Capping Stack may be applicable for a subsea loss of well control during Barossa drilling activities using a Semi-submersible Drilling Rig where the BOP is present on the seabed. The use of a Subsea First Response Toolkit (SFRT) (**Section 9.2.2**), together with subsea dispersant application capability (**Section 9.2.5.3** and **9.2.5.4**), may be applicable in assisting the installation of a Capping Stack.

A Capping Stack would only be used where there is suitable vertical access over the wellhead and a suitable restricted flow rate was determined. Santos has contracts in place with Wild Well Control (WWC) and would deploy their Singapore-based Capping Stack as the primary option another Capping Stack is available from Aberdeen). The Singapore-based Capping Stack would be assembled quayside, tested and then transported via barge to a suitable deployment vessel where it would then be transferred, fastened and then commence its transit to the well site. The deployment vessel will require an active heave compensator, capability of lifting 120 Tonne and 500 - 1,000 m^2 of deck space. Additional vessel specifications are outlined in the Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001).

Santos would be responsible for managing the customs and importation issues related to equipment arrival into Australian Waters, obtaining support from WWC. To ensure access to suitable vessels to deploy the Capping Stack to the incident location, during the activity Santos will monitor the availability of Capping Stack capable vessels on a monthly basis through shipbroker reports. This also includes current vessel Safety Case status. In addition, Santos has current contracts with vessels that have similar specifications for various scopes of work with approved Australian Safety Cases. These Safety Cases could be used as a basis of a Safety Case revision if one was required, which could create significant time efficiencies. Santos also has in place a contract with a specialist contractor highly experienced in the Safety Case revision process, to leverage their experience, further reducing the timeframes required to develop a Safety Case revision that meets NOPSEMA's requirements.

The location of these vessels can be tracked through Santos' offshore vessel tracking system accessed via the Santos Emergency Response Intranet page.

9.2.4.1 Capping stack schedule

An indicative Capping Stack schedule is provided in **Table 9-5**. This period is based on indicative mobilisation durations and is subject to weather conditions and availability of specialist personnel.

Table 9-5: Capping stack mobilisation schedule

LOWC Capping Stack timeline		
Task	**Duration (in days)**	**Controls**
Event reported – source suitable deployment vessel (with approved safety case) (Santos) Concurrently deploy Capping Stack components from warehouse to quayside (including assembly and testing) (WWC)	4	+ On-site communications + Active IMT on call including Operations/Drilling Team Lead + Well Contained Logistics Plan + Monthly monitoring of suitable vessels
Capping Stack lifted on to barge, fastened and then tug operations transit to anchored deployment vessel (WWC)	2	+ Active IMT + Santos Offshore Source Control Emergency Response Plan (DR-00-OZ-20001) + Capping Stack specialist services (Wild Well Control) + Well Contained Logistics Plan + Capping Stack Logistics Methodology
Handover of Capping Stack from WWC to Santos (WWC to continue to support via specialist personnel)		
Capping Stack mobilised to incident location by deployment vessel (Santos with support from vessel broker)	9	+ Stood-up Source Control Team (as per Santos Offshore Source Control Planning and Response Guideline (DR-00-0Z-20001) + Capping Stack specialist services contract (Wild Well Control) + Well Contained Logistics Plan
Total days before arrival, ready to commence Capping Stack operations	**15**	
Days to installation of Capping Stack (worst case allowing for potential removal of debris and issues due to damaged wellhead, BOP and/or LMRP)	2 to 28 (estimated)	

9.2.5 Subsea dispersant injection

SSDI has been observed to break-up oil droplets forcing greater entrainment of the oil into the water column below the sea surface (Adams *et al*., 2013). SSDI has additional benefits over surface dispersant application including its ability to reduce volatile organic compounds (VOCs) reaching the surface in the vicinity of a spill, making the area safer for responders (IPIECA, 2015; French-McCay *et al.*, 2021) and enabling them to bring the release under control quicker (e.g., via Capping Stack) and reducing the overall volume of hydrocarbons being released into the environment.

SSDI typically requires smaller volumes of dispersant to be used, as it has a higher encounter rate with the hydrocarbons than surface application. SSDI can also be used day and night, whereas surface application via vessel or aircraft can only occur during daylight hours.

The effectiveness of SSDI is influenced by dispersant efficacy on the hydrocarbon, how close to the release the dispersants may be added and the dispersant to oil ratio (DOR). It is assumed the DOR would commence at 1:100 and would be modified based on the results of the effectiveness monitoring, conducted as part of operational water quality monitoring. Research conducted by Brandvik *et al.* (2014) indicated that DORs of 1:50 to 1:100 may be sufficient to cause substantial additional dispersion, particularly if the dispersant is injected close to or into the release point.

Water depth is a further limitation to the effectiveness of SSDI for VOC control; If SSDI use is proposed primarily for safety reasons, shallower depths may not be sufficient to enable VOCs to be reduced to a point which ensures a safe operating environment on the surface (OSRL, 2017). Some research suggests this may be around 500 metres (Adams & Socolofsky, 2005, in: IPIECA, 2015); however, there is currently no definitive recommended minimum water depth for SSDI use. Water depths in the vicinity of the Barossa development operational area range from 220-280 metres.

Therefore, SSDI may be employed as a secondary response strategy for a Barossa LOWC for the purpose of VOC reduction, subject to the outcome of operational NEBA. The effectiveness of VOC reduction would be closely monitored through air quality monitoring as part of the overall dispersant effectiveness monitoring programme (refer to **Section 9.2.5.2**). If VOC reduction is minimal or ineffective, it is likely that SSDI operations would cease.

9.2.5.1 Dispersant selection process

9.2.5.1.1 Dispersant use

Dispersants should only be used when the risks associated with their use to the environment as a whole have been analysed, and it has been determined that there would be a net environmental benefit from their use. The type of dispersant that will be effective is influenced by the oil type and metocean conditions (Hook and Lee, 2015).

Most of the knowledge on the biological impacts of dispersants has been developed via laboratory experiments (Quigg *et al*., 2021) rather than from in-situ use. This is also the case for those dispersants listed as approved in the National Plan for Maritime Environmental Emergencies Register of Oil Spill Control Agents (OSCA). Before a dispersant can be considered for use by AMSA, its toxicological impact must be tested on a diverse range of aquatic taxa, including algae, invertebrates and fish (Hook and Lee, 2015). However, this screening process ensures that these compounds have comparatively low toxicity (according to US Environmental Protection Agency criteria; Hemmer *et al.*, 2011) and that they are much less toxic than oil (Hook and Lee, 2015).

Of the dispersants listed on the OSCA Register, only Corexit 9500A and 9527 (the latter is only on the transitional acceptance list) have been used in response to a large-scale spill and during subsea application, which was during the Macondo oil spill (Gulf of Mexico) in 2010. Six types of dispersant were used on the Montara oil spill in the Timor Sea in 2009, including Slickgone NS, Corexit 9500, Corexit 9527, Slickgone LTSW, Ardrox 6120 and Tergo R40 (AMSA, 2010). However, the total volumes sprayed equated to 150 m^3 (AMSA, 2010), as opposed to the 7,000 m^3 (4,100 m^3 surface application and 2,900 m^3 subsea application of just Corexit 9500A and 9527) (Quigg *et al*., 2021) used during the Macondo spill.

A detailed oil fate and mass balance assessment completed by French-McCay, *et al*. (2021) on the Macondo spill indicated on average, there was 9% less floating oil during the duration of the release due to subsea dispersant application. This assessment also showed subsea application was increasingly effective over the course of the spill in reducing VOC exposures in the immediate area of the wellhead by up to 27% (French-McCay *et al*., 2021), making source control operations safer for responders.

Despite the considerable amount of research, modelling and experimental work done to study the effects of subsea dispersant application, there is conflicting evidence as to the efficacy of the use of subsea dispersants (Quigg *et al*., 2021). However, NASEM (2020) found no compelling evidence that chemically dispersed oil at low to moderate oil concentrations was any more toxic than oil alone. At high concentrations the combination of oil and dispersant appeared more toxic (Quigg *et al*., 2021), suggesting caution should be applied when considering dispersant application rates and volumes. This also shows the importance of ongoing dispersant effectiveness monitoring (**Section 9.2.5.2**) and its use through the operational NEBA process.

9.2.5.1.2 Dispersant selection

Chemical dispersants listed as approved in the National Plan for Maritime Environmental Emergencies Register of Oil Spill Control Agents (OSCA) are to be prioritised for use. OSCA listed dispersants are readily available to Santos through AMOSC, OSRL and AMSA. These include Slickgone NS, Slickgone EW, Corexit EC9500A, Corexit 9527 (transitional acceptance) and Finasol 52.

If dispersant types additional to those on the Register of OSCA are required, Santos will use its Offshore Division Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) before application. Finasol OSR 52 has been pre- assessed as low risk using the Santos Offshore Division Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) and is therefore designated as acceptable for use.

The Santos Offshore Division Operations Chemical Selection, Evaluation and Approval Procedure requires the dispersant to be risk assessed and deemed environmentally acceptable. The criteria used for environmental acceptability includes aquatic toxicity, biodegradation and bioaccumulation potential data.

Where sufficient data is available, the chemical is risk assessed using the Offshore Chemical Notification Scheme (OCNS) Chemical Hazard and Risk Management (CHARM) or non-CHARM models depending on the model's applicability criteria. Chemicals that meet the selection criteria belonging to CHARM Colour-band Gold or Silver, or non-CHARM groups D or E are considered environmentally acceptable. According to the OCNS CHARM model, Gold ranked chemicals have a maximum Hazard Quotient (HQ) of <1 and Silver, HQ ≥1 and <30. According to the OCNS non-CHARM model guidelines, the worst case initial OCNS grouping would be group B based on aquatic toxicity data of LC50 or EC50 > 1 to 10 ppm. To obtain a final OCNS grouping of D, the chemical would need to be readily biodegradable (>60% biodegradation in 28 days) and non-bioaccumulative (Log Pow <3 or BCF ≤100 and molecular weight ≥700). The best case initial OCNS grouping would be group E based on aquatic toxicity data of LC50/EC50 > 1,000 ppm. The best case final OCNS grouping would remain E with the chemical readily biodegradable and non-bioaccumulative.

If the chemical cannot be rated using the method described above, it would be assigned a pseudo OCNS CHARM or non-CHARM group ranking. Where there is insufficient ecotoxicity data available to either rate the chemical or assign a pseudo ranking, robust justification demonstrating its environmental acceptability shall be provided, based on volume/concentration, receiving marine environment characteristics and ecotoxicity data (aquatic toxicity, biodegradability and/or bioaccumulation data where applicable; i.e., biodegradation and bioaccumulation potential are not applicable to inorganic substances).

During a response, chemical dispersant shall be tested on the released oil at a laboratory as part of the initial oil characterisation (refer **Section 10.6**) as well as through field testing using vessel-based spray systems/ dispersant shake test kits.

9.2.5.2 Dispersant effectiveness monitoring

To assess the effectiveness of dispersant application, Santos will use the SMART monitoring protocol (NOAA, 2006) to measure the efficacy of surface dispersants and the Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020) to determine the efficacy of subsea dispersant application. These techniques assist in characterising the nature and extent of subsea or near surface dispersed oil, aid in the validation and accuracy of plume trajectory models and allow for rapid quantification of data to enable the IMT to make decisions about continuation of dispersant application. The IMT assesses the effectiveness of continued dispersant use against an operational NEBA assessment.

The SMART protocol for surface dispersants allows for the acquisition of more robust data using fluorometry. This protocol includes the following tiers (which may be conducted at the same time):

+ **Tier I – Visual monitoring** requires the use of trained or experienced personnel to conduct visual monitoring of dispersant efficacy after a dispersant has been applied to the spill *in-situ*. This monitoring is usually performed after the shake jar test. If the shake jar test shows the dispersant to be effective, then a 'test spray' is performed and observed using this protocol, before full-scale deployment of dispersant spraying occurs. Tier I gives rapid (but qualitative) results and is used as the initial monitoring method until additional resources and equipment are deployed to conduct Tier II and III monitoring. It should be noted that visual monitoring does not provide any details on particle sizes (required to understand the stability of the suspension) nor does it indicate the overall loadings of oils into the water column (an indicator of both efficacy and the likelihood of toxic impacts). Visual observations may be taken by vessel and/or aircraft and will be used to assess whether dispersant application is successful in dispersing hydrocarbons. The effectiveness of the aerial based chemical dispersion strategy is communicated to the IMT Operations Section Chief via the Air-Attack Supervisor. Initial dispersant use decision making for surface application (Day 1 – Day 4) will be supported using these visual monitoring techniques and thereafter on-water monitoring techniques.
+ **Tiers II and III – On-water monitoring** requires the use of trained or experienced personnel to conduct on-water monitoring using CTD meter, fluorometer and water quality samples (collected as per operational water quality monitoring (**Section 10.7**)).

Subsea dispersant injection monitoring includes the following phases:

+ **Phase 1:** Confirmation of dispersant effectiveness near the discharge point and reduction in surface VOCs. This is conducted visually via ROVs and aerial imaging; and via VOC monitoring.
+ **Phase 2:** Characterisation of oil droplet size near plume and dispersed oil concentrations at depth in the water column. This is conducted using a particle size analyser close to the release site and water column monitoring (as per operational water quality monitoring (**Section 10.7**)).
+ **Phase 3:** Detailed chemical characterisation of water samples. This involves characterisation of collected water samples using accredited contract laboratories. The transfer and shipping would be handled using the logistical pathways utilised for operational water quality monitoring (**Section 10.7**).

For a Barossa subsea LOWC, SSDI application is considered a secondary strategy to surface dispersant application (refer to Section 4 of Barossa Development OPEP Addendum: Drilling and Completions (BAA-200-0316)) and is primarily included to reduce VOC exposure to response personnel working close to the well site. It is anticipated that operations in close proximity to the well site would only occur for deployment of the Capping Stack. Capping Stack deployment is only relevant to the situation where a semi-submersible MODU is used. If Capping Stack deployment is selected as a response strategy, SSDI would only be deployed for the length of time taken to deploy the Capping Stack to reduce VOC levels during these operations. SSDI would also only be considered where VOC levels in the vicinity of the wellsite are shown through monitoring to be unacceptable.

Prior to any application of subsea dispersants, an initial ROV survey would be conducted at the release point to determine the nature of the release. This information will inform the potential for Capping Stack deployment, the applicability of subsea chemical dispersion and initial choice of dispersant injection methods (e.g., number of nozzles, nozzle sizes) and DOR. In addition, as per Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020), subsea dispersant effectiveness monitoring should commence prior to the application of any dispersant, to ensure baseline data is captured.

9.2.5.3 Subsea dispersant injection logistics

If a subsea LOWC was to occur, the site would require a detailed assessment to determine the most suitable intervention methods for the incident. This may be achieved through the use of ROVs (supplied by Santos) and the Subsea First Response Toolkit (see **Section 9.2.2**), which is stationed in Fremantle and Jandakot and managed by AMOSC. The SFRT includes debris clearance equipment and subsea dispersant equipment, including a dedicated dispersant stockpile (500 m^3 of Dasic Slickgone NS) and ancillary equipment[9] (e.g., pumps, flying leads, dispersant wands). Santos can access a suitable vessel for transportation of the subsea dispersant injection system, dispersants and ancillary equipment including ROVs through its contracted vessel providers. As indicated in **Section 9.2.2**, the SFRT vessel and equipment would be infield and commencing operations by day 12.

The volumes of dispersant required will depend on the DOR used at the injection point. It has been assumed that the well release would require a DOR of 1:100. To achieve a DOR of 1:100 that IPIECA-IOGP (2015a) recommend for a flow rate of 20,000 bbl./day, a dispersant pump rate of 22 L/min is required. Scaling this dispersant application rate to align with the maximum credible flow rate for the Barossa subsea LOWC scenario (1,433 m^3/day or 9,015 bbl/day) results in a dispersant pump rate of 9.9 L/min (14.2 m^3/day).

A dispersant budget has been prepared considering the daily / weekly application requirements, daily volume of dispersant arriving in Darwin and balance on hand after each day. The total amount of dispersant required for subsea application is 1,121.8 m^3, noting application does not commence until day 12.

9.2.5.4 Dispersant supply

Supply stocks sufficient to cover dispersant requirements for the duration of the LOWC are presented in

[9] Coiled tubing will not be required due to the shallow water depths

Table 9-6. Santos has a detailed dispersant supply and logistics plan that ensures dispersant requirements can be met for the duration of the worst case LOWC scenario. Dispersant stockpiles are made available via AMOSC membership or AMSA MoU with most supplies within Australia being available within 48 to 55 hours. Santos can supply all required road logistics to meet these timeframes through its contracted logistics provider. Santos can also provide air logistics for all other stockpiles throughout Australia and internationally.

Dispersant availability is checked bi-annually against Santos' worst-case requirements across all operational, project and drilling activities.

Table 9-6:Dispersant supply stock locations and volumes (July 2021) (AMSA, 2021)

Source	Stock location	Volume (m^3)	Type	Total volume (m^3)
AMSA	Adelaide	10	Slick Gone EW	355
		10	Slick Gone NS	
	Brisbane	10	Slick Gone EW	
		10	Slick Gone NS	
	Townsville	10	Slick Gone EW	
		15	Slick Gone NS	
	Karratha	10	Slick Gone EW	
		10	Slick Gone NS	
	Darwin	10	Slick Gone EW	
		10	Slick Gone NS	
	Devonport	10	Slick Gone EW	
		10	Slick Gone NS	
	Fremantle	48	Slick Gone NS	
		52	Slick Gone EW	
	Horne Island	10	Slick Gone NS	
	Melbourne	10	Slick Gone EW	
		10	Slick Gone NS	
	Sydney	45	Slick Gone NS	
		55	Slick Gone EW	
AMOSC	Exmouth	75	Slick Gone NS	747
	Fremantle	8	Slick Gone NS	
		27	Corexit 9500	
		500 (SFRT stockpile)	Slick Gone NS	
	Geelong	75	Slick Gone NS	
		62	Corexit 9500	
OSRL (Santos has access up to 50% of SLA stockpile)	Various (Singapore, UK, Bahrain, USA)	779 (50% = 389)	Slick Gone NS Slick Gone EW Slickgone LTSW Finasol OSR 52 Corexit 9500 Corexit 9527	389
Total				**1,491**

Source	Stock location	Volume (m^3)	Type	Total volume (m^3)
OSRL Global Dispersant Stockpile (GDS)	Various (Singapore, UK, France, South Africa, USA, Brazil)	5,000	Slick Gone NS Finasol OSR 52 Corexit 9500	5,000
Total (including additional OSRL 50% SLA and GDS stocks)				**6,491**

9.3 Source control implementation guidance

Relief well drilling is the primary source control strategy to control a LOWC (subsea and surface) during Barossa Development activities. The installation of a subsea Capping Stack is considered a secondary strategy for a subsea release (see **Section 4** Barossa Development OPEP Addendum: Drilling and Completions (BAA-200 0316)).

The Source Control Planning and Response Guideline (DR-00-OZ-20001) outlines the overarching process for planning and mobilising personnel and equipment into the field for all source control methods.

A high-level summary of source control Implementation actions is provided in **Table 9-7**.

Table 9-7: Implementation guidance – loss of well control

	Action	Responsibility	Complete
Initial actions	**Relief well**		
	Implement the Source Control Planning and Response Guideline (DR-00-OZ-20001).	Relief Well Team Leader	❑
	Notify Santos Drilling and Completions Team to assemble a Source Control Team and immediately begin preparations.	Relief Well Team Leader	❑
	Notify well control service provider personnel for mobilisation.	Relief Well Team Leader and Source Control Branch Director	❑
	Source MODU through nearby drilling operations if available or procure from nearest operator through mutual aid agreement MoU.	Source Control Branch Director	❑
	Refine, as necessary, the relief well pre-planning work described in **Section 9.2.2**, and have prepared in time to procure equipment and personnel before MODU arrival on location.	Source Control Branch Director	❑
	Assess relief well equipment and personnel requirements. Procure and make ready.	Logistics Section Chief	❑
	Deploy equipment and personnel to site to begin spud and drill.	Relief Well Team Leader	❑
	SFRT		
	Activate Subsea First Response Toolkit (SFRT) equipment. Activate Oceaneering personnel for deployment.	Designated call-out authority (Incident Commander) Source Control Branch Director	❑
	Contract suitable vessel capable of deploying SFRT equipment and dispersant.	Logistics Section Chief Source Control Branch Director	❑
	Arrange road transport of SFRT equipment and dispersant from Jandakot to Darwin.	Logistics Section Chief Source Control Branch Director	❑
	Arrange equipment to be loaded on to vessel once in Darwin and authorise transit to field.	Logistics Section Chief Operations Section Chief Source Control Team Leader	❑

Santos

Action		Responsibility	Complete
	Conduct initial ROV survey at the release point to determine the nature of the release, behaviour of the oil, and estimate the oil and gas flow rates.	Operations Section Chief Source Control Branch Director	❑
	Capping Stack		
	Consider technical and safety constraints and assess the suitability of a Capping Stack for the incident.	Source Control Branch Director	❑
	Implement the Source Control Planning and Response Guideline (DR-00-OZ-20001).	Source Control Branch Director	❑
	Notify Santos Drilling and Completions Team to assemble a Source Control Team and immediately begin preparations.	Source Control Branch Director	❑
	Notify Capping Stack service provider of incident for activation of personnel and equipment as per the Source Control Planning and Response Guideline (DR-00-OZ-20001).	Source Control Branch Director	❑
	Contract suitable vessel capable of deploying Capping Stack via freight contractor.	Logistics Section Chief Source Control Branch Director	❑
	SSDI		
	Confirm operational NEBA supports subsea chemical dispersant injection.	Operations Section Chief Incident Commander Environment Unit Leader Planning Section Chief	❑
	Conduct initial ROV survey at the release point to determine the nature of the release, behaviour of the oil, estimate the oil and gas flow rates and determine DOR for injection.	Operations Section Chief Source Control Team Leader	❑
	Commence dispersant subsea injection adjusting DOR based on real-time monitoring.	Operations Section Chief Source Control Team Leader	❑
	Continue operational monitoring (including operational water quality monitoring and surveillance) near the release point to help determine dispersant effectiveness.	Source Control Branch Director Operations Section Chief	❑

Action		Responsibility	Complete
	If dispersant application is shown to be effective and approved by the Incident Commander, continue operations.	Source Control Branch Director Operations Section Chief Incident Commander	❑
Ongoing actions	**Relief well**		
	Design relief well, using relief well pre-planning work, as applicable, and have prepared in time to procure equipment and personnel before MODU arrival on location.	Source Control Branch Director	❑
	Assess relief well equipment and personnel requirements. Procure and make ready.	Logistics Section Chief	❑
	Deploy equipment and personnel to site to begin spud and drill.	Relief Well Team Leader	❑
	Monitor progress of relief well drilling and communicate to IMT.	Relief Well Team Leader	❑
	Capping Stack		
	Deploy equipment and personnel to site to begin capping process.	Source Control Team Leader	❑
	SSDI		
	Reassess dispersant use, utilising the NEBA process for each operational period.	Planning Section Chief Environment Unit Leader	❑

Table 9-8: Subsea dispersant injection – first strike response timeline

Task	Time from IMT call-out
IMT Source Control Team activated	<24 hours
Suitable SFRT-dispersant injection vessel/s mobilised to Darwin	<9 days
Oceaneering to mobilise personnel to Darwin	<9 days
AMOSC to mobilise SFRT and dedicated dispersant to Darwin	<7 days
Load equipment, steam to site and commence SSDI	<12 days
Minimum Resource Requirements	
+ Suitable vessel and crew + SFRT + Dispersant (with SFRT) + Oceaneering personnel	

9.4 Environmental performance

Table 9-9 indicates the environmental performance outcomes, controls and performance standards for the Source Control response strategy.

Table 9-9: Environmental performance – source control

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
Response Preparedness			
Source control – relief well drilling	Santos Source Control Planning and Response Guideline (DR-00-OZ-20001)	Relief well drilling controls the well by 77 days. In order to facilitate this schedule, the Santos Source Control Planning and Response Guideline (DR-00-OZ-20001) is in place and up to date during the activity	Santos Source Control Planning and Response Guideline (DR-00-OZ-20001)
	MODU Capability Register	A MODU Capability Register is maintained during the activity	MODU Capability Register
	Contract and Equipment Access Agreement with WWC	Contract and Equipment Access Agreement with WWC are maintained providing technical support and equipment	Contract with WWC
	Arrangements for source control emergency response personnel	Arrangements for access to source control personnel are maintained during the activity	Contract/ Memorandums of Understanding for source control personnel

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
Source control – BOP Activation	BOP Unit	BOP rams pressure/function tested on deployment and then at regular intervals throughout the drilling programme.	BOP rams function test records
		BOP battery and accumulators function tested prior to deployment.	BOP battery and accumulators function test records
	EDS	EDS function tested prior to deployment.	EDS function test records
	ROV hot-stab capability	Access to ROV capability for BOP hot-stab intervention maintained with MODU ROV contractor throughout the drilling programme.	ROV contractual arrangements
Source control - SFRT	Arrangements to enable access to SFRT equipment and personnel	Maintenance of access to SFRT equipment and personnel	AMOSC SFRT participating member
			OTA Agreement with Oceaneering
	Arrangements in place to monitor availability of vessels capable of transporting SFRT	Vessel availability shall be monitored regularly via Santos' contracted vessel broker	Shipbroker reports
	Maintenance of MSAs with multiple vessel providers	Santos maintains MSAs with multiple vessel providers	MSAs with multiple vessel providers
Source control-Capping Stack	Arrangements to enable access to Capping Stack and trained personnel	Maintenance of access to Capping Stack and personnel	Contract with Capping Stack service provider
	Arrangements in place to monitor availability of vessels capable of transporting Capping Stack	Vessel availability shall be monitored regularly via Santos' contracted vessel broker	Shipbroker reports
	Arrangements to enable timely mobilisation of Capping Stack	Capping Stack mobilised to site and ready to commence deployment by day 15	Capping Stack mobilisation schedule (**Table 9-5**)
	Maintenance of MSAs with multiple vessel providers	Santos maintains MSAs with multiple vessel providers	MSAs with multiple vessel providers
Source control – SSDI	Arrangements to enable access to dispersants, equipment and personnel	Maintenance of access to dispersant, equipment and personnel through AMOSC,	MoU for access to National Plan resources through AMSA

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
		AMSA and OSRL throughout activity	AMOSC Participating Member Contract
			AMOSC SFRT Participant
			OTA Agreement with Oceaneering
			OSRL Associate Member Contract and Global Dispersant Supply Supplementary Agreement
	Arrangements in place to monitor availability of vessels capable of transporting SFRT	Vessel availability shall be monitored regularly via Santos' contracted vessel broker	Shipbroker reports
	Maintenance of MSAs with multiple vessel providers	Santos maintains MSAs with multiple vessel providers	MSAs with multiple vessel providers
Source control - vessel collision	Vessel Spill Response Plan (SOPEP/SMPEP)	Support vessels have a SOPEP or shipboard marine pollution emergency plan (SMPEP) that outlines steps taken to combat spills	Audit records Inspection records
		Spill exercises on support vessels are conducted as per the vessels SOPEP or SMPEP	Spill exercise closeout reports
Response Implementation			
Source control – relief well drilling	Drilling and Completions Source Control Team	Drilling and Completions Source Control Team mobilised within 24 hours of the well release	Incident log
	Equipment/Services for Relief Well drilling	Equipment/Services for Relief Well drilling sourced within five days of the well release	Incident log
	Well Control Specialists	Well control specialists mobilised within 72 hours of the well release	Incident log

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
	Relief Well MODU	MODU for relief well drilling to be onsite by Day 41 from the start of a well release.	Incident log
	Relief Well	Relief well completed within 90 days of well leak incident	Incident log
	Source Control Planning and Response Guideline (DR-00-OZ-20001)	Relief well drilling implemented in accordance with the Source Control Planning and Response Guideline (DR-00-OZ-20001) during a well release	Incident log
Source control - SFRT	Access to suitable SFRT vessel	Vessel mobilised to Darwin within 9 days of IMT call-out	Incident Log
	Access to personnel for the deployment of the SFRT	Oceaneering to mobilise personnel to Darwin within 9 days of IMT call-out	Incident Log
Source control- Capping Stack	Access to Capping Stack and suitable vessel	Capping Stack to be onsite and ready to commence deployment by day 15 from the start of the release	Incident Log
	Access to trained personnel for the deployment and operation of the Capping Stack and well intervention equipment	Capping Stack trained personnel mobilised to site within 15 days	Incident Log
Source control - SSDI	Mobilisation of SFRT and dedicated dispersant resource requirements for subsea dispersant application	SFRT and dedicated dispersant stockpile mobilised to site within 11 to 12 days	Incident log
	Chemical Dispersant Application Plan	Only chemical dispersants that are listed as approved on the National Plan Oil Spill Control Agent (OSCA) list or evaluated as acceptable as per the Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) are to be used	Incident Log

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
		If dispersant application is approved by the Incident Commander, request OSRL to initiate dispersant manufacture in week 1 to ensure a build-up of supply	Incident Log
		Analysis of dispersant amenability provided to IMT within 24 hours of oil delivery to Laboratory	Incident Log
		If amenable to surface dispersants, and required oil volume can be collected, oil and dispersant samples to be sent immediately for laboratory ecotoxicity testing of oil and chemically dispersed oil	Incident Log
		If dispersant application is approved by the Incident Commander for subsea injection, ROV monitoring of the site will commence to help determine injection method/s	Incident Log IAP

Environmental Performance Outcome	Implementation of source control methods response strategies to stop the release of hydrocarbons into the marine/onshore environment and to reduce impacts to environmental receptors.		
Response Strategy	**Control Measures**	**Performance Standards**	**Measurement Criteria**
		Prepare operational NEBA to determine if chemical dispersant application is likely to result in a net environmental benefit. NEBA will consider: + forecast spill modelling of oil comparing simulations with and without effect of chemical dispersants + laboratory dispersant efficacy testing results + operational monitoring results (surveillance and shoreline assessment) showing distribution of floating, stranded oil and location of sensitive fauna and habitats + operational water quality monitoring results showing distribution and concentration of subsea oil (once available) + scientific monitoring water sampling results (SMP1) (once available) + consultation with DoT	Incident Log IAP
		NEBA undertaken each operational period by the relevant Control Agency to determine if response strategy is continuing to have a net environmental benefit. NEBA included in development of following period Incident Action Plan	IAP Incident Log
Source control - vessel collision	As per the vessel SOPEP	Actions to control spill associated with a vessel incident followed in accordance with SOPEP	Vessel logs

10 Monitor and evaluate

Understanding the behaviour and likely trajectory of an oil spill is critical to evaluate the appropriate response strategy. There are a number of methods that can be used to monitor and evaluate, including:

+ vessel surveillance
+ aerial surveillance
+ tracking buoys
+ oil spill trajectory modelling
+ satellite imagery
+ initial oil characterisation
+ operational water quality monitoring.

10.1 Vessel surveillance

Table 10-1 Table 10-1provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-1: Vessel surveillance – environmental performance outcome, initiation and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making	
Initiation criteria	Notification of a Level 2/3 spill - may be deployed in a Level-1 incident (to be determined by OSC)	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Vessel-based surveillance is undertaken at scheduled intervals during daylight hours and continues for 24 hours after the source is under control and a surface sheen is no longer observable, OR + NEBA is no longer being achieved, OR + Agreement is reached with Jurisdictional Authorities to terminate the response	

Direct observations from field support or other vessels can be used to assess the location and visible extent of the hydrocarbon incidents, and to verify modelling predictions and trajectories. Due to the proximity of observers to the water's surface, vessel surveillance is limited in its coverage in comparison to aerial surveillance and may also be compromised in rough sea state conditions or where fresh hydrocarbons at surface poses safety risks.

10.1.1 Implementation guidance

Table 10-2 provides guidance to the IMT on the actions and responsibilities to be considered when selecting this strategy. **Table 10-3** has a list of resources that may be used to implement this strategy. Mobilisation times for the minimum resources that are required to start initial vessel surveillance operations are listed in **Table 10-4**. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-2: Implementation guidance – vessel surveillance

	Action	Consideration	Responsibility	Complete
Initial actions	Notify nearest available Support Vessel to commence surveillance.	Current Santos on hire vessels or Vessels of Opportunity (VOO) can be used. Automatic Identification System (AIS) vessel tracking is available through Emergency Response (ER) intranet page.	On-Scene Commander Operations Section Chief	❑
	Source additional contracted vessels if required for assistance.		Logistics Section Chief	❑
	Record surface slick location and extent, weather conditions, and marine fauna. Complete vessel surveillance forms, located in **Appendix E** and provide to On-Scene Commander (Level 1 spills) or IMT (Level 2/3 spills).	Photographic images are to be taken where possible and included with surveillance forms. Trained observers will not be available immediately – photos and locations will provide initial information that can be interpreted by IMT.	Vessel Observers	❑
	Relay surveillance information (spill location, weather conditions, marine fauna sightings and visual appearance of the slick) to the IMT within 60 minutes of completing vessel surveillance.	Initial reports to the IMT may be verbal (followed by written transmission) if the vessel is out of range or has no facilities for transmitting forms.	Vessel Master and/or On-Scene Commander	❑
Ongoing actions	Review surveillance information to validate spill fate and trajectory.		Planning Section Chief/GIS	❑
	Use available data to conduct operational NEBA and confirm that pre-identified response options are appropriate.		Environment Unit Leader	❑
	Use monitor and evaluate data to periodically reassess the spill and modify the response (through the IAP), as required.	Surveillance data is useful in updating the Common Operating Picture.	Planning Section Chief	❑

Table 10-3: Vessel surveillance resource capability

Equipment type/ personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Contracted vessels and vessels of opportunity	Santos Contracted Vessel Providers. Vessels of opportunity identified through AIS Vessel Tracking.	Availability dependent upon Santos and Vessel Contractor activities.	Vessels mobilised from Darwin. Locations verified through AIS Vessel Tracking Software.	Pending availability and location. Expected within 12 hours.

Table 10-4: Vessel surveillance – first-strike response timeline

Task		Time from IMT call-out
IMT begins sourcing Santos-contracted vessel or VOO for on-water surveillance		<90 minutes
VOO onsite for surveillance		<48 hours (daylight dependent)
Minimum resource requirements		
One vessel. No specific vessel or crew requirements.		
Approximate steam time		
Deployment location	Approximate distance to operational area[10] (nautical miles)	Approximate steam time[11] (hours)
Darwin	200	20
Broome	750	75

10.2 Aerial surveillance

Table 10-5 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-5: Aerial surveillance – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Notification of a Level 2/3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Aerial surveillance undertaken at scheduled intervals during daylight hours and continues for 24 hours after the source is under control and a surface sheen is no longer observable, OR + As directed by the relevant Control Agency	

Aerial surveillance is used to record the presence and size of the hydrocarbon spill at surface as well as other environmental observations including weather conditions, marine fauna and sensitive receptors in the area. Aerial surveillance provides superior coverage over vessel surveillance for estimating the spatial extent of a spill but is generally required only for larger Level 2/3 spills.

10.2.1 Implementation guidance

Table 10-6 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy. **Table 10-7** provides a list of resources that may be used to implement this strategy.

---

[10] As measured to geometric centre point of operational area

[11] At average rate of 10 knots

Mobilisation times for the minimum resources that are required to commence initial aerial surveillance operations are listed in **Table 10-8**. The On-Scene Commander and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-6: Implementation guidance – aerial surveillance

Action		Consideration	Responsibility	Complete
Initial actions	Contact contracted aviation provider- provide details of incident and request mobilisation to spill site for initial surveillance.	If aviation asset is available near spill location, utilise where possible to gather as much information about the spill. If aviation asset not available at spill location IMT is to seek available resources through existing contractual arrangements. It is possible that the initial surveillance flight will not include a trained aerial surveillance observer. Initial flights can be conducted using a standard crew and initial surveillance should not be delayed waiting for trained personnel. Ensure all safety requirements are met before deployment. There should be an attempt to obtain the following data during initial surveillance: + name of observer, date, time, aircraft type, speed and altitude of aircraft + location of slick or plume (global positioning system [GPS] positions, if possible) + spill source + size of the spill, including approximate length and width of the slick or plume + visual appearance of the slick (e.g., colour) + edge description (clear or blurred) + general description (windrows, patches etc.) + wildlife, habitat or other sensitive receptors observed + basic met-ocean conditions (e.g., sea state, wind, current) + photographic/video images.	Operations Section Chief Logistics Section Chief	❑

Action		Consideration	Responsibility	Complete
	Source available Santos Aerial Observers, arrange accommodation/logistics and deploy to Forward Operations/Air base location.	Santos Aerial Observer list available from First-strike Resources on Santos Offshore ER Intranet page.	Operations Section Chief Logistics Section Chief	❑
	Develop flight plan (frequency and flight path) to meet IMT expectations and considering other aviation ops. Expected that two overpasses per day of the spill area are completed.	Flight plan to confirm with OSC that aircraft are permitted in the vicinity of the spill. Flights are only to occur during daylight and in weather conditions that do not pose significant safety risks.	Operations Section Chief/ Aviation Superintendent	❑
	Pre-flight briefing.		Aerial Observers Contracted aircraft provider/pilots	❑
	Aerial Observers to commence surveillance	Consider procedure for interacting with marine fauna.	Operations Section Chief	❑
	Determine spill extent by completing Aerial Surveillance Log (**Appendix F**) and Aerial Surveillance Surface Slick Monitoring Template. Calculate volume of oil (**Appendix G**). Take still and/or video images of the slick.	Thickness estimates are to be based on the Bonn Agreement Oil Appearance Code.	Aerial Observer	❑
	Record presence and type of fauna by completing the Aerial Surveillance Marine Fauna Sighting Record Sheet (**Appendix H**).		Aerial Observer	❑
	Relay all surveillance records: logs, forms, photographic images, video footage to the IMT.	Where possible, a verbal report via radio/telephone en-route providing relevant information should be considered if the aircraft has long transits from the spill location to base.	Aerial Observer Planning Section Chief Operations Section Chief	❑

Santos

Action		Consideration	Responsibility	Complete
Ongoing actions	Update flight schedule for ongoing aerial surveillance as part of broader Aviation Subplan of IAP	Frequency of flights should consider information needs of IMT to help maintain the Common Operating Picture and determine ongoing response operations.	Operations Section Chief/ Aviation Superintendent Planning Section Chief	❑
	Mobilise additional aircraft and trained observers to the spill location to undertake ongoing surveillance activities		Logistics Team Leader	❑
	Update Common Operating Picture with surveillance information and provide updates to spill trajectory modelling provider.		Planning Section Chief GIS Team Leader	❑

Table 10-7: Aerial surveillance resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Rotary Wing Aircraft & flight Crew	Santos contracted provider/s (primary provider currently Babcock)	Two contracted (one primary + one back-up) + additional as required	Darwin Karratha Learmonth Onslow	Wheels up within 1 hour for Emergency Response. Spill surveillance <10 hours (daylight dependent)
Aerial Surveillance Crew	Santos aerial observers AMOSC Industry Mutual aid	7 x Santos staff 7 x AMOSC staff AMOSC Core Group personnel available Additional trained industry mutual aid personnel	Perth and Varanus Island (VI) (Santos aerial observers) Australia wide	Santos trained personnel - next day mobilisation to airbase <24 hours
Drones and pilots ** secondary response to assist vessel-based surveillance	AMOSC OSRL – Third-Party UAV provider Local WA hire companies	2 x pilots 2 x qualified remote pilots, however response is on best endeavour 10+	Geelong Perth Perth and regional WA	<48 hours OSRL – depending on the port of departure, one to two days if within Australia

Table 10-8: Aerial surveillance – first-strike response timeline

<table>
<tr><th colspan="2">Task</th><th>Time from IMT call-out</th></tr>
<tr><td colspan="2">Aircraft activated for aerial surveillance</td><td><3 hours</td></tr>
<tr><td colspan="2">Aircraft onsite for aerial surveillance</td><td><10 hours (daylight dependent)</td></tr>
<tr><td colspan="2">Trained Aerial Observers mobilised to airbase (Darwin)</td><td><24 hours (daylight dependent)</td></tr>
<tr><th colspan="3">Minimum resource requirements</th></tr>
<tr><td colspan="3">+ Santos contracted helicopter and pilots (based in Darwin)
+ Santos trained Aerial Observers</td></tr>
<tr><th colspan="3">Approximate flight time</th></tr>
<tr><td>Airport</td><td>Approximate distance[12] (nm)</td><td>Approximate flight time[13] (hours: minutes)</td></tr>
<tr><td>Darwin</td><td>180</td><td>1:30</td></tr>
<tr><td>Broome</td><td>700</td><td>6:00</td></tr>
</table>

[12] As measured to geometric centre point of operational area

[13] At average flight speed of 120 knots

10.3 Tracking buoys

Table 10-9 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-9: Tracking buoys – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making	
Initiation criteria	Notification of a Level 2 or 3 spill May be deployed for a Level 1 spill if deemed beneficial by the OSC	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Tracking buoy deployment will continue for 24 hours after the source is under control and a surface sheen is no longer observable, OR + As directed by the relevant Control Agency	

10.3.1 Implementation guidance

Table 10-10 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy.

Table 10-11 provides a list of resources that may be used to implement this strategy. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-10: Implementation guidance – tracking buoys

	Action	Consideration	Responsibility	Complete
Initial actions	Deploy two tracking buoys at leading edge of slick.	Note deployment details and weather conditions in incident log.	Vessel Master	❑
	Inform IMT that tracking buoys have been deployed and provide deployment details. Monitor movement of tracking buoys.	Refer login details of tracking buoy monitoring website on Santos ER intranet site.	OSC Planning Section Chief/GIS	❑
	Use tracking buoy data to maintain Common Operating Picture.	Data tracked online.	IMT Planning Section Chief/ GIS	❑
	Relay information to spill fate modelling supplier for calibration of trajectory modelling.		IMT Planning Section Chief/ GIS	❑
Ongoing actions	Assess the need for additional tracking buoys in the spill scenario and identify/nominate preferred deployment locations.	Incident Action Plan to provide guidance regarding any additional deployments of tracking buoys.	Planning Section Chief	❑
	Mobilise additional tracking buoys if required from other Santos operations (Santos presently has 12 Tracker Buoys located on the North West Shelf) or from AMOSC stockpiles.		Logistics Section Chief	❑
	Direct the deployment of the Tracker Buoys – for continuous releases over multiple days use a rolling deployment/collection of buoys to provide better coverage of plume direction.		Operations Section Chief	❑
	Deploy tracking buoys.		Vessel Master	❑
	Monitor movement of tracking buoys.		Planning Section Chief/GIS	❑
	Relay information to spill trajectory modelling supplier for calibration of trajectory modelling.		Planning Section Chief/GIS	❑

Table 10-11: Tracking buoys resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Tracking buoys	Santos	2	MODU	MODU buoys – <2 hours for incident
		2	Darwin	Darwin – 20 hours to site pending vessel availability
		10	VI, Dampier	VI/Dampier buoys – 48-72 hours
AMOSC tracking buoys	AMOSC	4	Fremantle	Response via duty officer within 15 minutes of first call- AMOSC personnel available within 1 hour of initial activation call. Equipment logistics varies according to stockpile location (see **Table 10-12**)
		2	Geelong	

Table 10-12: Australian Marine Oil Spill Centre equipment mobilisation timeframes

	Perth	Darwin
Geelong	40 hrs 3,395 km	44 hr 3,730 km
Perth	NA	48 hrs 4,040 km
Exmouth	15 hrs 1,250 km	38 hrs 3,170 km
Broome	27 hrs 2,240 km	22 hrs 1,870 km

Table 10-13: Tracking buoy – first-strike response timeline

Task	Time from IMT call-out
Tracking buoys deployed from MODU	<2 hours
OR	
Tracking buoys deployed from Darwin	24 hours to site pending vessel availability
Minimum Resource Requirements	
+ Two tracking buoys for initial deployment	

10.4 Oil spill trajectory modelling

Table 10-14 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-14: Oil spill trajectory modelling – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Notification of a Level 2 or 3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Spill fate modelling will continue for 24 hours after the source is under control and a surface sheen is no longer observable, or until no longer beneficial to predict spill trajectory and concentrations, OR + As directed by the relevant Control Agency	

Oil spill trajectory modelling uses computer modelling (e.g., OILMAP, SIMAP) to estimate the movement, fate and weathering potential of spills. Santos has engaged RPS Group to provide forecast spill fate modelling. RPS Group use SIMAP and OILMAP modelling systems that comply with Australian Standards (ASTM Standard F2067 'Standard Practice for Development and Use of Oil Spill Models'). RPS Group also provide the capacity for forecast air quality monitoring to enable an assessment of potential health and safety risks associated with VOCs released from a surface slick.

A particular advantage of spill trajectory modelling is that the transport and weathering of spilled hydrocarbons can be forecast, at all times of the day and night, at any location, and under any type of metocean conditions. By contrast, aerial surveillance and vessel-based monitoring will be constrained to day-time use, and have limits imposed by the operating environment. Aerial surveillance and vessel-based monitoring are, however, essential for model validation, verification and calibration of any modelling or first principle predictions.'

10.4.1 Implementation guidance

Table 10-15 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy.

Table 10-16 provides a list of resources that may be used to implement this strategy. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-15: Implementation guidance – oil spill trajectory modelling

Action		Consideration	Responsibility	Complete
Initial actions	Initiate oil spill trajectory modelling (OSTM) by submission of an oil spill trajectory modelling request form (Santos Procedure Index). Request for three-day forecast trajectory modelling.		Environment Unit Leader	❑
	Determine requirement for gas/VOC modelling and request initiation.	Hydrocarbon releases have human health and safety considerations for responders (volatile gases and organic compounds). This to be considered for any tactics that monitor/recover oil – especially at close proximity to release site.	Safety Officer Environment Unit Leader	❑
	Operational surveillance data (aerial, vessel, tracker buoys) to be given to modelling provider to verify and adjust fate predictions of the spill and improve predictive accuracy.		Planning Section Chief/GIS	❑
	Login to the RPS Group data sharing website and maintain connection. Download modelling results.	Data should be stored digitally and backed up on to independent digital storage media. All datasets should be accompanied by a metadata summary and documented quality assurance and control procedures.	Planning Section Chief/GIS	❑
	Place RPS Group modelling data into GIS/Common Operating Picture.	RPS Group to provide at least daily updates to the IMT of trajectory model outputs to inform response planning. More frequent updates can be provided if weather conditions are highly variable or change suddenly.	Planning Section Chief/GIS	❑
	Identify location and sensitivities at risk based on the trajectory modelling and inform IMT. Conduct operational NEBA on proposed response strategies.		Environment Unit Leader	❑

Action		Consideration	Responsibility	Complete
Ongoing actions	Request spill trajectory modelling be provided daily throughout the duration of the response and integrate data into Common Operating Picture.		Planning Section Chief/GIS	❑
	Use results from other monitor and evaluate activities, and/or data derived from hydrocarbon assays of the source hydrocarbon or from other reservoirs in the region (that may be available) as input data (if or when available) to improve model accuracy.		Planning Section Chief / GIS	❑

Table 10-16: Oil spill trajectory modelling resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
RPS OST modellers and software	RPS under direct contract to Santos, also available through AMOSC	Daily OSTM reports	Perth – digital	2-4 hours from activation

Table 10-17: Oil spill trajectory modelling – first-strike response timeline

Task	Time from IMT call-out
RPS OSTM activated by IMT	<2 hours
OSTM provided to IMT	<4 hours
Minimum Resource Requirements	
+ Contracted OST modellers and software + OSTM Activation Form	

10.5 Satellite imagery

Table 10-18 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-18: Satellite imagery – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Notification of a Level 2 or 3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Satellite monitoring will continue until no further benefit is achieved from continuing; or as advised by relevant Control Agency.	

Satellite imagery is considered a supplementary source of information that can improve awareness but is not critical to the response and usage is at the discretion of the IMT.

Suitable imagery may be available via satellite imagery suppliers. This can be done through existing AMOSC and OSRL contracts. The most appropriate images for purchase will be based on the extent and location of the oil spill. Synthetic aperture radar and visible imagery may both be of value.

10.5.1 Implementation guidance

Table 10-19 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy. **Table 10-20** provides a list of resources that may be used to implement this strategy. The Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-19: Satellite imagery implementation guide

	Action	Consideration	Responsibility	Complete
Initial actions	Assess requirement for satellite imagery.		Planning Section Chief	☐
Initial actions	Notify AMOSC and OSRL Duty Officer to initiate request for available satellite imagery.	Formal written activation of resources from AMOSC and OSRL by designated call-out authorities (Santos Duty Managers/Incident Commanders) is required.	Planning Section Chief	☐
Initial actions	Assess suitability and order imagery.		Planning Section Chief	☐
Initial actions	Integrate satellite imagery into Common Operating Picture and provide to trajectory modelling provider for model validation.		GIS Team Leader Planning Section Chief	☐
Ongoing actions	Review surveillance information to validate spill fate and trajectory.		Planning Section Chief	☐
Ongoing actions	Use monitor and evaluate data to periodically reassess the spill and modify the response (through the IAP), as required.	Use surveillance data when updating the Common Operating Picture.	Planning Section Chief	☐

Table 10-20: Satellite imagery resource capability

Equipment type/ personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Satellite Imagery	KSAT – activated through AMOSC MDA – activated through OSRL	Dependent upon overpass frequency (TBC on activation)	Digital	AMOSC: one hour if satellite images available OSRL: Within 4 hours of satellite image acquisition (i.e., latest pass with no cloud)

10.6 Initial oil characterisation

Table 10-21 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-21: Initial oil characterisation – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Notification of a Level 2 or 3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Oil sample and analysis to terminate once enough data has been collected to profile the oil characteristics and dispersant amenability throughout weathering and to provide oil for toxicity testing, OR + As directed by the relevant control agency	

10.6.1 Overview

Given MDO is a common fuel type with known properties and Barossa Condensate is a hydrocarbon that has been previously assayed, the general physical and chemical characteristics of these hydrocarbons are known and have been presented in **Appendix A**. Nevertheless, sampling and analysis of the released hydrocarbon will provide the most accurate information on the hydrocarbon properties at the time of release.

The composition and physical properties of the hydrocarbon will also evolve over time through weathering processes that change its composition and properties, such as the viscosity, density, water content and pour point. The rate of change of the hydrocarbon properties will affect the likely time-window of opportunities 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.

10.6.2 Implementation guidance

Table 10-22 provides guidance to the IMT on the actions and responsibilities for this strategy. **Table 10-23** provides a list of resources that may be used to implement this tactic. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

10.6.3 Oil sampling and analysis

Laboratory analysis

Using onsite VOOs, oil samples are to be taken daily where possible from fresh oil, and from the weathered oil locations, nominally representing 24 hours old, 48 hours old and 72 hours old (as they occur) and dispatched to the laboratory for analysis.

Laboratory analysis of the chemical and physical properties of the recovered oil, including gas chromatography/mass spectrometry for the purpose of fingerprinting the oil constituents, is to be undertaken. Fingerprinting of the released hydrocarbon potentially allows contamination to be traced back to the source where this is otherwise unclear or in dispute.

Ecotoxicology assessment of the oil is to be conducted at an ecotoxicology laboratory following the revised Australian and New Zealand Water Quality Guidelines. The quantity of oil required for analysis will be confirmed by the laboratory but is expected to be in the order of 6 to 10 L of oil. Testing results will provide the concentrations at which toxicity endpoints consistent with revised Australian and New Zealand Water Quality Guidelines are met for each test. Overall species protection concentrations, including 90%, 95% and 99% species protection trigger levels are then to be generated using a species sensitivity distribution fitted to the data (e.g., by using the Burrlioz software program).

Table 10-22: Implementation guidance – initial oil characterisation

	Action	Consideration	Responsibility	Complete
Initial actions	Source available vessels (on hire or VOO) for oil sampling.	Can be multi-tasked – e.g., for vessel surveillance or tracking buoy deployment.	Operations Section Chief Logistics Section Chief	❑
	Source sampling equipment. Confirm sampling methodology. Confirm laboratory for sample analysis. Develop health and safety requirements/controls.	Refer **Table 10-23** for resource availability. Appendix A and D of CSIRO oil spill monitoring handbook provide suitable procedure.	Environment Unit Leader Safety Officer	❑
	Vessel directed to sampling location.	Sampling of oil at thickest part of slick – typically leading edge.	Operations Section Chief	❑
	Vessel crew to undertake sampling and delivery of samples to Darwin for dispatch to laboratory. Environment Unit Leader to confirm analysis of oil with lab.	Logistics personnel to assist with logistics of sending oil samples to laboratory for analysis.	Operations Section Chief Environment Unit Leader Logistics Section Chief	❑
Ongoing actions	Continue sample collection post release where oil is available.	Initial monitoring by crew of available vessels – Once mobilised to site Santos scientific monitoring provider to continue sampling of oil in conjunction with operational water quality monitoring.	Operations Section Chief Environment Unit Leader Logistics Section Chief	❑

Table 10-23: Initial oil characterisation – resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Oil sampling kits	Santos	1	Darwin	Within 48 hours
Bulk oil sampling bottles	Intertek/Santos	As required	Perth	Within 48 hours
Santos Contracted Vessel Providers Vessels of Opportunity identified through AIS vessel tracking system	Availability dependent upon Santos and Vessel Contractor activities	Availability dependent upon Santos and Vessel Contractor activities	Pending availability and location. Expected within 24 hours	Santos contracted vessel providers Vessels of Opportunity identified through AIS Vessel Tracking
National Association of Testing Authorities (NATA) accredited laboratory/ personnel for analysis	Intertek	NA	Perth	24+ hours

Table 10-24: Initial oil characterisation – first-strike response timeline

Task	Time from IMT call-out
Oil sample collection	<48 hours (daylight dependent)
Oil samples arrive at lab for analysis	<5 days
Minimum resource requirements	
+ One vessel; no special requirements; oil sampling can be done concurrently with other tasks + One oil sampling kit + Sampling jars for bulk oil collection	

10.7 Operational water quality monitoring

10.7.1 Operational water sampling and analysis

Table 10-25 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 10-25: Operational water quality sampling and analysis – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Notification of a Level 2 or 3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Operational water sampling and analysis will continue for 24 hours following control of the source provided oil is no longer detectable, OR + As directed by the relevant Control Agency, OR + Vessel surveillance will terminate if there are unacceptable safety risks associated with volatile hydrocarbons at the sea surface.	

Operational sampling of oil and oil in water will be undertaken at discrete locations, providing visual observations, real time fluorometry/ dissolved oxygen readings and providing oil and water samples for laboratory analysis. The intent of this sampling is to confirm the distribution and concentration of oil, validating spill trajectory modelling and providing and informing the selection and implementation of other response strategies, including scientific monitoring.

Table 10-26 presents the water quality sampling and analysis plan considerations.

This monitoring is complementary to scientific water quality monitoring (SMP1) delivered through the Oil Spill SMP in terms of methodology and required skillset and can be provided through Santos' Scientific Monitoring Provider (**Section 14**).

10.7.2 Implementation guidance

See

Table 10-27 for the operational water quality sampling and analysis implementation guide. The Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned. **Table 10-34** lists the environmental performance standards and measurement criteria for this strategy.

Table 10-26: Operational water quality sampling and analysis plan considerations

Considerations for operational water quality sampling and analysis	
Scope of work	The work scope for operational water quality monitoring will be driven by the IMT, confirming objectives for each operational period.
Survey design	The operational water sampling activities will be conducted by experienced environmental scientists and managed through the IMT Incident Action Planning process. The exact nature of the sampling activities will depend upon the objectives for each operational period; however, the sampling design and methodology will consider the following points: + Sampling locations will be moved with the slick and/or plume based on the observed or predicted location and movement of oil on water and subsea plumes. This will be informed by vessel/aerial surveillance, satellite tracking buoys and spill fate modelling. + At each discrete location, sampling will initially be conducted using a conductivity-temperature-depth (CTD) meter along a depth profile which captures the three-dimensional distribution of the oil. The CTD would require fluorometry and dissolved oxygen sensors as part of the sensor package to record the presence of oil (fluorometry) and the activity of hydrocarbon degrading bacteria (dissolved oxygen). Fluorometers appropriate to the hydrocarbon type will need to be selected. + The CTD would help inform the depth at which water samples would be taken; and in the case of incidents where dispersants are approved for use, may inform the water sampling locations for Special Monitoring of Applied Response Technologies (SMART) Protocol and subsea dispersant efficacy monitoring (using API (2020) Technical Report 1152) methods. + For a subsea release or where surface oil is present in shallow water (<5 m) sampling should involve a depth profile from the seabed to surface waters. Profiles should ensure that the full gradient of oil in water concentration can be determined. + Oil and oil in water samples are to be collected using suitable pumping or sampling apparatus. For samples at depth a Niskin bottle or similar device that allows remote closing and discrete sampling at depth is to be used. Alternatively, water samples can be pumped from defined depths using a hose suspended vertically using a suitable pump for water sampling (e.g., a peristaltic pump). + Samples are to be collected in clean, fully labelled glass jars, filled to the top and refrigerated/ kept cool and in darkness during storage and transport. Handling, storage and documentation requirements to be confirmed with laboratory but holding time <7 days is expected requirement. + Oil and oil in water samples will be replicated at each site to allow intra-site variability to be assessed and appropriate quality assurance and control samples incorporated into replicates. + Santos will coordinate transportation of samples from the sampling location to the laboratory. Samples will be accompanied with a completed Chain of Custody form. + Water samples also to be provided to an independent National Association of Testing Authorities-accredited laboratory in Perth for hydrocarbon suite analysis including polycyclic aromatic hydrocarbons.

Considerations for operational water quality sampling and analysis	
Analysis and reporting	+ All data collected on oil properties provided in spreadsheets (including GPS location, depth of sampling, timing, on water observations, in-situ readings and water sample label details) to IMT on an ongoing basis during spill response operations. + Daily field reports of results provided to the IMT. + Analytical analysis of oil properties following laboratory evaluation. + Final report detailing all data collected on oil properties throughout the monitoring program including relevant interpretation.

Table 10-27: Implementation guidance – operational water quality sampling and analysis

	Action	Consideration	Responsibility	Complete
Initial actions	Activate Santos Monitoring Service Provider for Operational Water Quality Monitoring.		Environment Unit Leader	❑
	Obtain spill trajectory modelling and provide to Monitoring Service Provider.		Environment Unit Leader Planning Section Chief GIS Support	❑
	Develop Monitoring Action Plan (Including Sampling and Analysis Plan) for operational water quality monitoring. Plan to also consider oil characterisation sampling (**Section 10.6**)– Monitoring Service Provider to take over this sampling once mobilised.	Sites to be selected using oil spill trajectory modelling and distribution of oil from surveillance tactics. Refer **Table 10-26** for considerations for Sampling and Analysis Plan.	Monitoring Service Provider Environment Unit Leader	❑
	Develop health and safety plan including potential exposure to volatile gases/VOCs.	Refer Santos Oil Spill Response HSE Management Manual (SO-91-RF-10016).	Monitoring Service Provider Safety Officer	❑
	Monitoring Service Provider to assemble team/s and water quality monitoring equipment.		Monitoring Service Provider	❑
	Organise Vessels, accommodation and transport requirements to mobilise monitoring team/s to site.	Monitoring Service provider to outline requirements in resource request form.	Logistics Section Chief	❑
	Sampling and analysis undertaken. Daily communication and confirmation of sampling plan with OSC and IMT. Daily activity/data reports provided to IMT. Oil/water samples dispatched to nominated laboratories for analysis.		Monitoring Service Provider On-Scene Commander Operations Section Chief Environment Unit Leader Logistics Section Chief	❑
Ongoing actions	Monitoring results to be conveyed to IMT through Common Operating Picture and provided to spill trajectory modeller to validate predictions.		Planning Section Chief GIS Support Environment Unit Leader	❑

Table 10-28: Operational water quality sampling and analysis – resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Water quality monitoring personnel	Monitoring Service Provider (currently Astron/BMT)	Approx. 15 (based on capability reports)	Perth based	Personnel and equipment within 72 hours from approval of work scope – pending vessel availability
Water quality sampling equipment and water quality meters	Third-party suppliers via Monitoring Service Provider (currently Astron/BMT)	Multiple providers	Australia based	
Contracted water quality monitoring vessels	Santos Contracted Vessel Providers	Availability dependent upon Santos and Vessel Contractor activities; suitable vessels identified through AIS Vessel Tracking	Locations verified through AIS Vessel Tracking Software	<72 hours

Table 10-29: Operational water quality sampling and analysis – first-strike response timeline

Task	Time from IMT call-out
IMT activates monitoring service provider.	<4 hours
Operational water quality monitoring personnel, equipment and vessel deployed to spill site.	<120 hours
Minimum resource requirements	
+ Water quality monitoring vessel/s – refer Santos Offshore ER Intranet for vessel specification. + Water quality monitoring team (through monitoring service provider). + Water quality monitoring equipment (through monitoring service provider).	

10.7.3 Continuous fluorometry surveys

Table 10-30 provides the environmental performance outcome, initiation criteria, termination criteria and other key aspects for this strategy.

Table 10-30: Continuous fluorometry surveys – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision -making	
Initiation criteria	Level 2/3 spill	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ Continuous fluorometry surveys will continue for 24 hours following control of the source provided oil is no longer detectable, OR + As directed by the relevant Control Agency.	

In addition to operational water sampling and sensor deployment at discrete locations, a continuous fluorometry survey(s) may be run across the expected slick/plume extent, as well as vertically through the water column. This allows a far greater area of coverage than discrete sampling, aiding in the mapping of entrained and dissolved oil movement.

Sub surface gliders containing fluorometers built into the body of the glider may be used for this monitoring and would be preferential for monitoring a continuous subsea release (subsea LOWC from all locations). This will allow continuous monitoring of entrained oil covering a large area and will provide near real-time three-dimensional data on the distribution of entrained oil to enable decision making within the IMT. Similarly, other sources of monitoring data (e.g., spill fate modelling) can be used in near real-time to inform the path of the sub surface glider. Sub surface gliders are particularly suited to subsea releases where oil may be distributed below surface layers.

Fluorometers towed behind vessels will be used as an alternative or complementary approach for a subsea release and would be preferred for surface spills and to monitor the effect of dispersant application at surface.

10.7.4 Implementation guidance

Table 10-31 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy. **Table 10-32** provides a summary of resources that may be used to implement this strategy. Table 10-33 details the minimum first-strike requirements to be mobilised on activation. The Incident Commander is ultimately responsible for the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 10-34 lists the environmental performance standards and measurement criteria for this strategy.

Table 10-31: Continuous fluorometry surveys – implementation guidance

Action		Consideration	Responsibility	Complete
Initial actions	Activate Monitoring Service Provider and engage to provide fluorometry services (personnel and equipment) as part of Operational Water Sampling and Analysis – refer **Table 10-27** for actions.		Monitoring Service Provider Environment Unit Leader	❑
	Activate OSRL monitoring and determine availability of subsea gliders and towed fluorometry equipment.	OSRL can provide specialist technical advice on operation of towed fluorometers. Consider: Engaging OSRL for review and input into monitoring action plan for towed fluorometry.	Incident Commander Environment Unit Leader	❑
	Determine suitability of subsea gliders for monitoring.	Sub surface gliders containing fluorometers built into the body of the glider may be used for this monitoring and would be preferential for monitoring a continuous subsea release (well leak scenario).	Environment Unit Leader	❑
	If gliders and pilot/s available and suitable for incident, engage provider to develop Monitoring Action Plan.	Arrange joint meeting with spill modelling provider and OSRL/glider operator to develop monitoring design and ongoing data transfer protocols to meet objective of model validation.	Environment Unit Leader	❑
	Source vessels and other logistics to support monitoring.		Logistics Section Chief Operations Section Chief	❑
	Conduct monitoring as per monitoring action plan with deployment area guided by other operational monitoring studies and dispersant application areas.	The scope of monitoring will be dictated by the response strategies being employed. Where dispersants application is being undertaken fluorometry surveys will have to be coordinated with application activities so subsea oil distribution can be assessed before and after dispersant addition in order to determine effectiveness. Appendix F of CSIRO oil spill monitoring handbook provide standard operating procedures for monitoring dispersant effectiveness using fluorometry equipment.	Operations Section Chief Planning Section Chief Environment Unit Leader	❑

Action		Consideration	Responsibility	Complete
Ongoing actions	Provide daily data reports and spatial outputs IMT.		Monitoring Provider	❑
	Monitoring results to be incorporated into Common Operating Picture.		Planning Section Chief GIS Support	❑

Table 10-32: Continuous fluorometry surveys – resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Towed fluorometers	OSRL	Towed Fluorometers: 6 Turner C3 fluorometers globally	3 in Southampton, 2 in Singapore and 1 in Fort Lauderdale	<72 hours
Glider mounted fluorometers	Monitoring Service Provider (currently Astron/BMT)	Subsea glider: Qty subject to availability from OSRL contractor – one engineer from OSRL contractor to deploy and operate the Glider	Gliders based in Australia (Perth, Sydney, Brisbane) OSRL towed fluorometers out of Singapore, Southampton and Fort Lauderdale	<120 hours dependent upon availability
Vertical particle size analyser – Sequoia LISST 100x	Monitoring Service Provider (currently Astron/BMT)	1	Perth	<72 hours
Water quality monitoring personnel to operate towed fluorometers	Monitoring Service Provider (currently Astron/BMT)	Approx. 15 (based on capability reports)	Perth based	<72 hours
Glider (remote) pilot/s and deployment crew	Third-party provider via OSRL	Subsea glider: Qty subject to availability from OSRL contractor – one engineer from OSRL contractor to deploy and operate the glider	Perth based pilot and deployment crew	<72 hours dependent upon availability

Table 10-33: Operational water quality sampling and analysis – first-strike response timeline

Task	Time from IMT call-out
IMT activates OSRL and Monitoring Service Provider.	<4 hours
Monitoring Service Provider water quality monitoring personnel deployed to site.	<120 hours
Towed fluorometers deployed to site.	<120 hours
Glider and pilot/s and deployment crew deployed (if gliders available and appropriate).	<120 hours (if gliders available and appropriate)
Minimum resource requirements	
+ Water quality monitoring vessel/s – refer Santos Offshore ER Intranet for vessel specification. + Water quality monitoring team (through monitoring service provider). + OSRL towed fluorometer (Turner C3). + Particle size analyser	

10.8 Environmental performance

Table 10-34: Environmental performance – monitor and evaluate

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
	Response preparedness		
Monitor and Evaluate – vessel and aerial surveillance	Maintenance of Master Services Agreements (MSAs) with multiple vessel providers	Santos maintains MSAs with multiple vessel providers	MSAs with multiple vessel providers
	MSA with aircraft supplier	MSA in place with helicopter provider throughout activity	MSA with aircraft suppliers
	Santos trained Aerial Observers	Santos maintains a pool of trained aerial observers	Exercise Records Training Records
	AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	Maintenance of AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	AMOSC Participating Member Contract
	Aircraft charter companies for fauna observations	Maintain a list of aircraft charter companies that could potentially provide fauna observation services	List of providers
	Response implementation		
Monitor and Evaluate – vessel and aerial surveillance	Vessel surveillance	Resource requirements mobilised in accordance with **Table 10-4** and **Section 10.1**Table 10-4	Incident log
		Daily observation reports submitted to IMT until termination criteria is met	Incident log
	Vessels and aircraft compliant with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003)	Vessels comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which includes controls for minimising the risk of collision with marine fauna	Vessel contractor procedures align with Santos's Protected Marine Fauna Interaction and Sighting Procedure

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
		Aircraft comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which includes controls for minimising interaction with marine fauna	Aircraft contractor procedures align with Santos' Protected Marine Fauna Interaction and Sighting Procedure
	Aerial surveillance	Resource requirements mobilised in accordance with **Table 10-8** and **Section 10.2**	Incident log
		Following initiation two passes per day of spill area by observation aircraft provided	Incident log; Incident Action Plan
		Trained Aerial Observers supplied from Day 2 of response	Incident log
		Flight schedules are maintained throughout response	Incident Action Plan
		Observers completed aerial surveillance observer log following completion of flight	Aerial Observer Logs
Monitor and Evaluate – tracking buoys	**Response preparedness**		
	Tracking buoys available	Maintenance of 2 tracker buoys throughout the activity	Computer tracking software Tracker buoy tests
Monitor and Evaluate – tracking buoys	**Response implementation**		
	Tracking buoy mobilisation	Minimum requirements mobilised in accordance with **Table 10-11**	Incident log

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
	Response preparedness		
Monitor and Evaluate – oil spill modelling	Maintenance of contract for emergency response modelling	Maintenance of contract for forecast spill trajectory modelling services throughout activity	Modelling services contract
	Response implementation		
Monitor and Evaluate – oil spill modelling	Oil spill modelling	Oil Spill Modelling provider will be contacted immediately (within two hours) upon notification of a Level 2 or 3 spill	Incident log
		Modelling delivered to IMT within two hours of request to service provider	Incident log
	Response preparedness		
Monitor and Evaluate – satellite imagery	Satellite imagery	Maintain membership with AMOSC and OSRL to enable access and analysis of satellite imagery	Membership contracts with AMOSC and OSRL
	Response implementation		
Monitor and Evaluate – satellite imagery	Satellite imagery	Data incorporated into Common Operating Picture and provided to spill modelling provider	Incident log; Incident Action Plan
	Response preparedness		
Monitor and Evaluate – oil characterisation and operational water quality monitoring	Maintenance of Monitoring Service Provider contract for water quality monitoring services	Maintain access to specialist monitoring personnel and equipment by maintaining contract with Monitoring Service Provider throughout activity	Contract with monitoring service provider
	Capability reports from Monitoring Service Provider	Obtain monthly capability reports from Monitoring Service Provider	Capability reports
	Entrained oil monitoring equipment and services	Maintenance of arrangements to enable access to fluorometry services throughout activity	Arrangement with provider of fluorometry equipment

Environmental performance outcome	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision-making		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
	Water quality monitoring vessels	Maintenance of vessel specification for Water quality monitoring vessels	Vessel specification
	Oil and water quality monitoring equipment	Oil sampling kit pre-positioned at Darwin	Evidence of deployment to site
Monitor and Evaluate – oil characterisation and operational water quality monitoring	**Response implementation**		
	Initial Oil Characterisation	Minimum requirements mobilised in accordance with **Table 10-24**	Incident log
		Oil samples sent to laboratory for initial fingerprinting	Incident log
		Oil samples to be sent immediately for laboratory ecotoxicity testing of oil	Incident log
		90, 95 and 99% Species protection triggers levels will be derived from ecotoxicity testing results (minimum five species' tests) within 24 hours of receiving all results	Ecotoxicity report from environmental contractor
	Operational oil and oil in water monitoring	IMT activates monitoring service provider within four hours	Incident log
		Operational water quality sampling and analysis surveys mobilised within 120 hours of approval	Incident log
		Fluorometry surveys mobilised within five days of initiation	Incident log
		Daily report including fluorometry results provided to IMT	Incident log

11 Mechanical dispersion

Table 11-1 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 11-1: Mechanical dispersion – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	To create mixing for oil and water to enhance natural dispersion	
Initiation criteria	Operational monitoring identifies thin oil patches at sea surface that are not naturally dissipating in sea surface and is posing risks to wildlife and shorelines by remaining on the surface	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ There is no longer a noticeable reduction of surface oil resulting from the activity, or + NEBA is no longer being achieved, or + Unacceptable safety risks associated with gas and VOCs at the sea surface, or + Agreement is reached with Jurisdictional Authorities to terminate the response	

11.1 Overview

This response strategy assists with the natural dispersion process; creating mixing through physical agitation by using a vessel's propellers and wake, which encourages the oil to break into smaller particle sizes that are more easily biodegraded. The two common activities associated with mechanical dispersion are:

+ manoeuvring a vessel through the slick, using propeller wash and vessel wake to create mixing in the water body
+ spraying water from the fire hose of a vessel and moving the vessel through the water body to create additional mixing and breakup of the slick.

11.2 Implementation guidance

Table 11-2 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy.

Table 11-3 provides a list of resources that may be used to implement this strategy. The OSC and/or Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Santos

Table 11-2: Implementation guidance – mechanical dispersion

	Action	Consideration	Responsibility	Complete
Initial actions	The operational NEBA will confirm the suitability and environmental benefit of conducting mechanical dispersion at appropriate locations.	Water depth, sea state, possible impacts to sensitive shorelines and/or wildlife before spill naturally disperses. This activity is to be conducted during daylight hours only and once the safety plan has been developed.	Operations Section Chief Environment Team Lead Planning Section Chief	❑
	Safety team lead to develop a safety plan for the activity with respect to potentially dangerous gasses and VOCs (including applicable controls).		Operations Section Chief Safety Officer	❑
	Notify vessel-based responders to trial mechanical dispersion.		Operations Section Chief	❑
	Response personnel on vessels to evaluate the effectiveness of the use of mechanical dispersion operations to reduce the volume of oil on the water surface. Communicate the information to the IMT Operations Section Chief for inclusion in operational NEBA.		Vessel Master/s Santos AMOSC Core Group Responders	❑

Table 11-3: Mechanical dispersion resource capability

Equipment type/personnel required	Organisation	Quantity available	Location	Mobilisation timeframe
Vessels undertaking other activities	Santos contracted vessel providers	Availability dependent upon Santos and Vessel Contractor activities.	Vessels mobilised from Darwin. Locations verified through AIS Vessel Tracking Software.	Pending availability and location.

11.3 Environmental performance

Table 11-4 indicates the environmental performance outcomes, controls and performance standards for this response strategy.

Table 11-4: Environmental performance – mechanical dispersion

Environmental performance outcome	To create mixing for oil and water to enhance natural dispersion		
Response strategy	**Control measures**	**Performance standard**	**Measurement criteria**
Mechanical dispersion	**Response preparedness**		
	Mechanical Dispersion Plan Safety Plan Operational NEBA	Mechanical dispersion is to be conducted during daylight only, once the safety plan has been developed and operational NEBA confirms suitability and environmental benefit	Incident log IAP

12 Oiled wildlife

Note: the NT IMT and WA DoT are the Control Agencies, and the Department of Environment, Parks and Water Security (DEPWS) and WA Department of Biodiversity, Conservation and Attractions (DBCA) are the Jurisdictional Authorities for oiled wildlife response within NT and WA State waters, respectively. Santos and AMSA are the Control Agencies for oiled wildlife response within Commonwealth waters from facility and vessel spills respectively.

Table 12-1 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 12-1: Oiled wildlife response – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement tactics in accordance with relevant Santos / State/ Territory Oiled Wildlife Response Plans (OWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanise wildlife
Initiation criteria	Operational monitoring shows that wildlife are contacted or are predicted to be contacted by a spill
Termination criteria	+ Oiling of wildlife have not been observed over a 48-hour period, and + Oiled wildlife have been successfully rehabilitated, and + Agreement is reached with Jurisdictional Authorities and stakeholders to terminate the incident response

12.1 Overview

The short-term effects of hydrocarbons on wildlife may be direct such as the external impacts from coating or internal effects from ingestion and inhalation. Oiled wildlife response (OWR) includes wildlife surveillance/reconnaissance, wildlife hazing, pre-emptive capture and the capture, cleaning, treatment, and rehabilitation of animals that have been oiled. In addition, it includes the collection, post-mortem examination, and disposal of deceased animals that have succumbed to the effects of oiling.

Long-term effects of a spill on wildlife may be associated with loss/degradation of habitat, impacts to food sources, and impacts to reproduction. An assessment of such impacts is covered under scientific monitoring (**Section 14**).

Table 12-2 provides guidance on the designated control agency and jurisdictional authority for Commonwealth and Territory/State waters for OWR. For a petroleum activity spill in Commonwealth and Territory waters, Santos acts as the control agency and will be responsible for the wildlife response. The Santos Oiled Wildlife Response Framework Plan (SO-91-BI-20014) will be referred to for guidance for coordinating an OWR when Santos is the Control Agency, otherwise the relevant State/Territory OWR Plan will be referred to, as described below.

For level 2/3 spills that contact NT shorelines the NT IC will assume the role of control agency with support from Santos. AMOSC on behalf of AMOSC Titleholder Members ConocoPhillips, INPEX and Shell Australia have developed a Northern Territory Oiled Wildlife Response Plan (NTOWRP), this plan also has application for other titleholders as it provides operational guidance to respond to injured and oiled wildlife along the NT coastline and island groups.

If a spill occurs in WA State waters or enters State waters, DBCA is the jurisdictional authority for wildlife, and for level 2/3 spills, will also lead the oiled wildlife response under the control of the Department of

Transport (DoT). For level 1 spills, Santos will be the Control Agency, including for wildlife response. It is however also an expectation that for level 2/3 petroleum activity spills, Santos will conduct the initial first-strike response actions for wildlife and continue to manage those operations until DBCA is activated as the lead agency for wildlife response.

The key plan for OWR in WA is the Western Australian Oiled Wildlife Response Plan (WAOWRP). The WAOWRP establishes the framework for preparing and responding to potential or actual wildlife impacts during a spill and sets out the management arrangements for implementing an OWR in conjunction with the State Hazard: SHP-MEE. It is the responsibility of DBCA to administer the WAOWRP under the direction of the DoT (**Table 12-2**).

Table 12-2: Jurisdictional and control agencies for oiled wildlife response

Jurisdictional boundary	Spill source	Jurisdictional authority for OWR	Control agency		Relevant documentation
			Level 1	Level 2/3	
Commonwealth waters (three to 200 nautical miles from territorial/state sea baseline)	Vessel	Department of Agriculture, Water and the Environment (DAWE)	AMSA		
	Petroleum activities		Titleholder		
Western Australian (WA) state waters (State waters to three nautical miles and some areas around offshore atolls and islands)	Vessel	Department of Biodiversity, Conservation and Attractions (DBCA)	WA DoT[14]		Western Australian Oiled Wildlife Plan (WAOWRP)
	Petroleum activities	WA DoT	Titleholder	WA DoT	
Northern Territory (NT) waters (territorial sea baseline to three nautical miles and some areas around offshore atolls and islands)	Vessel	Department of Environment, Parks and Water Security (DEPWS)	Vessel owner	NT IMT[15]	Northern Territory Oiled Wildlife Response Plan (NTOWRP) developed by AMOSC on behalf of AMOSC Titleholder Members ConocoPhillips, Inpex and Shell Australia to support their OWR operations in the NT.
	Petroleum activities		Titleholder[16]		

[14] If an OWR is required in WA State waters, the DBCA is responsible for the administration of the Western Australian Oiled Wildlife Response Plan (WAOWRP) under the direction of the DoT.

[15] For Level 2/3 spills that contact NT shorelines the NT IC will assume the role of control agency.

[16] The Northern Territory Government have the following interim arrangements in place for OWR management:

- The NT Emergency Management Council will delegate responsibilities associated with wildlife and relevant activities in National Parks, Reserves and Marine Parks.
- Direct coordination shall be managed through the designated NT Government Functional Group.

12.2 Wildlife response levels

To guide OWR resourcing requirements, **Table 12-3** has been adapted from the incident classification outlined in the National Plan (AMSA, 2020) in terms of wildlife at risk, incident duration and resourcing requirements.

The credible spill scenarios for the Barossa development show no shoreline contact, and large aggregations of wildlife are not expected or known to occur within the moderate exposure thresholds zone of a potential Barossa Development spill release. Consequently, it is not anticipated that there will be large numbers of oiled wildlife in the event of a spill.

Table 12-3: Wildlife incident level guidance

Characteristic	Level 1	Level 2	Level 3
Wildlife	Individual fauna	Groups of fauna or threatened fauna	Large numbers of fauna
Duration	0-3 days	Days to weeks	Weeks to months
Establishment of a wildlife facility	Not required	Likely required	Required

12.3 Implementation guidance

Table 12-4 provides guidance to the IMT on the actions and responsibilities that should be considered when implementing an oiled wildlife first-strike plan. This will enable an initial assessment of the OWR response level and initiation of a Wildlife Division for wildlife level 2/3 spills (**Table 12-3**) where Santos is the control agency and as outlined in the Santos Oiled Wildlife Response Framework Plan (SO-91-BI-20014). Mobilisation times for the minimum resources that are required to commence initial oiled wildlife operations are listed in **Table 12-5**. Information on resource capability for this strategy is shown in **Appendix N**.

Wildlife surveillance/reconnaissance will likely form the main component of an OWR associated with the Barossa Development. Refer to the Santos Wildlife Framework Plan, Section 7.3 for a list of the wildlife reconnaissance aims and objectives, tactics, species and life-cycle stages to consider when developing a wildlife reconnaissance plan. Wildlife reconnaissance should be undertaken in close consultation with personnel undertaking relevant monitor and evaluate activities.

Table 12-4: Implementation guidance – oiled wildlife response

	Action	Consideration	Responsibility	Complete
Initial wildlife assessment and notifications				
Initial actions	Personnel conducting monitor and evaluate activities shall report wildlife sightings in or near the spill trajectory (including those contacted with hydrocarbons or at risk of contact) and report them to the IMT within two hours of detection.	Record all reports of wildlife potentially impacted and impacted by spill. Record reports on: + location + access + number + species + condition of impacted animals (if available).	Surveillance personnel	❑
	If wildlife are sighted and are at risk of contact (or have been contacted), initiate wildlife response by notifying AMOSC Duty Manager; and + if in Territory waters also notify DEPWS (Pollution Response Hotline; Environmental Operations); and/or + if in State waters also notify DCBA State Duty Officer (who will then activate their respective Oiled Wildlife Advisers).	Obtain approval from IC before activating AMOSC Oiled Wildlife Adviser. If a Level 2/3 facility spill reaches the Northern Territory shoreline, the NT IMT will be the control agency for the shoreline. DoT will be the control agency for OWR in State waters.	Environment Unit Leader	❑
	Notify Department of Agriculture, Water and the Environment if there is a risk of death or injury to a protected species (including Matters of National Environmental Significance [MNES]).	Refer to **Table 6-1** for reporting requirements. A list of MNES is provided in the Existing Environment Section of the EP (Section 3).	Environment Unit Leader	❑
	Review all wildlife reports from surveillance or opportunistic activities and contact personnel who made the reports (if possible) to confirm information collected.		Environment Unit Leader Wildlife Response Branch Director	❑

Action		Consideration	Responsibility	Complete
	Use information from initial assessments to prepare an operational NEBA. Use this information to help determine: + initial OWR Response Level (1 to 3), see **Table 12-3** + for level 2/3 wildlife incidents where Santos is the control Agency, a Wildlife Division should be established (see the Santos Oiled Wildlife Framework Plan [SO-91-BI-20014]) + if OWR activities are likely to result in a net environmental benefit + prepare a Wildlife Plan for inclusion in the IAP.	Oiled wildlife response activities such as hazing and pre-emptive capture can cause additional stress and mortality on individuals than oil pollution alone. The Environment Unit Leader and Wildlife Division Coordinator will determine via an operational NEBA whether strategies such as hazing/pre-emptive capture will result in a net environmental benefit. This may be done in consultation with the DCBA/ designated NT Government Functional Group and AMOSC Oiled Wildlife Advisers and any Subject Matter Experts as relevant (if available, but an operational NEBA should not be delayed if they are not immediately available).	Environment Unit Leader If Wildlife Response Branch is activated Wildlife Response Branch Director	❑
	Prepare a Wildlife Plan for inclusion in the IAP	Refer to the Santos Oiled Wildlife Framework Plan (SO-91-BI-20014), Section 7.1.	Environment Unit Leader If Wildlife Response Branch is activated: Wildlife Response Branch Director	❑
Mobilisation of wildlife resources				
Determine resources required to undertake wildlife reconnaissance and provide list to Logistics Section.		Confirm best reconnaissance platform (e.g., vessel, aerial, shoreline). Consider ability to share resources (e.g., Monitor and Evaluate activities, Scientific Monitoring).	AMOSC OWA If Wildlife Response Branch is activated: Wildlife Division Coordinator Wildlife Reconnaissance Officer	❑

Action	Consideration	Responsibility	Complete
Determine number of Oiled Wildlife Responders and IMT Wildlife related positions required based on the likely number of oiled wildlife and arrange access to resources via AMOSC, DBCA and/or DEPWS. .	Consider need for veterinary care.	AMOSC OWA Logistics Section Chief If Wildlife Response Branch is activated: + Wildlife Response Branch Director NT shoreline: + Designated NT Government Functional Group State waters: + DBCA OWA	❑
Commence mobilisation of equipment (including adequate PPE) and personnel to required location/s.		Logistics Section Chief	❑
Contact OSRL to activate Sea Alarm if additional support is likely to be required to sustain an ongoing OWR.		Environment Unit Leader	❑

Table 12-5: Oiled wildlife response – first-strike response timeline

Task	Time from oiled wildlife contact (predicted or observed)
IMT notifies regulatory authorities and AMOSC of oiled wildlife / potential for contact	<2 hours
Mobilise Santos personnel for oiled wildlife reconnaissance **this will be already occurring through Aerial Observer mobilisation**	<24 hours
Mobilisation of AMOSC/AMSA oiled wildlife equipment and industry OWR team to forward staging area	<48 hours
Minimum resource requirements	
The requirements for oiled wildlife response will be situation specific and dependent upon reconnaissance reports. Indicative minimum resource requirements below align with personnel requirements for a scenario with low wildlife impact as per the WAOWRP: + Seven trained industry oiled wildlife response team personnel (AMOSC staff & contractors/ AMOSC Industry OWR group) + One AMOSC OWR treatment container + One AMOSC Oiled Wildlife Deterrence Kit	

12.4 Environmental performance standards

Table 12-6 indicates the environmental performance outcomes, controls and performance standards for this response strategy.

Table 12-6: Environmental performance – oiled wildlife response

Environmental performance outcome	Implement tactics in accordance with relevant State/Territory Oiled Wildlife Response Plans (OWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanise wildlife		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
Oiled wildlife response	**Response preparedness**		
	Maintenance of access to oiled wildlife response equipment and personnel	Maintenance of access to oiled wildlife response equipment and personnel through Santos, AMOSC, AMSA National Plan and OSRL throughout activity	MoU for access to National Plan resources through AMSA
			AMOSC Participating Member Contract.
			OSRL Associate Member Contract.
	Santos Oiled Wildlife Framework Plan (SO-91-BI-20014)	Santos Oiled Wildlife Response Framework provides guidance for coordinating an OWR when Santos is the control agency and outlined Santos's response arrangements	Santos Wildlife Framework Plan
	Labour hire contract	Maintenance of contract with labour hire provider	Contract
	Labour hire onboarding procedure (for low skilled shoreline clean-up- personnel)	Development of onboarding procedure for oil spill response labour hire	Onboarding procedure
	Response implementation		
	Mobilisation of minimum requirements for initial response operations	Minimum requirements mobilised in accordance with **Table 12-5** unless directed otherwise by relevant control agency	Incident log
	OWR managed in accordance with the Santos Oiled Wildlife Framework Plan (SO-91-BI-20014) in Commonwealth, NT OWRP in Territory waters and the WAOWRP in state waters.	Prepare operational NEBA to help classify OWR level and determine if OWR activities are likely to result in a net environmental benefit (particularly in relation to hazing/pre-emptive capture)	Records indicate operational NEBA completed before OWR operations commencing
		Wildlife Plan developed and included in the IAP to provide oversight and management of OWR operation	Records indicate IAP Wildlife Plan prepared before OWR operations commencing

13 Waste management

Table 13-1 provides the environmental performance outcome, initiation criteria and termination criteria for this strategy.

Table 13-1: Waste management – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible	
Initiation criteria	Response activities that will be generating waste have been initiated	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	+ All waste generated from the oil spill response has been stored, transported and disposed as per the regulatory requirements, and + Agreement is reached with Jurisdictional Authorities to terminate the response	

13.1 Overview

The implementation of some spill response strategies will generate waste solid and liquid waste that will require rapid management, storage, transport and disposal. It is important that waste is collected and removed quickly to ensure waste management does not create a bottleneck in response operations.

The type and amount of waste generated during a spill response will vary depending on the spill type/characteristics, volume released, and response strategies implemented. To account for this potential variability, waste management (including handling and capacity) needs to be scalable to allow a continuous response to be maintained.

The worst-case oil spill modelling conducted for the Barossa project predict no beaching of surface oil for MDO or Barossa condensate. Potential waste management requirements are therefore likely to be limited to oiled wildlife response and water quality monitoring activities. Significant volumes of waste from the applicable response activities for this OPEP are not anticipated due to the propensity of MDO and Barossa condensate to disperse naturally.

Where Santos is the Control Agency, or at the request of the designated Control Agency, Santos will engage its contracted Waste Service Provider (WSP) to provide sufficient waste receptacles to store collected waste and manage oily waste collection, transport and disposal associated with spill response activities. The WSP will arrange for all personnel, equipment and vehicles to carry out these activities from nominated collection points to licensed waste management facilities. All transport will be undertaken via controlled-waste-licensed vehicles and in accordance with the *Waste Management and Pollution Control Act* (NT). Santos' Oil Pollution Waste Management Plan (QE-91-IF-10053) provides detailed guidance to the WSP in the event of a spill.

13.2 Implementation guidance

Table 13-2 provides guidance to the IMT on the actions and responsibilities that should be considered when selecting this strategy. The Incident Commander is ultimately responsible for implementing the response, and may therefore determine that some tasks be varied, should not be implemented or be reassigned.

Table 13-2: Implementation guidance – waste management

	Action	Consideration	Responsibility	Complete
Initial actions	Contact WSP (Primary or Secondary Contact Person) and activate Waste Project Manager.	Refer to Incident Response Contacts Directory (SO-00-ZF-00025.020) for contact details.	Logistics Section Chief	❑
	Based on operational modelling and applicable response strategies communicate the type and quantity of empty liquid and solid waste receptacles required to support planned operations.	It is better to overestimate volumes and scale back resources then to underestimate waste volumes.	Logistics Section Chief Planning Section Chief	❑
	Using most recent monitor and evaluate data and any existing and future response activities, determine most suitable locations for waste receptacles to be positioned and for temporary storage locations to be established.	Consideration would be given to positioning receptacles and locating temporary storage sites to ensure secondary contamination of sensitive receptors is avoided or minimised. The approval of temporary storage sites would be given through the NT Department of Environment, Parks and Water Security (DEPSW) via the NT Environment Protection Authority.	Logistics Section Chief Planning Section Chief Environment Unit Leader	❑
	For each receival location indicate the anticipated: + material types + material generation rates + material generation quantities + commencement date/time + anticipated clean-up duration + receptacle types required + logistical support requirements + any approvals required from Ports, Local Governments, Landowners, State Government Agencies (Refer to Oil Pollution Waste Management Plan (QE-91-IF-10053)).	Consider facilities for waste segregation at source.	Logistics Section Chief Planning Section Chief	❑

	Action	Consideration	Responsibility	Complete
	Once the above information is obtained, ensure all necessary waste management information is included in the IAP.	Waste management should be done in accordance with Santos' Oil Pollution Waste Management Plan (QE-91-IF-10053); and where relevant, the *Waste Management and Pollution Control Act* (NT); DoT Waste Management Guidelines (WA), the respective Port, Port Operator and/or Ship Owner's waste management plan.	Logistics Section Chief (or delegate) Planning Section Chief WSP location Responsible Person or Operations Supervisor	❑
	Mobilise waste management resources and services to agreed priority locations.		WSP location Responsible Person or Operations Supervisor Logistics Section Chief	❑
Ongoing actions	Provide ongoing point of contact between IMT & WSP.		Logistics Section Chief	❑
	Ensure all waste handling, transport and disposal practices comply with legislative requirements.	Alert Logistics Section Chief (or delegate if any non-compliance is anticipated or detected. Site clean-up, removal and disposal of response waste should be conducted in accordance with Santos' Oil Pollution Waste Management Plan (QE-91-IF-10053); and where relevant, the *Waste Management and Pollution Control Act* (NT); DoT Waste Management Guidelines (WA), the respective Port, Port Operator and/or Ship Owner's waste management plan.	WSP location Responsible Person or Operations Supervisor	❑

Action		Consideration	Responsibility	Complete
	Ensure records are maintained for all waste management activities, including but not limited to: + waste movements (e.g., types of receptacles, receival points, temporary storage points, final disposal locations) + volumes generated at each site (including total volume and generation rates) + types of waste generated at each site + approvals obtained (as required).		WSP location Responsible Person or Operations Supervisor	❑

13.3 Waste approvals

Site clean-up, removal and disposal of response waste should be conducted in accordance with Santos' Oil Pollution Waste Management Plan (QE-91-IF-10053); and where relevant, the *Waste Management and Pollution Control Act* (NT), the DoT Waste Management Guidelines and the respective Port, Port Operator and/or Ship Owner's waste management plan. In addition, regulatory approval may be required for the temporary storage, transport, disposal and treatment of waste, through the NT EPA or WA Department of Water and Environment Regulation (DWER).

The DEPWS administers the *Waste Management and Pollution Control Act* (NT) and DWER administers the *Environmental Protection Act 1986* (WA). The EPA is the relevant regulatory Authority for waste management approvals in the NT and DWER is the relevant authority in WA. The Santos Oil Pollution Waste Management Plan (QE-91-IF-10053) provides detail on the regulatory requirements for each port/location likely to be used for waste management during any spill response operation associated with Santos' activities.

13.4 Resource requirements

Based on the credible spill scenarios for the Barossa Development, Santos do not anticipate that large volumes of waste will be generated. The potential types and total volumes of waste anticipated for each response option are provided in **Table 13-3.**

+

Table 13-4 summarises the waste storage, treatment and disposal options available to manage waste associated with the spill response options.

Given that large volumes of a waste are not anticipated, storage space on the spill response vessels is anticipated to be adequate. However, as soon as the details of an actual spill are available, waste management arrangements to allow a continuous response to be maintained should be reviewed.

The waste products are likely to be transported by vessel from the response location to Darwin Port. Waste will be transported from Darwin Port to licensed waste disposal facilities by a dedicated waste contractor. Santos has existing service agreements with a WSP which include the provision of waste management services during a spill response. Transport to the licensed waste management facilities would be undertaken via controlled-waste-licensed vehicles and in accordance with the NT *Waste Management and Pollution Control Act, 2015*.

Table 13-3: Waste types and volumes anticipated during a spill response

Spill response option	Oily liquid waste	Solid oily waste	PPE and consumables
Monitor and evaluate	None	None	< 1 m^3/day
Mechanical dispersion	None	None	< 1 m^3/day
Wildlife response	< 1 m^3/day	< 1 m^3/day	< 3 m^3/day

Table 13-4: Spill response waste storage, treatment and disposal options

Waste category	On-site storage	Treatment/disposal option
Liquid waste (e.g., recovered oil/water mixture)	Holding on vessels, oil drums, tanks, oil barges and flexible bladders	Wastewater treatment process and discharge (e.g., dust suppression) Incineration
Solid waste – PPE and consumables (e.g., oily gloves)	Lined skips, oil drums, industrial waste bags, plastic rubbish bags	Recovery (e.g., thermal desorption or fixation process) and recycling Incineration Landfill
Oiled wildlife response	Industrial waste bags, plastic rubbish bags	Incineration Landfill

13.5 Waste service provider capability

Detailed guidance on Santos' WSP responsibilities for spill response waste management is provided in the Santos Oil Pollution Waste Management Plan (QE-91-IF-10053).

Key responsibilities of the WSP include:

+ Maintain emergency response standby preparedness arrangements, including:
  - Have access to personnel, equipment and vehicles required for a first strike and ongoing response commensurate to Santos worse case spill and waste requirements.
  - Provide primary and secondary contact details for activation of spill response waste management services.
  - Have suitably trained personnel for completing critical tasks in spill response waste management.
  - Participate in exercises undertaken by Santos.
+ Maintain ability to assist in the control agency's IAP and Waste Management Sub-plan process as required.
+ Mobilise resources to waste collection points identified by the control agency.
+ Ensure waste handling, transport and disposal practices meet legislative requirements.
+ Keep auditable records of waste streams from collection points to final disposal points.
+ Provide regular progress reporting to the control agency IMT and a final report relating to quantities and destinations of collected waste.
+ Provide a project manager responsible for the rollout of spill response resources to meet spill response waste management objectives.
+ Provide location-specific Operations Supervisor/s to handle on-site operational aspects (management of personnel and equipment, reporting, liaison with relevant field-based spill responders).

13.6 Environmental performance

Table 13-5 indicates the environmental performance outcomes, controls and performance standards for this response strategy.

Table 13-5: Environmental performance – waste management

Environmental performance outcome	Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
Waste management	**Response preparedness**		
	Maintain access to waste management equipment, personnel, transport and disposal facilities	Maintain access to waste management equipment, personnel, transport and disposal facilities throughout activity	Contract with WSP for emergency response services
	Response implementation		
	Implement Oil Pollution Waste Management Plan (QE-91-IF-10053)	WSP to appoint a Project Manager within 24 hours of activation	Incident log
		WSP shall track all wastes from point of generation to final destination	Waste tracking records
		WSP to provide monthly waste management reports and more regular situation reports during the response until termination criteria are met	Waste reports

14 Scientific monitoring

Table 14-1: Scientific monitoring – environmental performance outcome, initiation criteria and termination criteria

Environmental performance outcome	Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill or affected by spill response	
Initiation criteria	Refer to individual Receptor SMPs – **Appendix J**	
Applicable hydrocarbons	**MDO**	**Condensate**
	✓	✓
Termination criteria	Refer to individual SMPs – **Appendix J**	

Oil spill scientific monitoring is the principal tool for detecting and quantifying environmental impact and recovery to sensitive receptors from an oil spill. Santos is required to have an oil spill SMP in place for Petroleum activities in State/Territory and Commonwealth waters.

Santos will activate and implement scientific monitoring in State/Territory and Commonwealth waters for hydrocarbon spills in line with its SMPs unless directed otherwise by the relevant Control Agency/s.

14.1 Objectives

The overarching objective of Santos' SMPs is to provide guidance to staff, consultants and contractors in developing monitoring a monitoring program for detecting impacts and recovery to environmentally sensitive receptors contacted by a spill.

Receptor-specific SMPs have different objectives as outlined in **Appendix J**.

14.2 Scope

Santos will implement its SMPs, as applicable, for Barossa development activity oil spills across both Territory / State and Commonwealth waters. For oil spills that contact NT shorelines, Santos will liaise directly with the NT IMT and provide all of the required support to implement scientific monitoring on NT shorelines. In the event that control of scientific monitoring in State waters is taken over by DoT under advice from the State Environmental Scientific Coordinator, Santos will follow the direction of DoT and provide all necessary resources (monitoring personnel, equipment and planning) to assist as a supporting agency.

14.3 Relationship to operational monitoring

Operational monitoring (**Section 10**) is monitoring undertaken to obtain information which will provide situational awareness and assist in the planning and execution of the oil spill response.

Scientific monitoring activities have different objectives to operational monitoring**,** which influences the monitoring methods likely to be used, the degree of scientific rigour required to meet the monitoring objectives, and the scope of studies. Scientific monitoring may occur in parallel to operational monitoring and is typically conducted over a wider study area, extending beyond the spill footprint. It is also typically conducted over a longer time period, extending beyond the spill response.

Scientific monitoring is designed to provide data for short term and longer-term environmental effects assessment. This is typically required to be quantitative in nature and appropriate for statistical analyses.

However, these two types of monitoring are related, and Operational Monitoring outputs typically inform the final design of the related SMP.

14.4 Scientific monitoring plans

Owing to the diverse nature of sensitive receptors that could be contacted by an oil spill and the different techniques and skillsets required to monitor impact and recovery to these receptors, there are a number of Oil Spill Scientific Monitoring Plans relevant to Barossa Development activities (**Table 14-2**). These are detailed further in **Appendix J**; each SMP has corresponding objectives, initiation/termination criteria, methodologies, baseline data sources and analysis and reporting requirements, noting that in a response controlled by DoT methodology, termination criteria and analysis/reporting requirements may differ.

Table 14-2: Oil spill scientific monitoring plans relevant to Barossa development activities

Study	Title
SMP1	Marine water quality
SMP2	Marine sediment quality
SMP3	Shorelines and coastal habitats – sandy beaches and rocky shores
SMP4	Shorelines and coastal habitats – mangroves
SMP5	Shorelines and coastal habitats – intertidal mudflats
SMP6	Benthic habitats
SMP7	Seabirds and shorebirds
SMP8	Marine megafauna (incl. Whale sharks and mammals)
SMP9	Marine reptiles
SMP10	Seafood quality
SMP11	Fish, fisheries and aquaculture
SMP12	Whale sharks

14.5 Baseline monitoring

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

In the event of a spill to marine or coastal waters, reactive pre-impact monitoring should, where practicable, be implemented to gather additional data on the current state of the environment.

Santos periodically reviews the status, availability and suitability of existing baseline data sources related to key environmental sensitivities in its areas of operations. **Appendix L** provides further information on Santos baseline data reviews and outlines a baseline data assessment conducted on high priority areas for scientific monitoring in the event of a Barossa Development oil spill.

14.6 Monitoring service providers

Oil Spill Scientific Monitoring will be conducted on behalf of Santos by contracted monitoring service providers (MSPs) and applies to the implementation of SMPs 1 to 11 (**Table 14-2**). These services are provided by Astron Environmental Services (Astron) and primary sub-contractor (BMT).

For whale sharks, in addition to the monitoring that will be undertaken as part of SMP8 Marine Megafauna, additional scientific monitoring of whale sharks within the foraging BIA will be undertaken (SMP12). Santos has historically and currently supports research on the behaviour, demography and migration patterns of whale sharks at Ningaloo Reef conducted by AIMS. In the event of a spill that could impact whale sharks, Santos will leverage off this long-term research program to assess potential impacts to whale sharks within the foraging BIA. SMP12 is regarded as complementary to SMP8 which will detect potential impacts to whale sharks from visual surveys of whale sharks wherever they may occur in relation to a spill.

As per the Santos Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162), Santos' MSP provides the following scientific monitoring services to Santos:

+ 24/7 monitoring support accessed through 24 hr call out number
+ provision of a suitably trained Monitoring Coordination Team including a Monitoring Coordinator, Monitoring Operations Officer, Planning and Logistics Officer and Safety Officer
+ provision of Technical Advisers and Field Teams (staff and contractors) for first-strike deployments
+ maintenance of standby monitoring equipment
+ monthly personnel capability reports
+ provision and review of Scientific Monitoring Sub-plans
+ provision and review of Standby Service Manual (EA-00-RI-10162) and associated response activation forms
+ participation in audits, workshops, drills and exercise to facilitate readiness.

Appendix J provides an overview of Santos' processes in place to provide assurance that its oil spill scientific monitoring arrangements for SMPs 1-11 are fit for purpose to meet the worst case first-strike monitoring requirements associated with the Barossa development activities.

14.7 Activation

The SMP Activation Process is outlined in **Appendix K**. SMPs are activated as per the initiation criteria for each as outlined in **Appendix J**. The SMP Activation Form is available on the Santos Procedures Index and IMT Environment Unit Leader folder.

The Santos IMT Environment Unit Leader with support from IMT Environment Unit members is responsible for activating the primary MSP. The Santos Environment Unit will assist the MSP Monitoring Coordination personnel and relevant Technical Advisers in defining the monitoring study design, monitoring locations and field methodologies based on Operational Monitoring information (e.g., spill modelling and aerial surveillance information), relative location of sensitive receptors to the spill and the timing of the spill with respect to seasonality of sensitive receptors.

This process will identify monitoring operational objectives and resourcing/ mobilisation requirements which the Environment Unit Leader will feed back to the IMT for approval. Mobilisation times for the minimum resources that are required to commence initial scientific monitoring operations are listed in

Table 14-3.

In the event that a designated control agency takes command of scientific monitoring, Santos will follow the direction of the control agency providing planning and resourcing support through its MSPs as required.

Table 14-3: Scientific monitoring – first-strike response timeline

Task	Time from activation of SMP
Santos IMT approve initial monitoring plan	<24 hours
Santos to mobilise sampling platforms to deployment location	<120 hours (72 hours from monitoring plan approval)
SMP teams and monitoring equipment mobilised to deployment locations	<120 hours (72 hours from monitoring plan approval)
Minimum resource requirements	
Initial resourcing requirements will be dependent upon the number of SMPs activated and the requirement for post spill baseline data to be collected. First-strike personnel requirements for scientific monitoring field teams at Protection Priority areas are presented in **Appendix L**. + Suitable vessels for on-water monitoring or transfer of personnel to remotes areas/islands + Vehicle/s as required + Helicopter for aerial surveys as required + Scientific monitoring personnel for first-strike teams (refer **Appendix L**) + Scientific monitoring equipment as detailed in the relevant SMP	

14.8 Environmental performance

Table 14-4 indicates the environmental performance outcomes, controls and performance standards for this response strategy.

Table 14-4: Environmental performance – scientific monitoring

Environmental performance outcome	Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
Scientific monitoring	**Response preparedness**		
	Maintenance of Monitoring Service Provider contract for scientific monitoring services	Maintain access to specialist monitoring personnel and equipment by maintaining contract with Monitoring Service Provider throughout activity	Contract with monitoring service provider
	Capability reports from Monitoring Service Provider	Obtain monthly capability reports from Monitoring Service Provider	Capability reports
	Conduct periodical review of existing baseline data sources across the Santos combined EMBA	Regular review of baseline data	Baseline data review report
	Water quality monitoring vessels	Maintenance of vessel specification for water quality monitoring vessels	Vessel specification
	Response implementation		
	Activate Scientific Monitoring Plans	Initiation criteria of SMPs will be reviewed during the preparation of the initial IAP and subsequent IAPs; and if any criteria are met, relevant SMPs will be activated	Incident Action Plan and Incident log
		If any SMPs are activated, the subsequent activation of MSP is to follow the process outlined in the Santos Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162)	Incident log
		MSP shall commence activation process within 30 mins of initial notification form being received from Santos	Monitoring Service Provider records

Environmental performance outcome	Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill		
Response strategy	**Control measures**	**Performance standards**	**Measurement criteria**
		Santos personnel to support MSP through the provision of operational monitoring information and relative location of sensitive receptors to the spill	Incident log and Monitoring Service Provider records
	Mobilisation of minimum requirements for initial scientific monitoring operations	Minimum requirements mobilised in accordance with **Table 14-3**	Incident log

15 Response termination

The decision to terminate the spill response is made in consultation with the relevant Control Agency/s, Jurisdictional Authorities and other Statutory Authorities that play an advisory role. This decision will be made with consideration of:

+ the efficacy and benefit of current response options
+ any potential for additional pollution
+ any potential for additional environmental damage caused by further clean-up efforts
+ an assessment of prevailing weather conditions that can increase risk to response teams or increase the efficacy in weathering hydrocarbon.

An operational NEBA will be conducted to inform the decision-making process. Termination criteria are defined within each section of contingency response activities defined within the OPEP.

Upon conclusion of the spill response activity, Santos will:

+ prepare detailed reports and collate all documents
+ report on the performance objectives of each individual spill response that was mobilised
+ undertake an inventory of consumables and prepare accounts
+ arrange for the return of equipment
+ arrange for the refurbishment of consumed equipment
+ investigate the cause of the incident and report to relevant authorities
+ assess long-term environmental monitoring requirements.

16 References

Adams et al., 2013 *Evolution of the Macondo well blowout: simulating the effects of the circulation and synthetic dispersants on the subsea oil transport*. Environ. Sci. Technol., 47 (20) (2013), p. 11905

Adams, E. E. & Socolofsky, S. A. (2005), Review of Deep Oil Spill Modeling Activity Supported by the DeepSpill JIP and Offshore Operators Committee. December 2004, revised 2005.

American Petroleum Institute (API). 2020. Industry Recommended Subsea Dispersant Monitoring Plan. Version 1.0. API Technical Report 1152. https://www.oilspillprevention.org/-/media/Oil-Spill-Prevention/spillprevention/r-and-d/dispersants/api-1152-e1-industry-recommended-subsea.pdf

Australian Marine Oil Spill Centre (AMOSC) (2019), Northern Territory Oiled Wildlife Response Plan, version 2.0, February 2019

Australian Maritime Safety Authority (AMSA) (2010). Response to the Montara Wellhead Platform Incident: Report of the Incident Analysis Team. March 2010. Accessed 19th August 2021 - https://www.amsa.gov.au/marine-environment/incidents-and-exercises/response-montara-wellhead-platform-incident

AMSA (2017). Australian Government Coordination Arrangements for Maritime Environmental Emergencies. Prepared by the Australian Maritime Safety Authority, October 2017.

AMSA (2020). National Plan for Maritime Environmental Emergencies. Australian Maritime Safety Authority, Canberra, Australian Capital Territory. Accessed 11th June 2021 - https://www.amsa.gov.au/sites/default/files/amsa-496-national-plan.pdf

AMSA (2021), NEMO Public Equipment Portal, Australian Maritime Safety Authority, Canberra, Australian Capital Territory. Accessed 11th August 2021 - https://www.amsa.gov.au/marine-environment/pollution-response/national-environmental-maritime-operations

Australian Marine Oil Spill Centre (AMOSC) (2019), Northern Territory Oiled Wildlife Response Plan, version 2.0, February 2019.

Brandvik, P. J., Johansen, Ø., Farooq, O., Angell, G. and Leirvik, F. 2014. Subsurface oil releases - Experimental study of droplet distributions and different dispersant injection techniques Version 2. A scaled experimental approach using the SINTEF Tower basin. SINTEF report no. A26122. Trondheim, Norway. Accessed 11 July 2021 at http://www.oilspillprevention.org/~/media/Oil-Spill-Prevention/spillprevention/r-and-d/dispersants/sintef-api-d3-phase-i-effectiveness-repo.pdf

Department of Marine Safety (2014) Northern Territory Oil Spill Contingency Plan. 151 pp.

European Maritime Safety Agency (EMSA). (2010). Manual on the Applicability of Oil Spill Dispersants. Version 2.

French McCay, D., Crowley, D., 2018. Sensitivity Analysis for Oil Fate and Exposure Modelling of a Subsea Blowout – Data Report. Prepared for American Petroleum Institute. API Project 2015-110161.

French-McCay, P., Jayko, K., Li, Z., Spaulding, M., Crowley, D., Mendelsohn, D., Horn, M., Isaji, T., Kim, Y.H., Fontenault, J., Rowe, J. (2021). Oil fate and mass balance for the Deepwater Horizon oil spill, Marine Pollution Bulletin. No. 171. October 2021, 112681

Hemmer, M.J., Barron, M.G. And Greene, R.M., 2011—Comparative toxicity of eight oil dispersants, Louisiana sweet crude oil (LSC), and chemically dispersed LSC to two aquatic test species. Environmental Toxicology and Chemistry, 30 (10), 2,244–52.

Hook, S. and Lee, K. (2015). Risk analysis of chemical oil dispersants on the Australian register. APPEA Journal 2015.

Government of Western Australia. (2019). State Hazard Plan – Marine Environmental Emergencies. Department of Transport, Perth, Western Australia. Accessed 11th June 2021- https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_StateHazardPlanMaritimeEnviroEmergMEE.pdf

International Petroleum Industry Environmental Conservation Association and International Association of Oil and Gas Producers (IPIECA-IOGP). 2015a. Dispersants: subsea application - Good practice guidelines for incident management and emergency response personnel. Accessed 11 July 2021 at https://www.iogp.org/bookstore/product/dispersants-subsea-application/

McKinney, K. and Caplis, J. (2017) Evaluation of Oleophilic Skimmer Performance in Diminishing Oil Slick Thicknesses. International Oil Spill Conference Proceedings: May 2017, Vol. 2017, No. 1, pp. 1366-1381.

NASEM (National Academies of Sciences, Engineering, and Medicine). 2020. The Use of Dispersants in Marine Oil Spill Response. The National Academies Press, Washington, DC, 340 pp., Accessed 19th August 2021 - https://www.nap.edu/catalog/25161/the-use-of-dispersants-in-marine-oil-spill-response

National Oceanic Atmospheric Administration (NOAA), US Coastguard, US Environmental Protection Agency. 2006. Special Monitoring of Applied Response Technologies (SMART) monitoring protocol, Accessed 27th July 2021 - https://response.restoration.noaa.gov/sites/default/files/SMART_protocol.pdf

National Oceanic and Atmospheric Administration (NOAA) (2013). Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments. https://response.restoration.noaa.gov/sites/default/files/Characteristics_Response_Strategies.pdf

Northern Territory Government (2019). Territory Emergency Plan. Accessed 11th June 2021 - https://pfes.nt.gov.au/sites/default/files/uploads/files/2019/TEP%20April%202019.pdf

RPS (2019). COP Barossa Development: Condensate Well Blowout Modelling Study. Rev 2.

Oil Spill Response Limited (OSRL) (2017), Technical Information Sheet: Dispersants Global Dispersant Stockpile.

Quigg, A., Farrington, J., Gilbert, S., Murawski, S., and John, V. (2021). A Decade of GoMRI Dispersant Science: Lessons Learned and Recommendations for the Future. Oceanography, Vol.34, No.1

Western Australian (WA) Department of Transport (DoT) (2015). Oil Spill Contingency Plan. Prepared by the WA Department of Transport, January 2015.

WA DoT. (2020a). State Hazard Plan – Marine Environmental Emergencies (MEE). Department of Transport, Perth, Western Australia. Accessed 11th June 2021- https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_StateHazardPlanMaritimeEnviroEmergMEE.pdf

WA DoT (DoT). (2020b). Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements. Accessed 11th June 2021 at https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf

Western Australian Parks and Wildlife (DPaW). (2014). Western Australian Oiled Wildlife Response Plan (WA OWRP). Accessed 11th June 2021 at https://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/West_Australian_Oiled_Wildlife_Response_Plan_V1.1.pdf

Appendix A: Hydrocarbon characteristics and behaviour

Marine diesel oil (MDO)

ITOPF (2011) and Australian Maritime Oil Spill Centre-AMOSC (2011) categorises MDO as a light group II hydrocarbon. The physical characteristics of MDO are summarised in **Table A-1.** In the marine environment, a 5% residual of the total quantity of MDO spilt will remain after the volatilisation and solubilisation processes associated with weathering. For full details on the properties of MDO, see 7.5.3 of the Barossa Development Drilling and Completions EP (BAD-200 0003).

In summary, in the marine environment MDO will behave as follows:

+ Diesel will spread rapidly in the direction of the prevailing wind and waves.
+ In calm conditions evaporation is the dominant process contributing to the fate of spilled MDO from the sea surface and will account for 60 to 80% reduction of the net hydrocarbon balance.
+ Has a strong tendency to entrain into the upper water column (0 m–10 m) (and consequently reduce evaporative loss) in the presence of moderate winds (> 10 knots) and breaking waves. However, it resurfaces when the conditions calm.
+ The evaporation rate of MDO will increase in warmer air and sea temperatures such as those present around the Barossa Development operational area.
+ Diesel residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

Figure provides the predicted weathering and fates of surface MDO. The graphs show that MDO on the sea surface is expected to evaporate rapidly, with up to 79% of the spilled hydrocarbon expected to evaporate after a few days, depending on weather conditions, sea state and time of year.

Table A-1: Characteristics of MDO

Hydrocarbon	Initial density (kg/m^3)	Viscosity (cP) @ 20°C	Component	Volatiles (%)	Semi-volatiles (%)	Low volatility (%)	Residual (%)
			Boiling Points (°C)	<180	180–265	265–380	>380
Diesel	829	4.0	% of total	6	35	54	5

Source: APASA (2013a)

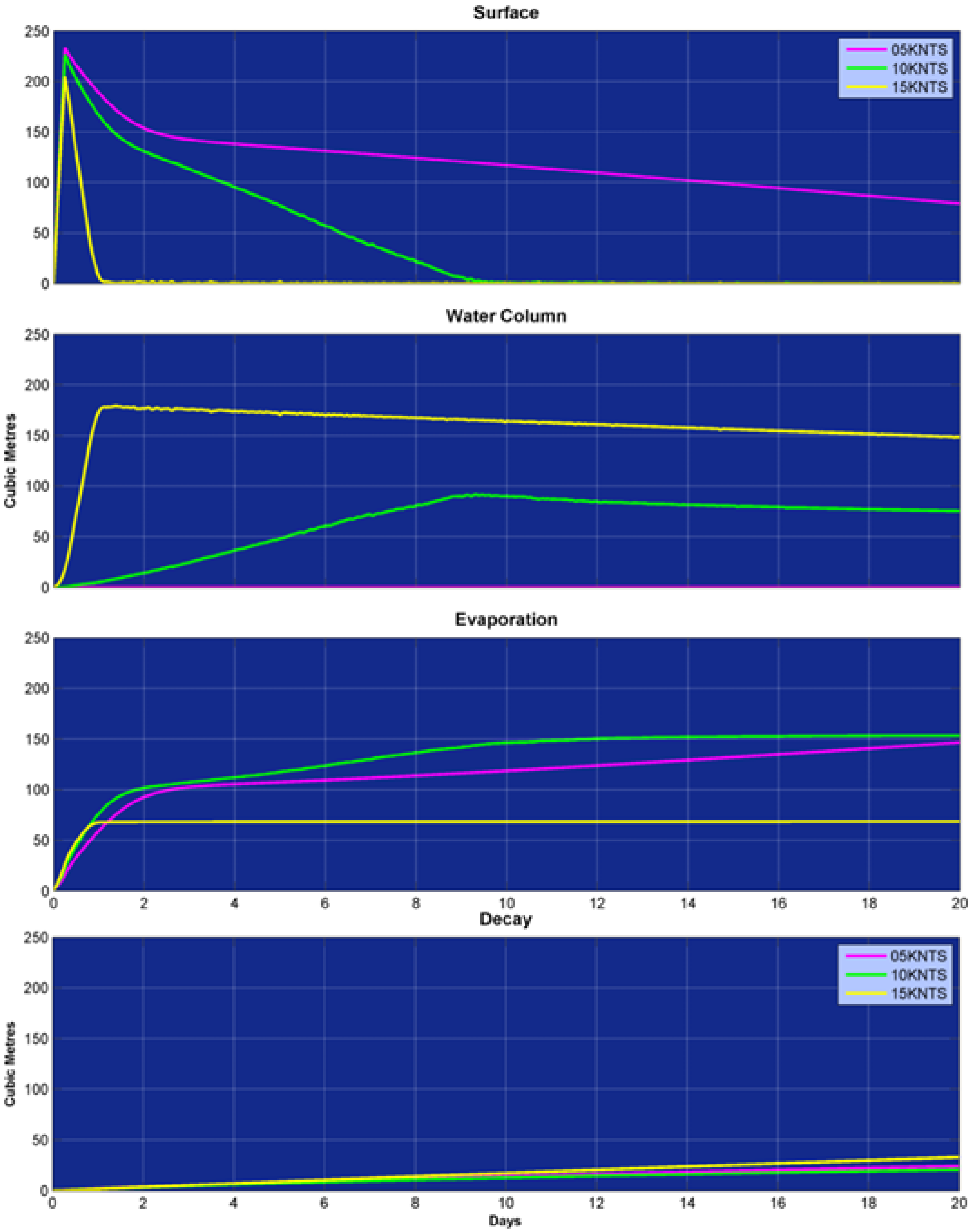


Figure A-1: Predicted weathering and fates of MDO for a 250 m^3 spill (RPS, 2019)

Barossa condensate

Barossa condensate is characterised by a low viscosity and is considered a Group I oil (non-persistent) hydrocarbon, as per the grouping classification presented by AMSA (2015). If spilt on the sea surface, the condensate would rapidly spread and thin out resulting in a large surface area of hydrocarbon available for evaporation. The volatile component of Group I oils (non-persistent) tend to dissipate through evaporation within a few hours (ITOPF 2015). Based upon the Barossa condensate assay, up to 57% of the hydrocarbon would evaporate over the first few hours or day, with up to 79% evaporated after a few days when on the sea surface, depending on weather conditions, sea state and time of year. Only 7% of the condensate is considered persistent, which would eventually breakdown due to the decay (RPS, 2019). Physical characteristics of Barossa condensate are summarised in **Table A.**

The fate of the condensate will depend greatly on the proportion that reaches the surface after rising through the water column (RPS 2019). Condensate at surface will be subject to atmospheric weathering and will be transported by prevailing currents and wind. Condensate that entrains or dissolves in the water column will be transported by prevailing current and hence, will follow a different path. Condensate in the water column will also be subject to different weathering processes in comparison to floating condensate. Hence, discharge conditions (which affect droplet size distributions and rise times) will have a strong influence on exposure risks for surrounding resources (RPS 2019).

Table A-2: Barossa Condensate Characteristics (RPS, 2019)

Hydrocarbon type	Density at 16 °C (kg/m³)	Viscosity at 10 °C (cP)	API	Component	Volatile (%)	Semi-volatile (%)	Low volatility (%)	Residual (%)
				BP (ºC)	<180	180–265	265–380	>380
Condensate	782	1.35	50.6	% of total:	57	22	14	7

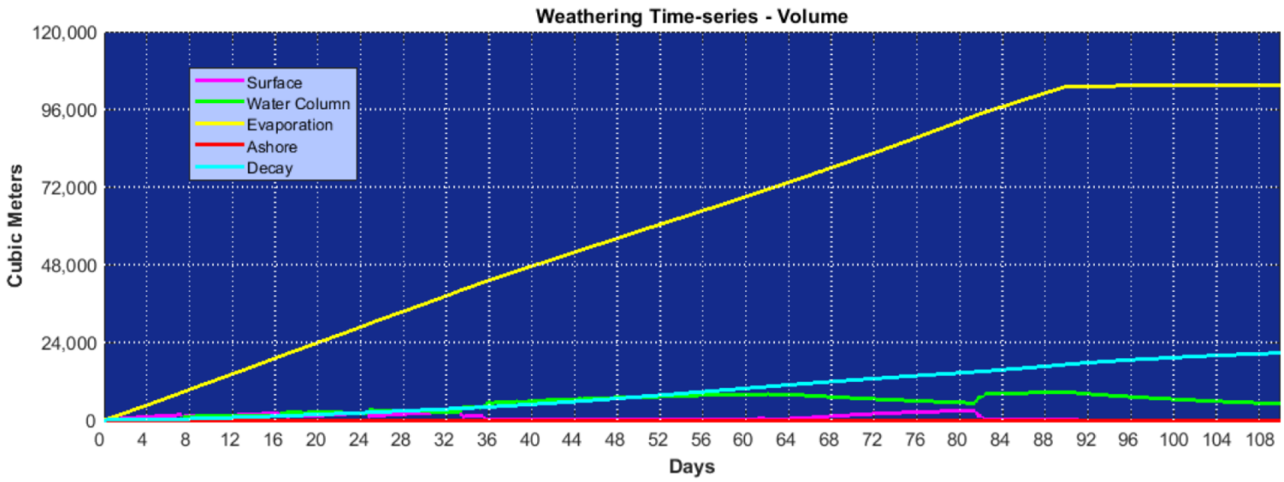


Figure A-2: Predicted weathering and fates graph for the trajectory with the largest sea surface swept area at the 10 g/m² threshold (RPS, 2019)

Figure A-2 provides the predicted weathering and fates of surface condensate for the largest sea surface swept area at the moderate threshold. The graph shows that condensate on the sea surface is expected to evaporate rapidly (RPS 2019).

Appendix B: ALARP assessment framework

1. Rationale

As part regulatory approval requirements for petroleum activities, the Environment Plan (EP) and/or Oil Pollution Emergency Plan (OPEP) must demonstrate that through the implementation of all reasonable control measures, environmental risks have been reduced to a level that is As Low As Reasonably Practicable (ALARP).

With respect to hydrocarbon spill risk and response planning, this includes an assessment to demonstrate that the oil spill response control measures are reducing risk to a level that is ALARP.

This ALARP Assessment Framework provides a process to facilitate the identification of all existing and potential spill response control measures, the selection or rejection of which are supported by reasoned arguments.

2. Guidance documents

Guidance documents used in the preparation of this framework include:

+ Oil Spill Risk Assessment and Response Planning Procedure QE-91-II-20003;
+ NOPSEMA Guidance Note ALARP N-04300-GN0166 Revision 6 June 2015;
+ NOPSEMA Guidance Note Control Measures and Performance Standards N04300-GN0271 Revision No 4 Last Reviewed 2020;
+ NOPSEMA Guideline Environment Plan Decision Making N-04750-GL1721 Revision 6 – November 2019;
+ NOPSEMA Guidance Note Risk Assessment GN0165 Revision 5 May 2017; and
+ NOPSEMA Oil Pollution Risk Management GN1488 Rev 2 February 2018

3. Overview

The ALARP Assessment Framework uses activity specific information to systematically assess existing and potential control measures and ensure that all practicable control measures are identified and documented.

When selecting controls to reduce risk is it good practice to apply a preferential order; elimination, substitution, prevention, reduction and mitigation. In the context of this ALARP Assessment Framework for oil spill response, all control measures are response strategies to reduce the impacts of an unplanned event that has already occurred. All source control response measures may be classed as ‘reduction’ in the hierarchy of controls with all other response measures classed as ‘mitigation’.

The ALARP Assessment Framework is shown in **Figure B-1.**

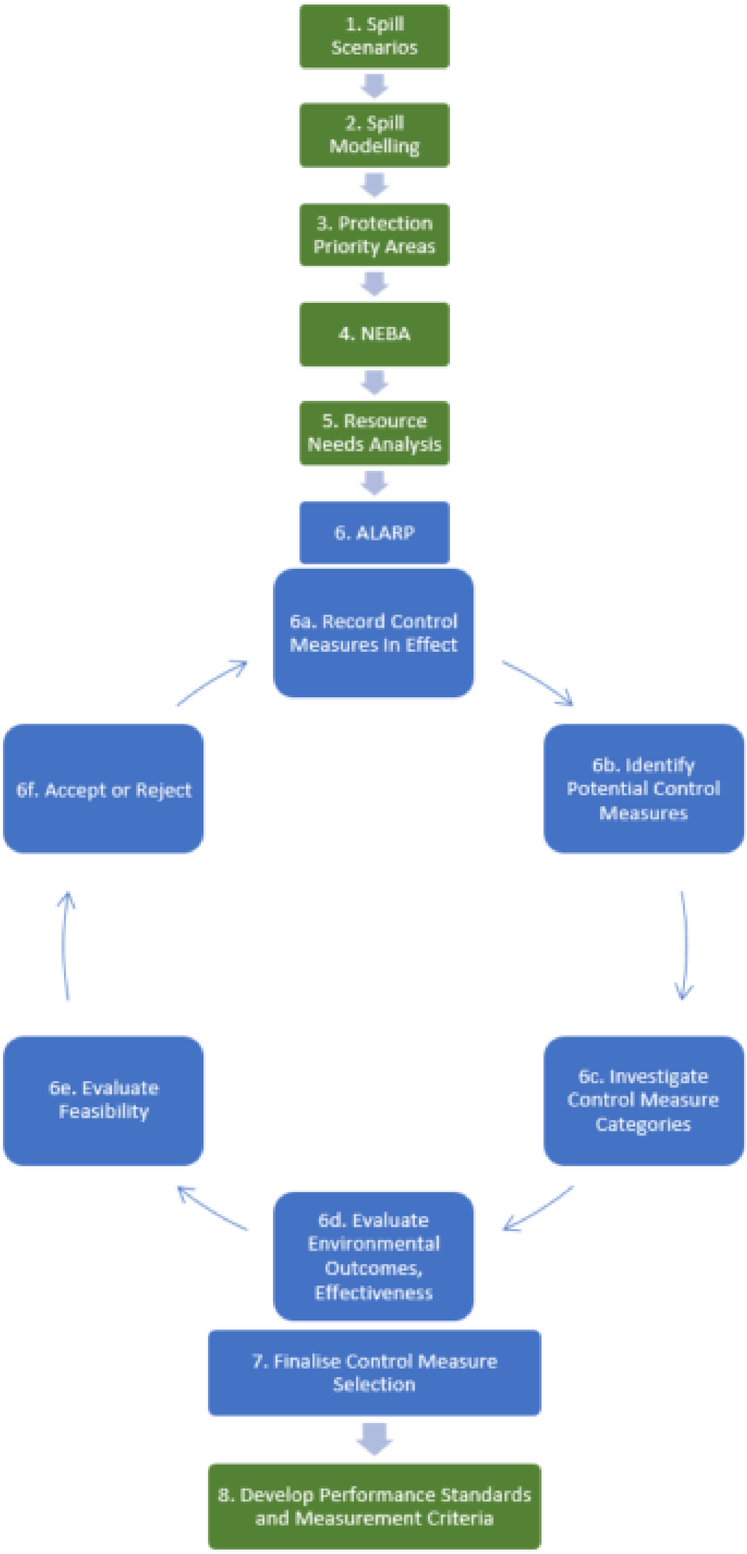


Figure B-1: ALARP Assessment Framework

In **Figure B-1**, Steps 1 to 5 (in GREEN) denote input information into the ALARP Assessment Framework. This information comprises:

1. <u>Spill Scenarios</u>: This step will involve assessing all possible spill scenarios from the activity and identifying the worst-case credible scenarios as a basis for pollution response planning.

2. Spill Modelling: A quantitative spill modelling assessment is conducted for the worst-case credible scenarios identified in Step 1.
3. Protection Priority Areas: The Environment that may be Affected (EMBA) is the largest area within which impacts from hydrocarbon spills associated with the activity could extend. The EMBA is predicted using spill modelling results from Step 2. Protection Priority Areas are locations of high ecological value within the EMBA that would be targeted in response. Selection of Protection Priority Areas is detailed in the Oil Spill Risk Assessment and Response Planning Procedure QE-91-II-20003
4. NEBA: Net Environmental Benefit Analysis (NEBA) is used to select the most effective response strategies to protect the Protection Priority Areas identified in Step 3.
5. Resource Needs Analysis: For the response strategies identified through NEBA, the worst-case resource, timing, and location requirements are determined, using quantitative spill modelling information where applicable. An Implementation Guidance is then developed to detail what arrangements and actions are required to be initiated by the Incident Management Team (IMT) to meet the incident requirements up to a worst-case incident.

Through the development of the Implementation Guidance, it may be possible to identify resource, timing and location requirements that could be improved. These areas of improvement should be noted in the ALARP so that additional, alternative or improved control measures can be considered in this context.

A detailed ALARP Assessment Framework for the evaluation of control measures is shown in Figure 1, Step 6 (in BLUE). Criteria and definitions used to evaluate control measures are shorn in Table 1.

6a) Record Control Measures In Effect: The spill response control measures currently in place for Santos Offshore are listed here. The environmental outcomes and effectiveness of the in-effect control measures are noted, using the Resource Needs Analysis to assess whether there are any areas of improvement. Environmental outcomes include potential harmful effects of control measures.

6b) Identify Potential Additional Control Measures: Potential control measures are identified, with a focus on any control measures that address areas of improvement identified in Step 6a.

6c) Investigate Control Measure Categories: In-effect and potential control measures from Steps 6a and 6b are classified as either additional, alternative or improved, and as either people, system, equipment or procedures. This step serves as a prompt to ensure that potential control measures from all categories are explored.

6d) Evaluate Environmental Outcomes, Effectiveness: The environmental outcomes and effectiveness are assessed for all control measures identified and described through Steps 6a, b and c.

6e) Evaluate Feasibility: Time, cost and effort required for implementation are assessed for all control measures identified and described through Steps 6a, b and c.

6f) Accept or Reject: The potential control measure will be accepted or rejected on the basis of environmental outcomes and effectiveness described in Step 6d and whether cost is grossly disproportionate, as described in Step 6e.

When evaluating potential control measures, implementation plans of in-effect control measures are carefully considered to ensure that any accepted control measures will equal or improve Santos capacity to meet resource needs. Potential control measures are also considered within the context of current Santos response arrangements to determine if synergies or resource conflicts might occur.

As control measures are evaluated for selection or rejection, they can be compared with industry good practise to ensure that all practicable control measures were implemented. Where unique circumstances exist and further analysis is required, a different evaluation technique may be used, such as technical analysis, detailed cost benefit analysis or combination of approaches.

New information on risks, impacts and response strategies obtained through analysis of operations, exercises and scheduled documentation reviews can be incorporated into the ALARP Assessment Framework cycle in a process of continual improvement.

In **Figure B-1**, Steps 7 and 8 show the conclusion of the ALARP Assessment Framework:

7. Finalised Control Measure Selection: Outputs from the ALARP Assessment shown in Step 6 comprise finalised control measures (in BLUE).
8. Develop Performance Standards and Measurement Criteria: For each control measure finalised in Step 7, performance standards and measurement criteria are then developed and documented in the OPEP (in GREEN).

Performance standards for all accepted control measures should be written to enable the operator to measure, monitor and test effectiveness. Only the key aspects of any given control will require performance standards and these may include the various measures of effectiveness; functionality, availability, reliability, survivability, dependency and compatibility. Parameters set in the performance standard should be 'SMART'; specific, measurable, appropriate, realistic and timely.

Corrective action based on deviations or trends in performance should be taken by amending either the performance standard or the control measure, as appropriate.

4. Criteria and definitions

Standardised criteria and definitions are used to bring consistency to the ALARP assessment across diverse activities and response strategies. Criteria and definitions are shown in **Table B-1**.

Table B-1: Criteria and definitions of ALARP Assessment Framework

Column	Description
Strategy	Response Strategy
Control Measure	Aspect of Response Strategy being evaluated Description of the control measure that is In Effect or description of the potential control measure
In Effect, Alternative, Additional, Improved	In Effect control measures are already in place. Alternative control measures are evaluated as replacements for the control already in effect. Additional control measures are evaluated in terms of their ability to reduce an impact or risk when added to the existing suite of control measures. Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures. Adapted from NOPSEMA Guideline Environment Plan Decision Making N-04750-GL1721 Revision 6 – November 2019
Control Measure Category	A range of different types of controls generally provide effective protection as they provide independence and multiple layers of protection. The OPGGS(S) Regulations refer to technical and 'other' controls where technical control measures involve hardware like shutdown valves and alarms. 'Other' control measures include administrative and procedural control measures such as inductions, a drug and alcohol policy or an inspection regime. Industry practice has further developed this concept of a range of different types of controls based on a POiSTED framework to assess organisational capability: People – personnel System – organisation, information/communications, support facilities, training/ competency Equipment – equipment Procedures – doctrine Santos aims to implement a range of different types of controls where possible.
Environmental Outcomes	Assessment of environmental benefits, particularly those over and above those environmental benefits documented in the Control Measure that is in effect.

Column	Description
	Environmental impacts of the Control Measure are also considered here.
Effectiveness	The effectiveness of a Control Measure in reducing the risk to ALARP is evaluated using the following six criteria. Functionality The functional performance of a control measure is what it is required to do. How does the control perform in order to achieve the required risk reduction? Availability Probability that the control measure will be available when required and has not failed or is undergoing a maintenance or repair. Reliability The reliability of a control measure is the probability that at any point in time it will operate correctly for a further specified length of time. Reliability is all to do with the probability that the system will function correctly and is usually measured by the mean time between failure. Survivability Whether or not a control measure is able to survive a potentially damaging event such as fire or explosion is relevant for all control measures that are required to function after an incident has occurred. To achieve their purpose, oil spill response control measures should have high survivability. However, some control measures, such as those involving equipment deployment from an FPSO would have low survivability in an incident that involves an FPSO explosion or fire. Dependency The dependency of the control measure is its degree of reliance on other systems in order for it to be able to perform its intended function. If several control measures can be disabled by one failure mechanism (common mode failure), or the failure of one control measure is likely to cause the failure of others, then the control measures are not independent and it may not be appropriate to count such measures as separate. Several control measures are reliant on equipment, people and vessels, hence have high dependence. Compatibility Whether or not a control measure is compatible takes into account how alternative control measures may interact with other controls and the rest of the facility, if introduced. Consideration should be given to whether new control measures are compatible with the facility and any other control measures already in use. Adapted from NOPSEMA Guidance Note Control Measures and Performance Standards N04300-GN0271 Revision No 4 Last Reviewed 2020
Feasibility	Feasibility describes the time, cost and/or effort required to implement the Control Measure.
Accept/ Reject	Outcome of assessment and key reasons for the decision

Appendix C: Pollution report

Department of **Transport**

When blank, this form is classed as **OFFICIAL**, when filled out, this form is classed as **OFFICIAL-SENSITIVE.**

Marine Pollution Report (POLREP)

BEFORE completing this form please contact the MEER duty officer on (08) 9480 9924 (24hrs). Immediate reporting will enable a rapid response.

Return completed form to:
Maritime Environmental Emergency Response
Department of Transport
Email: marine.pollution@transport.wa.gov.au and rccaus@amsa.gov.au
Phone (08) 9480 9924
Fax: 1300 905 866

INCIDENT DETAILS

Date of Incident:________________ Time of Incident *(24 hr format)*: ________________

Location name/description: ________________________________

Incident Coordinates Latitude of spill________________ Longitude of spill ________________

Format of coordinates used *(select one)* ☐ *Degrees & decimal degrees* ☐ *Degrees, minutes & decimal minutes* ☐ *Degrees, minutes & seconds*

Description of Incident: ________________________________

POLLUTION SOURCE

☐ Vessel ☐ Land *(Specify)* ________________ ☐ Other *(Specify)* ________________ ☐ Unknown

Vessel type *(if known)* ☐ Tanker ☐ Container ☐ Bulk ☐ Cargo
☐ Fishing ☐ Defence ☐ Recreational ☐ Other *(Specify)*________________

Vessel name:________________ Flag State / Callsign:________________ Australian vessel? ☐ Yes ☐ No

POLLUTANT

☐ **Oil** ***(type)*** ☐ Bilge ☐ Diesel ☐ HFO bunker ☐ Crude ☐ Unknown ☐ Other *(Specify)*________________

☐ **Chemical** Name:________________ MARPOL cat / UN Nos: ________________

☐ **Garbage** Details/description: ________________

☐ **Packaged** Details/description: ________________

☐ **Sewage** Details/description: ________________

☐ **Other** Details/description: ________________

EXTENT

Size of spill ***(length & width in metres):*** ________________

Amount of pollutant, if known ***(litres):*** ________________

Has the discharge stopped? ☐ Yes ☐ No ☐ Unknown

Weather conditions at site: ________________

☐ **Photos taken** Details:________________ held by: ________________

☐ **Video taken** Details:________________ held by: ________________

☐ **Samples taken** Description:________________ held by: ________________

☐ **Items retrieved** Description:________________ held by: ________________

ADDITIONAL INFORMATION

Response action undertaken? ☐ Yes ☐ No If yes, provide details below, please include any environmental impact.

Equipment used? ☐ AMSA ☐ State / NT ☐ Industry

Is assistance for an investigation required from DoT ◯ Yes ◯ No

ORIGINAL REPORT SOURCE

Name:__________ Position:__________ Phone: __________

Combat agency:__________ Statutory agency: __________

SENDER DETAILS

Name:__________ Agency:__________ Date:__________

Phone: __________ Fax: __________ Email:__________

PRIVACY STATEMENT

The Department of Transport is collecting the information on this form to enable it to carry out its role as Jurisdictional Authority as per WestPlan - Marine Oil Pollution. The Department of Transport and/or AMSA may give some or all of this information to other government bodies, non-government organisations who have responsibilities under the National Plan, and law enforcement agencies.

Once you have completed the form please check that all relevant fields have been filled with accurate data.
Please email completed form to marine.pollution@transport.wa.gov.au

Appendix D: Situation report

Department of
Transport

When blank, this form is classed as **OFFICIAL**, when filled out, this form is classed as **OFFICIAL-SENSITIVE.**

Marine Pollution Situation Report (SITREP)

Send completed form to:
Maritime Environmental Emergency Response
Department of Transport
GPO Box C102 PERTH, WA 6839
Email: marine.pollution@transport.wa.gov.au
and rccaus@amsa.gov.au
Fax: 1300 905 866

MARINE POLLUTION SITUATION REPORT (SITREP)

This is advice from the Control Agency of the current status of the incident and the response.

This form is transmitted to all relevant agencies including:

- Jurisdictional Authority
- Support Agencies

Incident Name:______________________________ **Ref. No.** ________________

Priority ☐ Urgent ☐ Immediate ☐ Standard

Final SITREP? ☐ Yes ☐ No Next SITREP on: ____________

Date:____________________ **Time:**______________

POLREP Reference: ______________________________

Incident location Latitude________________ Longitude________________

Brief description of incident and impact:

Overall weather conditions:

Summary of response actions to date:

Current Strategies:

Summary of resources available/deployed:

Expected developments:

Other Information:

SITREP Prepared By	Name:	
	Agency:	
	Role:	
	Contact	Telephone
		Fax
		Mobile
	No of Pages Attached:	

To post the form please click on the "POST" button below

POST

RESET

MEP_Sitrep_1114

Appendix E: Vessel surveillance observer log

Santos

Vessel Surveillance Observer Log – Oil Spill

Survey Details			
Date	Start time:	End Time:	Observers:
Incident:			Area of Survey:
Vessel:			Master:

Weather Conditions	
Wind speed (knots):	Wind direction:
Time high water and height (LAT):	Current direction:
Time low water and height (LAT):	Current speed (nM):
Tide during observations:	Sea state:
Stage of tide during observations (incoming/falling):	Other weather observations:

Santos

Slick Details						
Slick grid parameters by lat/long:		Slick grid parameters (vessel speed)		Slick grid dimensions: N/A		
Length Axis:	Width Axis:	Length Axis: N/A		Width Axis	Length	nm
Start Latitude	Start Latitude	Time (seconds)		Time (seconds)	Width	nm
Start Longitude	Start Longitude				Length	nm
End Latitude	End Latitude	Speed (knots)		Speed (knots)	Width	nm
End Longitude	End Longitude				Grid area	km^2

Code	Colour	%age cover observed	Total grid area		Area per oil code		Factor	Oil volume	
1	Silver			km^2		km^2	40-300 L/ km^2		L
2	Iridescent (rainbow)			km^2		km^2	300-5,000 L/ km^2		L
3	Discontinuous true oil colour (Brown to black)			km^2		km^2	5,000-50,000L/ km^2		L
4	Continuous true oil colour (Brown to black)			km^2		km^2	50,000 – 200,000 L/ km^2		L
5	Brown / orange			km^2		km^2	>200,000 L/ km^2		L

Timeline of observations:

Time	Description

Appendix F: Aerial surveillance observer log

Aerial Surveillance Observer Log – Oil Spill

Survey Details				
Date:	Start time:	End Time:	Observer/s:	
Incident:			Area of Survey:	
Aircraft type:	Call sign:		Average Altitude:	Remote sensing used:

Weather Conditions	
Wind speed (knots)	Wind direction
Cloud base (feet)	Visibility
Time high water	Current direction
Time low water	Current speed (nM)

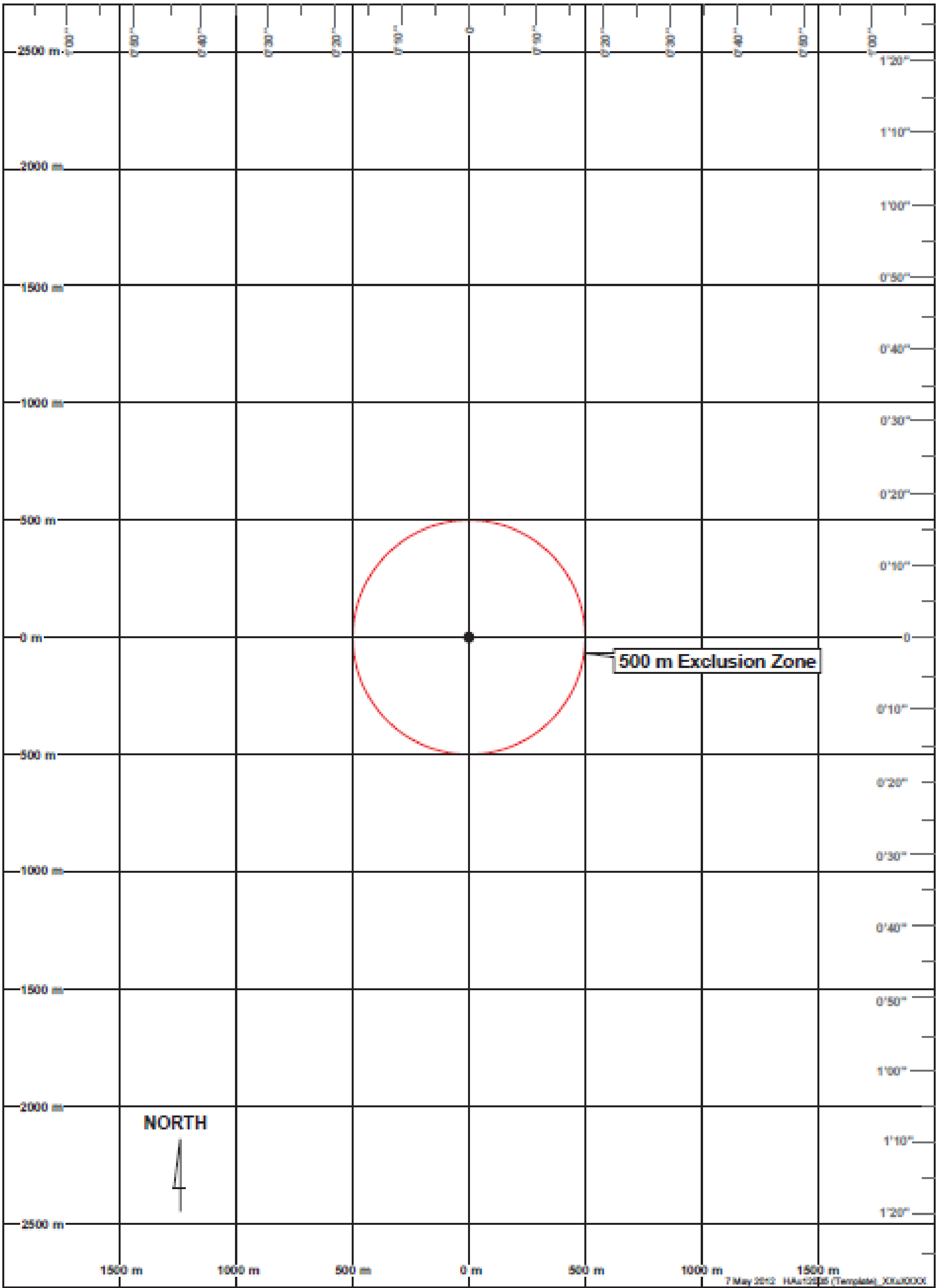
Santos

Slick Details						
Slick grid parameters (lat/long)		Slick grid parameters (air speed)		Slick grid dimensions		
Length Axis	Width Axis	Length Axis		Width Axis	Length	nm
Start Latitude	Start Latitude	Time (seconds)		Time (seconds)	Width	nm
Start Longitude	Start Longitude				Length	nm
End Latitude	End Latitude	Air Speed (knots)		Air Speed (knots)	Width	nm
End Longitude	End Longitude				Grid area	km^2

Code	**Colour**	**% cover observed**	**Total grid area**		**Area per oil code**		**Factor**	**Oil volume**	
1	Silver			km^2		km^2	40-300 L/ km^2		L
2	Iridescent (rainbow)			km^2		km^2	300-5,000 L/ km^2		L
3	Discontinuous true oil colour (Brown to black)			km^2		km^2	5,000-50,000L/ km^2		L
4	Continuous true oil colour (Brown to black)			km^2		km^2	50,000 – 200,000 L/ km^2		L
5	Brown / orange			km^2		km^2	>200,000 L/ km^2		L

Appendix G: Aerial surveillance surface slick monitoring template

AERIAL SURVEILLANCE SURFACE SLICK MONITORING TEMPLATE



	NAME:	VESSEL / AIRCRAFT:
	DATE / HOUR:	OTHER REFERENCE:

Appendix H: Aerial surveillance marine fauna sighting record

Santos

OIL SPILL SURVIELLANCE - MARINE FAUNA SIGHTING RECORD SHEET

Date:		**Time:**	
Latitude:		**Longitude:**	

MARINE FAUNA ID GUIDE


◯ Humpback whale


◯ Blue whale


◯ Minke whale


◯ Sperm whale


◯ Killer whale


◯ Bryde's whale

◯ Whale species unknown


◯ Whale shark


◯ Dugong


◯ Hawksbill turtle


◯ Loggerhead turtle


◯ Green turtle


◯ Flatback turtle


◯ Bottlenose dolphin


◯ Spinner dolphin

◯ Dolphin species unknown


◯ Leatherback turtle

◯ Turtle species unknown

Santos

FAUNA DETAILS					
Category	**Type/species?** **Adult/juvenile?** **ID confidence?**	**Number**	**Date/Time**	**Photo/ video taken?** **Reference No.**	**<u>Behaviour / Comments.</u>** **Proximity to oil? Oiled?** **Milling? Feeding? Transiting?**
Cetaceans (Whales/ Dolphins)					
Turtles					
Birds					
Dugongs					
Sharks					
Other					

Santos

Other details for each observation location

WEATHER DETAILS

Sea State ◯ Mirror calm ◯ Small waves ◯ Slight ripples
◯ Large waves some whitecaps ◯ Large waves, many whitecaps

Visibility ◯ Excellent ◯ Good ◯ Moderate ◯ Poor ◯ Very Poor

OBSERVER DETAILS

Observer Name	Observer signature	**Observer** ◯ Inexperienced ◯ Experienced

Appendix I: Oiled wildlife response personnel and equipment

In the event of a spill impacting wildlife, Santos will commence arrangements to mobilise personnel and equipment to fill responder positions as identified in the WAOWRP. An overview of sources of personnel is provided in Table 1 and an overview of ‘first-strike’ equipment for initial deployment is provided in Table 2.

In the event of large-scale OWR, further specialised OWR equipment and personnel will be provided by in-country and international organisations, as necessary, accessed through AMOSC (primary) and OSRL (secondary). Equipment and personnel required for the development and operation of staging areas/ treatment facilities can be provided locally (for example veterinary personnel and supplies). The East Kimberley regional operational OWR plan and the West Kimberley regional operational OWR plan (as per the WAOWRP) provide detail of local organisations and suppliers for personnel and equipment.

In addition to OWR providers mobilised through AMOSC and OSRL/Sea Alarm, Santos maintains access to the workforce marketplace during an emergency response. Level 1 oiled wildlife responders, of which the WAOWRP indicates 90+ could be required for a Level 6+ event, could be provided through Santos workforce hire arrangements. On the job training requirements for Level 1 responders could be provided by DBCA, AMOSC or Sea Alarm personnel. Skilled but ubiquitous roles required for manning and maintaining facilities and staging areas, such as trades, technicians and vets, could also be filled through workforce hire arrangements. The East Kimberley regional operational OWR plan and the West Kimberley regional operational OWR plan (as per the WAOWRP) provide contact details for local trade personnel, vets and wildlife specialists that could be employed for manning/maintenance of forward response wildlife response facilities.

Table 1: Sources of Oiled Wildlife Response Personnel

<table>
<tr><th colspan="2">AMOSC / INDUSTRY RESPONDERS</th><th>Activated through</th><th>Capability</th></tr>
<tr><td colspan="2">AMOSC Technical Advisor – Oiled Wildlife – assistant in IMT (as industry OWA if required)</td><td rowspan="3">AMOSC Duty Officer</td><td>1*</td></tr>
<tr><td colspan="2">AMOSC OWR Industry Team– Level 2-4 responders (DBCA training)</td><td>18*</td></tr>
<tr><td colspan="2">WA Petroleum industry personnel – Trained by individual petroleum industry companies – activated via mutual aid</td><td>~50*</td></tr>
<tr><th colspan="2">AUSTRALIAN OWR EXPERTISE</th><th>Activated through</th><th>Capability</th></tr>
<tr><td colspan="2">Blue Planet Marine (ACT and WA) – Oiled Wildlife Responders</td><td rowspan="3">AMOSC Duty Officer</td><td>10-20*</td></tr>
<tr><td colspan="2">Phillip Island National Parks(VIC) – Oiled Wildlife Responders</td><td>~70 staff
~45 volunteers*</td></tr>
<tr><td colspan="2">NatPlan Mutual Aid</td><td>50-100*</td></tr>
<tr><td rowspan="2">Perth Zoo – Duty Veterinarian</td><td>Wildlife care and rehabilitation advice, expertise and management</td><td colspan="2" rowspan="2">Personnel potentially available to petroleum industry (currently there is no formal arrangement)</td></tr>
<tr><td>Links to wildlife</td></tr>
</table>

	rehabilitation networks		
OWA		DBCA State Duty Officer	1 per shift
Personnel			
DBCA staff with wildlife and emergency management skill set who currently operate in fire preparedness and response			
INTERNATIONAL OWR EXPERTISE		Activated through	Capability
DwyerTECH NZ – Facilities Management Personnel (call-off contract)		AMOSC Duty Officer	2*
Wild base, Massey University (NZ) - Oiled Wildlife Responders			4-6*
International Bird Rescue (USA)- Oiled Wildlife Responders			4*
Sea Alarm (Belgium) – Expert assistance with organisational set-up and global OWR resourcing		OSRL Duty Officer	2/3** (Sea Alarm) + additional OWR responders accessed through global network

* As per AMOSC Oiled Wildlife Response Capacity Statement, 25 Jun 2020
** As per Sea Alarm/OSRL Service Level Agreement Statement

Table 2: First Strike Deployment-Ready OWR Equipment

AMOSC OWR Equipment*	Activated through	Location
1 x AMOSC owned OWR container 1 x AMOSC owned box kit 1 x Fauna Hazing and Exclusion kit	AMOSC Duty Officer	Fremantle
1 x AMOSC owned OWR container 1 x AMOSC owned box kit 1 x Fauna Hazing and Exclusion kit		Geelong
1 x AMOSC owned box kit		Exmouth
1 x AMOSC owned box kit		Broome
National Plan (NatPlan) OWR Equipment*	Activated through	Location
1 x NatPlan OWR container 1 x NatPlan/DBCA Box/trailer kit	AMSA RCC	Dampier

1 x NatPlan OWR container		Darwin
1 x NatPlan OWR container		Townsville
1 x NatPlan OWR container		Devonport
WA DBCA OWR Equipment*	Activated through	Location
1 x DoT OWR container	DoT Duty Officer	Fremantle
DBCA OWR trailer kit		Karratha
DBCA OWR trailer kit		Kensington
NSW Maritime OWR Equipment*	Activated through	Location
1 x NSW Maritime OWR container	AMSA RCC	Sydney
OSRL OWR Equipment**	Activated through	Location
1 x Search and rescue response package 1 x Cleaning and rehabilitation response package 1 x Cleaning and rehabilitation medical package	OSRL Duty Officer	UK
1 x Cleaning and rehabilitation response package		Singapore
2 x Search and rescue response package 1 x Cleaning and rehabilitation response package		Bahrain
1 x Cleaning and rehabilitation response package		Fort Lauderdale, USA

* As per AMOSC capacity statement 25 June 2020
** As per OSRL SLA Equipment Report August 2021

Appendix J: Scientific monitoring plans

1 Scientific Monitoring Principles

1.1 Monitoring Design

In the event of an oil spill the monitoring design will depend upon the nature of the spill, the availability of baseline data in relation to the spill extent and expert opinion. In order to ensure the application of robust designs and sampling approaches which have the highest likelihood of detecting an environmental impact while allowing suitable flexibility, this plan provides a set of Guiding Principles for monitoring design and sampling (**Table 1**). A structured decision making framework for allocating monitoring effort in both time and space is described in **Figure 1**.

Table 1: Guiding Principles for Oil Spill Monitoring Design and Methodologies.

Principle	Explanation	Key guiding references
Match baseline	Designs and methodologies should follow those used in appropriate baseline studies wherever possible.	N/A
Comprehensive sampling	Sampling methods should seek to sample the full range of taxa within each assemblage. This may require the use of several complimentary techniques (the exception is if indicator taxa are employed; see below).	N/A
Reliable indicator taxa	If indicator taxa are targeted then the choice of indicator should be defensible, and a link to the response of the broader assemblage demonstrated. Indicators of ecosystem function should also be considered.	Hilty and Merenlender (2000)
Appropriate sample area or volume	Size of sampling unit should be determined based on the level of clustering of individuals and whether the goal is to quantify this clustering, or establish low inter-sample variability (probably more the latter for oil spill studies).	Kenkel et al. (1989)
Reduce within sample variation over time	Wherever possible repeated measures are carried out on the same sample space in order to reduce within treatment variation.	N/A
Compositing of samples	Appropriate compositing to increase statistical power should be considered.	Carey and Keough (2002)
Account for environmental gradients and partition variations	Sources of variation are considered and compartmentalised to best reduce within treatment variation, and thereby maximise power to detect an impact. This is managed through several means:	English et al. (1997), Snedecor and Cochran (1989)

Principle	Explanation	Key guiding references
	Environmental covariates are considered in sampling design recorded and incorporated statistically. A hierarchical or stratified sampling design is used to address variation at multiple scales Design is standardized, by sampling equivalent strata (e.g., level of exposure, depth etc.).	
Assess statistical power	Where null-hypothesis tests are planned, statistical power of the design is assessed prior to execution.	Gerrodette (1987) Legg and Nagy (2006) Toft and Shea (1982)
Appropriate sampling extent	Sample the range of hydrocarbon concentration (and at least the upper end).	Skalski (1995)
Independence amongst samples	Site selection should aim for independence amongst samples and potential spatial or temporal autocorrelation should be considered.	Hurlbert (1984)
Reduce observation error	Observer bias and amongst observer variation should be considered.	Thompson and Mapstone (1997)
Appropriate spatial replication	Sites are replicated. A limitation is that there is only one spill, but control sites should be replicated and spatially Interspersed. Ideally, the design should be able to detect an impact at several possible scales.	Underwood (Underwood 1991, 1992, 1994)
Appropriate temporal replication	Sampling should account for natural temporal variation.	Underwood (Underwood 1991, 1992, 1994)

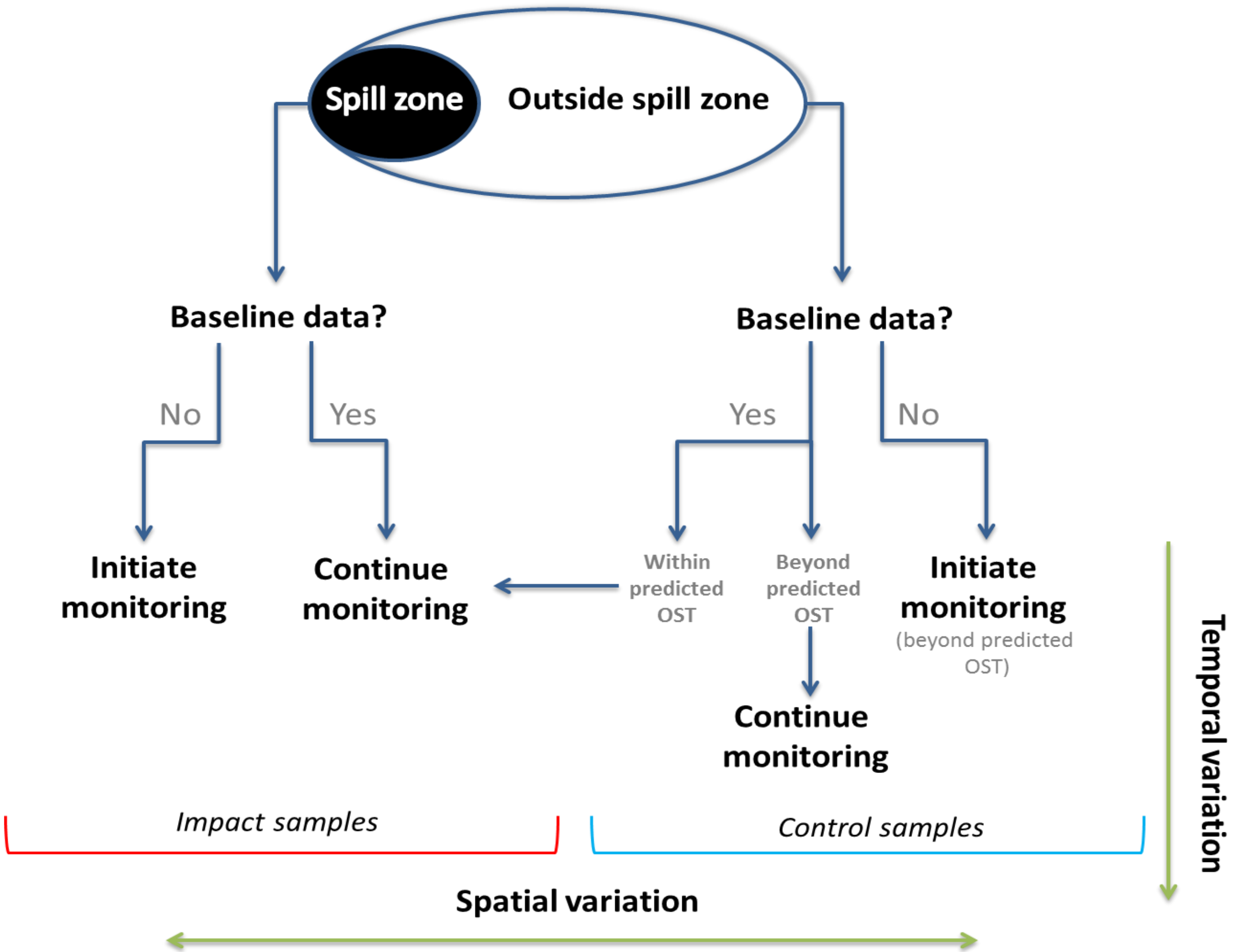


Figure 1: Structured Decision Making Process Based on Gregory et al. (2012) in Reference to Monitoring Programs, the Availability of Baseline Data, and Oil Spill Trajectory. An ideal design sampling would occur across a gradient of exposure rather than 'impact' and 'control' per se.

1.2 Data Analysis

Appendix B details the most important approaches to statistical analysis and related sampling design. These approaches are summarised in Table 2 (below). An important consideration is how this information is best summarised and communicated to guide further decision making and management. **Appendix B** also describes the reporting of environmental outcomes through the use of report card systems and includes a summary of their structure and design.

Table 2: Summary of Data Analysis Techniques.

Analysis type		Description	Strength	Limitations	Addressing limitations
Gradient analysis		Impact is quantified in terms of distance from spill.	Can be established post-spill.	Doesn't account for inherent spatial patterns present prior to spill.	Include spatial covariates in model. Incorporate a temporal component.
Control chart	Univariate	Single variable is monitored and plotted over time, and breaching of control limits tested.	Control sites are not required. Takes account of natural variation in system.	Control limits do not necessarily have biological meaning. Doesn't control for broader spatial scale temporal variation.	Include control charts for control sites which incorporate broad scale temporal variation.
	Multivariate	Multiple variables are combined, monitored and plotted over time, and breaching of control limits tested.	Ability to combine suite of data (e.g. community composition) into one variable. Sites plots not required.	Individual responses are masked. Control limits do not necessarily have biological meaning. Significant control limits challenging to define. Direction of change is undefined.	Compliment with graphical approaches to identify direction of change and individual species responses.
	Reference	Control limits are based on knowledge of biological system (e.g. minimum viable population size, toxicity).	Control limits have recognised biological meaning or consequence.	Control limits may be considered arbitrary.	Use established standards for control limits.

Analysis type	Description	Strength	Limitations	Addressing limitations
BACI	Quantifies state before and after potential impact, and also at impacted and control sites. Impact is tested by statistical interaction of terms.	Controls for natural variation, by incorporating control sites.	Limited power to detect significant impact. Requires appropriate matching of control (non-impacted) sites. Requires pre-impact data.	Increase power by increasing temporal component. Choose indicators with low natural variability.

2 Scientific Monitoring Plans by Receptor

Table 3 provides a glossary of an SMP as prepared in this report.

Table 3: Glossary of Scientific Monitoring Plans.

SMP Receptor	
Rationale	Importance of receptor, possible impact and importance of monitoring program.
Aim	Description of program aim(s)
Baseline	Refer to **Table 2**, detailed in Baseline Data Review (Astron Environmental Services 2019) (QE-00-BI-20001)
Contact	Contact is defined as occurring where any aerial, visual or florescence observation reports submitted to the Incident Command Team (ICT) show presence or likely presence of oil; or spill fate modelling predicts oil at sensitive receptors of > 1g/m^2 for surface oil, and >10 ppb for entrained and dissolved oil. This then activates the relevant SMP, which determines if any impact has occurred based upon applicable thresholds.
Initiation criteria	Initiation criteria, based on data from OMPs.
Termination criteria	Termination criteria based on analysis of Scientific Monitoring data translated to the Incident Management Team (IMT) through the planning function.
Receptor impact	Measured states and pressures according to the State-Pressure-Response model.
Methodological approach	Descriptions of sampling methods in order to carry out scientific monitoring, including reference to methods described in an appendix.
Scope of works	Timeline for scope of works (SoW) development.
Statistically significant	The basis of the significance is determined by the methodological approach as outlined in the relevant SMP.
Resources	List of required resources which may not necessarily be listed within a description of a particular method as described in **Appendix C**.
Implementation	Mobilisation requirements for service provider(s).
Analysis and reporting	Summary of analysis, data management and reporting.

SMP1 – Marine Water Quality	
Rationale	The release of hydrocarbons at sea will pollute marine waters via floating, entrained or dissolved aromatic hydrocarbons. The water quality SMP may also be used in conjunction with OMP1 (Surveillance and Monitoring), to inform the sampling design of other SMPs where objectives are to evaluate impact to and recovery of sensitive receptors, in relation to hydrocarbon contamination.
Aim	To monitor changes in water quality following an oil spill and associated response activities for the purpose of detecting a potential impact and recovery and for informing other scientific monitoring studies.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). In addition, relevant available metadata will be reviewed for applicable marine water quality baseline data. In the absence of baseline data for hydrocarbons, data from appropriate reference sites will be used in place of the baseline values.
Initiation criteria	Upon notification of a Level 2 or 3 incident (a level 2 or 3 incident includes those which may have an adverse effect on the environment. This may be informed by operational water quality monitoring)
Termination criteria	Concentrations of hydrocarbon contaminants, attributable to the released hydrocarbon, are not significantly higher than baseline data or similar non-impacted sites data. In the absence of baseline or similar non-impact sites data, concentrations of hydrocarbon contaminants, attributable to the released hydrocarbon, are below the relevant hydrocarbon contaminant trigger level within the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments 2018), or the relevant regulatory site-specific trigger level (where these exist), if this is lower and values are not significantly different to reference sites. Forensic fingerprinting of the released hydrocarbon and water quality sample analysis by way of gas chromatography/mass spectrometry (GC/MS) may be used to determine the source of contaminants where this is not otherwise clear from operational monitoring.
Receptor impact	Impacts to specific receptors from hydrocarbons within marine waters are described in individual SMPs.
Methodological approach	Overall sampling design approach will be enacted according to the availability of baseline data guided by the structured decision-making process based on Gregory et al. (2012): 1. If sites are contacted in which long-term baseline data is available, a control chart (time-series) design will be applied; 2. If insufficient long-term baseline data is available, where appropriately matched baseline data sites are impacted and non-impacted, a before-after-control-impact (BACI) approach to monitoring will be applied;

SMP1 – Marine Water Quality	
	3. Where no baseline data sites are involved, a gradient approach to quantifying impacts will be applied. See **Appendix B** and **Figure 1** for detailed description of these approaches. The selection of potentially impacted and non-impacted sites will be informed by Operational Monitoring, including operational water quality monitoring and spill trajectory modelling. Sampling frequency will be dictated by the spatial extent of the spill, the number and location of sampling sites and the philosophy of the sampling design. Water profiles SMP1 – Marine Water Quality A water quality probe will be used to measure conductivity (to derive salinity in PSU), temperature and depth (CTD), dissolved oxygen (% and mg/L), turbidity (FNU or NTU), and fluorometry along a depth profile. Sampling methods will be aligned with the recommended standard operating procedures for the use of sensors for oil spill monitoring found in Appendix F of the Oil Spill Monitoring Handbook (Hook et al. 2016). Water quality Water quality samples will be taken along a similar depth profile as the CTD measures using a Niskin bottle, Van Dorn water sampler, rosette sampler or equivalent instrument. The laboratory(ies) will inform and supply the appropriate sample containers, storage requirements, holding times, detection limits/limit of reporting for required analytes and the analysis required for each sample. Water samples shall be analysed for key contaminants of concern including polycyclic aromatic hydrocarbons (PAHs), monocyclic aromatic hydrocarbons (including benzene, toluene, ethylbenzene, xylene), and nutrients, metals and chlorophyll-a. At each site, replicate water samples (at least three samples) will be collected to allow appropriate statistical analyses to be made including samples for quality assurance and quality control (QA/QC) purposes (i.e. split sample, triplicate sample, field blanks, transport blanks). Water sample collection and handling will align with Standard operating procedures found in the Oil Spill Monitoring Handbook (Hook et al., 2016), specifically the following sections: + Appendix A & B hydrocarbon analysis; + Appendix C Volatile Organic Compounds Analysis; and + Appendix D Surface Oil Analysis. Environmental DNA (eDNA) will also be collected to detect for the presence of marine species in the water column. Water samples will be collected in Nalgene bottles and sent to an appropriate laboratory for analysis. Sample processing will depend on holding times required (<8 hours ideal) and may involve filtering and freezing of each sample (Grochowsi and Stat 2017).

SMP1 – Marine Water Quality	
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP having been activated.
Resources	+ Marine scientist with experience in water quality sampling + Geographic Information Systems (GIS) personnel + National Association of Testing Authorities (NATA) accredited laboratories for water sample analysis + Vessel and tender in operation + Refuelling facilities + Sample containers and preservative + Sampling equipment + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	Service provider able to mobilise within 72 hours of the SoW following approval by Santos (this time allows for costing, preparation of equipment and disposables and travel time to site).
Analysis and reporting	Chemical analysis will be carried out by NATA-accredited laboratories. A government endorsed laboratory for forensic fingerprinting (GS/MS) will be used. Data will be entered to spatially explicit database. Data will be analysed appropriately in order to determine if there was a statistical difference in water quality before and after a hydrocarbon impact. Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP2 – Sediment Quality	
Rationale	Hydrocarbons released during a spill scenario may contact, settle and/or accumulate in marine sediments. Toxic substances found in accumulated hydrocarbons may lead to impacts to ecosystem processes associated with this primary producer habitat. Sediments and marine infauna will be sampled concurrently in order to establish potential correlations amongst the two parameters.
Aim	To monitor the fate and persistence of hydrocarbons in marine sediments following an oil spill and associated response activities. To monitor marine benthic infauna assemblages as an indicator of sediment quality, in relation to an oil spill and associated response activities.

SMP2 – Sediment Quality	
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). In addition, relevant available databases will be reviewed for applicable marine baseline sediment quality and infauna data. In the absence of baseline sediment quality data, hydrocarbon contaminant trigger values for marine sediments as listed in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments 2018) will be used as a proxy for baseline levels. Where other regulatory site-specific trigger levels exist, the lower of these levels and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments 2018) levels will be used as proxy baseline levels.
Initiation criteria	Operational Monitoring or SMP1 indicates that contacted sediment or sediment predicted to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Concentrations of hydrocarbons in marine benthic and shoreline sediments, attributable to the released hydrocarbon, are not significantly higher than baseline or similar non-impact sites. In the absence of baseline or similar non-impact sites data, concentrations are below marine sediment quality interim guideline levels within the ANZG (2018), or the relevant regulatory site-specific trigger level (where these exist), if this is lower. For infauna assemblages, abundance and species diversity/richness/composition are not significantly different from baseline (where baseline data exists) or are not statistically significantly different from comparable non-impacted benthic infauna assemblages. Forensic fingerprinting of the released hydrocarbon and sediment quality samples by way of GC/MS may be used to determine the source of contaminants where this is not otherwise clear from operational monitoring.
Receptor impact	Impact to sediment quality is measured through change in hydrocarbon content and concentration. Change to sediment quality is also reflected by changes to infaunal assemblages. Potential impact to infaunal assemblages are measured through change(s) in: + Taxonomic diversity + Assemblage composition + Abundance of indicator species Other pressures to these states are: + Discharge of other toxicants + Physical disturbance including dredging + Sedimentation + Introduction of marine pests

<table>
<tr><th colspan="2">SMP2 – Sediment Quality</th></tr>
<tr><td></td><td>
+ Shading from marine infrastructure
+ Climate change
</td></tr>
<tr><td>Methodological approach</td><td>
Overall sampling design approach will be enacted according to the availability of baseline data guided by the structured decision-making process based on Gregory et al. (2012):
1. If sites are contacted in which long-term baseline data is available, a control chart (time-series) design will be applied;
2. If insufficient long-term baseline data is available, where appropriately matched baseline data sites are impacted and non-impacted, a before-after-control-impact (BACI) approach to monitoring will be applied;
3. Where no baseline data sites are involved, a gradient approach to quantifying impacts will be applied.
See Appendix B and Figure 1 for detailed description of these approaches. The selection of potentially impacted and non-impacted sites will be informed by Operational Monitoring, including operational water quality monitoring and spill trajectory modelling.
Sampling frequency will be dictated by the spatial extent of the spill, the number and location of sampling sites and the philosophy of the sampling design
<u>Sediment quality</u>
Operational Monitoring (including spill trajectory modelling) and the results of SMP1 Marine Water Quality monitoring will be used to inform the location of potentially impacted sediment sites.
Sediment monitoring sites in nearshore and shoreline locations will also consider and align where practicable, with sites selected for habitat monitoring (i.e. SMP3, 4, 5 and 6).
Sampling frequency will be dictated by the spatial extent of the spill, the number and location of sampling sites and the philosophy of the sampling design.
At each site, replicate sediment samples will be taken including those for QA/QC purposes.
Sediment grab (i.e. Van Veen or Box corer) or coring equipment will be selected based on water depth (offshore, inshore or shoreline) and sample size requirements.
Sediment sample collection and handling will align with Standard operating procedures found in the Oil Spill Monitoring Handbook (Hook et al. 2016), specifically the following sections according to sampling equipment utilised:
+ Appendix G hydrocarbon analysis (Grab samplers)
+ Appendix H hydrocarbon analysis (Ship borne corer)
+ Appendix H Manual push corer, and
+ Appendix O Sediment infauna.
The laboratory(ies) will inform and supply the appropriate sample containers, storage requirements, holding times, detection limits/limit of reporting for required analytes and the analysis required for each sediment sample.
</td></tr>
</table>

SMP2 – Sediment Quality	
	Sediment samples shall be analysed for key contaminants of concern including metals, hydrocarbons, nutrients, particle size distribution, and nutrients. <u>Infauna samples</u> A subset of the sediment sample shall be sieved in the field (if time permits) with collected infauna preserved (10% buffered formalin or 70% ethanol as prescribed by the receiving laboratory) and sent to laboratory for identification of infauna to lowest taxonomic resolution possible. eDNA will also be collected to detect for the presence of marine infauna species in sediments. Sediment will be removed from the surface of a subset of the sediment sample and sent to an appropriate laboratory for analysis.
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP having been activated.
Resources	+ Marine scientist with field experience in deep sea sediment sampling + Scientist with skills in infauna identification + GIS personnel + NATA accredited laboratory for sample contaminant analysis + Laboratory for infauna sorting and taxonomic identification + Vessel with appropriate davit/winch to deploy grab/corer equipment and tender in operation + Refuelling facilities + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	Service provider to be capable of mobilising within 72 hours of the SoW having been approved by Santos. Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and associated timing requirements.
Analysis and reporting	Sediment samples analysed by NATA-accredited laboratories for presence and concentrations of hydrocarbons associated with the spill including full suite PAHs and total organic carbon. A government endorsed laboratory for forensic fingerprinting (GC/MS) will be used. Infauna samples sorted and identified by qualified marine invertebrate specialist to acceptable taxonomic groups. Data will be entered to spatially explicit database and analysed statistically in order to detect significant differences among sites. Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review

SMP2 – Sediment Quality	
	of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP3 – Sandy Beaches and Rocky Shores	
Rationale	Contact of entrained oil and stranded floating oil of shoreline habitats may occur on sandy beaches and rocky shores. Rocky and sandy shores provide habitat for a variety of intertidal organisms, which in turn provide food for shorebirds. Large tides tend to create a large degree of horizontal zonation amongst taxa. Rocky and sandy shores are included within the one receptor as they are often spatially mixed and both represent high energy regions.
Aim	To monitor changes in biota of sandy and rocky shoreline habitats in relation to an oil spill and associated activities.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). In addition, relevant available databases shall be reviewed for applicable rocky shoreline and sandy beach biota baseline data.
Initiation criteria	+ Operational monitoring, SMP1 or SMP2 indicates that rocky and/or sandy shorelines are contacted or predicted to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Shoreline assemblage structure, and hydrocarbon concentration levels in representative invertebrate species, are not significantly different from their baseline state (where baseline data exists) or are not statistically significantly different from comparable non-impacted assemblages; AND SMP2 Sediment Quality monitoring at the site has been terminated AND Shoreline clean-up at the site has been completed.
Receptor impact	Impact to shoreline invertebrates from pressures including hydrocarbons is measured through change in: + Species diversity + Assemblage composition + Abundance of indicator taxa. Other pressures to these states are: + Physical disturbance + Discharge of toxicants + Litter/waste + Introduction of marine pests

<table>
<tr><th colspan="2">SMP3 – Sandy Beaches and Rocky Shores</th></tr>
<tr><td></td><td>+ Over-collection
+ Nutrification
+ Climate change.</td></tr>
<tr><td>Methodological approach</td><td>Monitoring will be designed as follows:
1. Where long-term baseline data sites are contacted, a control chart (time-series) design will be applied.
2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied.
3. Where no baseline data sites are involved, a post-spill pre-impact (preferable) or gradient approach to quantifying impacts will be applied.

Owing to potentially high spatial variation in assemblage structure, post-spill pre-impact monitoring will be a priority where no baseline data exists. If this opportunity is not available, a gradient approach to monitoring will be applied.

Sampling frequency will be dictated by the number and location of sampling sites and the philosophy of the sampling design.

Rocky shoreline intertidal assemblages (fauna and flora) will be monitored using a quadrat/transect approach, with the positioning of quadrats/transects accounting for any natural variation in assemblage structure along a seaward-landward gradient. Assemblage structure to be recorded through in-situ counts of fauna and flora or still images taken for further analysis.

Sandy shoreline infauna will be sampled by way of replicated grab/core samples. Sampling sites within impacted and non-impacted areas to consider any cross-shore gradient in assemblage structure that may exist. Where baseline data exists, the methodology will be adapted to available data so that results are comparable.

Samples to be sieved with collected infauna preserved (10% buffered formalin or 70% ethanol as prescribed by the receiving laboratory) and sent to laboratory for identification of fauna to lowest taxonomic resolution possible. Process to follow that for baseline data where this pre-exists.

Biomonitoring of hydrocarbon concentrations in shoreline invertebrates will occur through collection of replicated tissue samples from representative, and preferably widely available species, across impact and non-impacted locations.

The laboratory(ies) will supply and inform the appropriate method for collection, storage and holding times of tissue samples for required laboratory analysis and to avoid cross-contamination among samples.

Where limitations in the distribution and abundance of representative invertebrate species preclude collection of sufficient samples for analysis, in-situ biomonitoring using a locally available species (e.g. the use of caged oysters) shall be considered for assessing spatial and temporal changes in bioaccumulation of hydrocarbon concentrations in invertebrates across impact and reference sites.</td></tr>
</table>

SMP3 – Sandy Beaches and Rocky Shores	
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	+ Senior Scientist with experience in shoreline macroinvertebrates sampling + Supporting Scientist + GIS personnel + Helicopter or available vessel and tender in operation + Refuelling facilities + Sample containers and preservative + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby + Laboratory facilities for sorting and taxonomic identification of specimens
Implementation	With the aim of collecting post-spill pre-impact data, service provider able to mobilise within 72 hours of the SoW having been provided to them (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and associated timing requirements.
Analysis and reporting	Specimens not identified in situ (in the field) will be processed and identified in the laboratory by appropriately qualified scientists. Biota tissue samples (if collected) analysed for hydrocarbon contaminants by NATA-accredited laboratories. Data will be entered to spatially explicit database and analysed in order to test for significant difference between impacted and non-impacted assemblages. Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP4 – Shorelines and Coastal Habitats - Mangrove Communities	
Rationale	In the event of Tier 2 or 3 spill, mangroves may be contacted by floating or entrained oil. Mangrove health may be adversely affected due to increased concentration of hydrocarbons in sediments and coating due to surface oil, which in turn can lead to leaf-loss, mortality and a reduction in areal extent of mangrove habitat. This plan's focus is mangrove vegetation. Associated monitoring of sediment quality and mudflat fauna is described in SMP2 and SMP5, respectively.

SMP4 – Shorelines and Coastal Habitats - Mangrove Communities	
Aim	To monitor changes to mangrove extent and health in relation to an oil spill and associated activities.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). Baseline extent and of mangroves is monitored by remote sensing in several regions, and further historical and post-impact data for mangrove health and extent can be obtained as remotely sensed imagery (e.g., Sentinel, Landsat and WorldView).
Initiation criteria	Operational Monitoring, SMP1 or SMP2 indicates that mangroves are contacted or predicted to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Mangrove extent and health are not significantly different from their baseline state (where baseline data exists) or are not statistically significantly different from comparable non-impacted mangroves; AND Sediment quality monitoring (SMP2) at the site has been terminated; AND Shoreline response at the site has been completed.
Receptor impact	Impact to mangroves from pressures including hydrocarbons is measured through change in: + Tree health + Aerial extent. Other pressures to these states are: + Physical disturbance + Discharge of toxicants + Litter + Introduction of marine pests + Dust + Sedimentation from human activities + Climate change.
Methodological approach	Remote sensing data will be accessed for the purpose of detecting change in aerial cover and change in canopy health through and index of plant health (e.g., NDVI or MSAVI) (Astron Environmental Services 2013). Where long term on-ground baseline monitoring has occurred, further post impact on-ground monitoring should be carried out to complement any analysis of remote sensing. Analysis of long-term on-ground monitoring data will be as follows: 1. Where long-term baseline data sites (only) are contacted a control chart (time-series) design will be applied.

SMP4 – Shorelines and Coastal Habitats - Mangrove Communities	
	1. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. 2. Where no baseline data sites are involved a gradient approach to quantifying impacts will be applied (See **Appendix B** for detailed description of these approaches and **Figure 1,** detailed in Baseline Data Review (Astron Environmental Services 2019) (QE-00-BI-20001)). On-ground monitoring of mangroves will aim to detect change in mangrove health, including canopy cover and plant/leaf health indices. Field methodology will follow the routine monitoring techniques currently employed for Santos operations (Quadrant Energy Australia Limited 2018), adapting where required to align with pre-existing baseline field data, where available. Sampling of sediments as per SMP2 will occur at mangrove health assessment sites to allow any changes in mangrove health to be related to sediment hydrocarbon levels. In-field mangrove health sampling frequency will be dictated by the number and location of sampling sites and the sampling design applied.
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	+ Senior Scientist with experience in mangrove condition assessment + Supporting Scientist + GIS and remote-sensing personnel + Available vessel in operation + Satellite and/or aerial imagery
Implementation	On-ground monitoring will only occur where long-term baseline data has been collected, and hence no post-spill pre-impact data collection will be required. On-ground post-spill data will be collected at an appropriate time as guided by the analysis of remote sensing imagery, and potential on-ground assessment.
Analysis and reporting	Data will be entered to spatially explicit database and analysed in order to test statistically significant change to parameters associated with hydrocarbon spill. Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP5 – Shorelines and Coastal Habitats - Intertidal Mudflats	
Rationale	Intertidal mudflat communities are primary producer habitats which support invertebrate fauna, which in turn provides a valuable food source for shorebirds. High diversity of infauna (particularly molluscs) occur within these habitats and may be affected by

SMP5 – Shorelines and Coastal Habitats - Intertidal Mudflats	
	penetrating oil. At high tide, these habitats become foraging grounds for vertebrates such as rays and sharks. These habitats are at high risk of impact as the sheltered environments promote high faunal diversity combined with low-energy wave action.
Aim	To monitor changes in intertidal mudflat communities associated with an oil spill and associated activities.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). In addition, relevant available baseline databases shall be reviewed for applicable intertidal mudflat infauna baseline data.
Initiation criteria	+ Operational Monitoring, SMP1 or SMP2 indicates that mudflat habitats are contacted or predicted to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Mudflat infaunal assemblages are not significantly different from their baseline state (where baseline data exists) or are not statistically significantly different from comparable non-impacted assemblages; AND SMP2 Sediment Quality monitoring at the site has been terminated; AND Clean-up of the shoreline site has been completed.
Receptor impact	Impact to mudflat epifauna and infauna from pressures, including hydrocarbons, is measured through change in: + Species diversity + Assemblage composition + Abundance of indicator taxa. Other pressures to these states are: + Physical disturbance + Discharge of toxicants + Overfishing (bait collecting) + Introduction of marine pests + Climate change.
Methodological approach	Monitoring will be designed as follows: 1. Where long-term baseline data sites are contacted, a control chart (time-series) design will be applied. 2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. 3. Where no baseline data sites are involved a post-spill pre-impact (preferable) or gradient approach to quantifying impacts will be applied (See **Appendix B** for detailed description of these approaches and **Figure 1**).

SMP5 – Shorelines and Coastal Habitats - Intertidal Mudflats	
	Owing to potentially high spatial variation in assemblage structure, post-spill pre-impact monitoring will be a priority if baseline data are not available. If this opportunity is not available, a gradient approach to monitoring will be applied. Mudflat infauna will be sampled by way of replicated grab/core samples. Sampling sites within impacted and non-impacted areas to consider any cross-shore gradient in assemblage structure that may exist. Where baseline data exists methodology to adapt to available data such that results are comparable. Sites selected for mudflat infauna sampling to be concurrently sampled for sediment quality as per SMP2. Sampling frequency will be dictated by the number and location of sampling sites and the philosophy of the sampling design. Samples to be sieved with collected infauna preserved (buffered formalin or 70% ethanol as prescribed by the receiving laboratory) and sent to laboratory for identification of fauna to lowest taxonomic resolution possible. Process to follow that for baseline data where this pre-exists.
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	+ Senior Scientist with experience in epifauna and infauna assessment and sampling + Supporting Scientist + GIS personnel + Helicopter or available vessel and tender in operation + Refuelling facilities + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	With the purpose of collecting post spill pre-impact data, service provider able to mobilise within 72 hours of the scope of work having been provided to them (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilization time will depend on the decision to adopt post-spill pre-impact monitoring and associated timing requirements.
Analysis and reporting	Data will be entered to spatially explicit database and analysed to determine significant differences between impacted and non-impacted assemblages. Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

<table>
<tr><th colspan="2">SMP6 – Benthic Habitats</th></tr>
<tr><td>Rationale</td><td>Benthic habitats are those habitats associated with the seafloor. Major benthic habitats at risk are:
+ Coral reefs (likely high susceptibility to spill)
+ Macroalgae and seagrass (likely moderate susceptibility to spill)
+ Non-coral benthic filter feeders (likely moderate susceptibility to spill)
+ Sub-tidal pavement (likely moderate susceptibility to spill)
+ Soft-substrate (likely lower susceptibility to spill).
Macroalgal and seagrass communities are important primary producers that also provide habitat, refuge areas and food for fish, turtles, dugongs, and invertebrates. Seagrass and macroalgae also increase structural diversity and stabilise soft substrates. Non-coral benthic filter feeders, which include sponges, molluscs, sea whips and gorgonians, are considered indicators of disturbance due to their immobility and long life cycles. Corals are important primary producers that provide food, substrate, and shelter for a diversity of marine life, including invertebrates and fish. They also protect coastlines from wave erosion and provide important substrate for algae. Undisturbed intertidal and subtidal coral reefs occur in several locations throughout the region.</td></tr>
<tr><td>Aim</td><td>To monitor changes in the cover and composition of benthic habitats in relation to an oil spill and associated activities.
To monitor change in hard coral health and reproduction in relation to an oil spill and associated activities.</td></tr>
<tr><td>Baseline</td><td>Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0).
In addition, relevant available baseline metadata databases will be reviewed for applicable benthic habitat and coral health and reproduction baseline data.
Remote sensing data, satellite and aerial imagery previously acquired may also be applicable for shallow clear-water benthic habitats to detect changes in benthic habitat cover and composition.
Pollution-induced change to benthic habitat cover and composition may take some time to be detected. Therefore, post-spill, pre-impact benthic survey data will be collected when required to have a baseline state following initial oil contact.</td></tr>
<tr><td>Initiation criteria</td><td><u>Benthic habitat cover and composition</u>
Operational Monitoring, SMP1 or SMP2 indicates that subtidal benthic habitats are contacted or are predicted to be contacted by a hydrocarbon spill.
<u>Coral health and reproduction</u>
+ Operational Monitoring, SMP1 or SMP2 indicates that coral habitat is contacted or is predicted to be contacted by a hydrocarbon spill as defined in Table 1.</td></tr>
</table>

SMP6 – Benthic Habitats	
Termination criteria	<u>Benthic habitat cover and composition</u> Cover and composition of benthic habitats are not statistically significantly different from that of their baseline state (where baseline data exists) or are not statistically significantly different from comparable non-impacted assemblages. <u>Coral health and reproduction</u> Hydrocarbon concentration in corals, reproductive state and settlement indices are not statistically different from the baseline state (where baseline data exists) or from comparable non-impacted assemblages.
Receptor impact	Impact to benthic habitats from pressures including hydrocarbons is measured through change in: + Species diversity + Assemblage composition + Percent cover. Other pressures to these states are: + Physical disturbance + Discharge of toxicants + Introduction of marine pests + Shading + Climate change.
Methodological approach	Monitoring design will be as follows: 1. Where long-term baseline data sites are contacted, a control chart (time-series) design will be applied. 2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. 3. Where no baseline data sites are involved, a gradient approach to quantifying impacts will be applied (See **Appendix B** for detailed description of these approaches and **Figure 1**). <u>Benthic Habitat Cover and Composition</u> Field survey methodology will be based upon acquiring repeat digital imagery (video or still images) of benthic habitats along random transects (preferable), using a stratified sampling approach at each site to target different habitat types and depths where clear gradients in these conditions exist. Site selection and image acquisition methodology will aim to align applicable baseline studies where these exist, such that imagery is comparable. The number of sites and frequency of sampling will depend upon the sampling design philosophy.

SMP6 – Benthic Habitats	
	Divers, towed video or remotely operated vehicles (ROVs) will be employed to collect imagery considering safety aspects and the depth of water at survey locations. Where divers are employed, fish species may also be recorded where practicable (for example following methodologies employed by Babcock et al. (2008) to contribute to SMP11. <u>Coral Health and Reproduction</u> Using divers, selected coral colonies will have tissue samples removed for the purpose of laboratory analysis of the concentration of accumulated hydrocarbons and for determining reproductive state, noting sampling for reproductive state will be dependent upon the timing of coral spawning. Reproductive state will be determined from measures of gamete size, stage and fecundity determined from in-field examination and laboratory analysis of histological samples. In addition to the standard suite of ecotoxicology testing done on the released hydrocarbon as part of the Operational Monitoring Program, ecotoxicology testing of the released hydrocarbon on the larval competency of representative coral species will be conducted. Settlement plates will be deployed to monitor settlement of coral recruits following spawning periods to ascertain the level of coral recruitment at impacted and non-impacted sites.
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	+ Senior Marine Scientist with experience in benthic habitat assessment + Supporting Scientist + Divers or ROV operators + GIS personnel + Available vessel in operation + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby + Diving equipment or ROVs + Video recording facilities + Satellite imagery
Implementation	Service provider is to be able to mobilise within 72 hours of the SoW being approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and associated timing requirements.

SMP6 – Benthic Habitats	
Analysis and reporting	Digital imagery will be analysed using a point-count technique (using software such as AVTAS, Coral Point Count with Excel extensions (CPCe) or TransectMeasure (SeaGIS)) to estimate the percentage cover of biotic and abiotic categories (in line with the CATAMI classification scheme) comprising the benthic habitat. Biotic categories to include the following as applicable: corals; macroalgae and seagrass; and non-coral benthic filter feeders. Live, dead and bleached coral cover shall be recorded. The imagery collected will allow for the determination of percent cover, abundance, measurement of size (if scaling lasers are included in the image) and a visual assessment of health (Kohler and Gill 2006). NATA accredited laboratory analysis to determine the concentration of hydrocarbons within coral tissue. Reproductive output to be determined by complementary means, including in-field and laboratory analysis of gametes, including microscopic examination of histological samples preserved in the field. Coral larval competency tests to be conducted by ecotoxicological laboratory in addition to standard suite of ecotoxicological tests using released hydrocarbon. Data will be entered to spatially explicit database and analysed to determine significant differences between impacted and non-impacted assemblages. Data and conclusions will be summarised in an environmental report card provided as part of report. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP7 – Seabirds and Shorebirds	
Rationale	Marine waters and coastal habitats in the EMBA contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year. Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds, both migratory and resident. For the purposes of this document, seabirds and shorebirds are defined as: + shorebirds – those birds that inhabit and feed in the intertidal zone and adjacent areas and are resident or migratory, using the area principally during the austral summer. + seabirds – those birds associated with the sea and deriving most of their food from it, and typically breeding colonially, including the marine raptors osprey and white-bellied sea eagle.
Aim	Quantify seabirds and shorebirds, in the spill and response areas.

SMP7 – Seabirds and Shorebirds	
	Quantify lethal and/or sub-lethal impacts of hydrocarbon spill exposure on seabirds and shorebirds. Monitor changes in seabird populations (reproductive success) in relation to the hydrocarbon spill and clean-up activities.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). The Oil Spill Response Atlas (Australian Maritime Safety Authority (AMSA)), National Conservation Values Atlas (Department of Agriculture, Water and the Environment (DAWE) (http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) and any local oiled wildlife response plans should also be consulted.
Initiation criteria	Operational monitoring indicates that known foraging, roosting or nesting areas for seabirds and/or shorebirds has been contacted, or are predicted to be contacted, by a hydrocarbon spill; OR Operational monitoring indicates that seabirds and shorebirds have been contacted, or are predicted to be contacted, by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Detectable levels of hydrocarbons attributable to the hydrocarbon spill are not present in seabird and shorebird tissues; AND Measured variables are not statistically significantly different from their baseline or pre-spill state (where these data exist) or from measured variables at non-impacted sites; AND Monitoring is terminated in consultation with the relevant environmental authority (relevant regional authority and/or DAWE).
Receptor impact	Impact to seabirds and shorebirds from pressures including hydrocarbons is measured through change in: + Species diversity + Bird abundance + Health/condition + Breeding success (resident species only). Other pressures to these states are: + Physical disturbance of foraging and nesting habitat + Accidental chemical spillage + Entanglement in litter + Displacement by less favourable species (e.g. Silver Gull) + Predation + Climate change.

SMP7 – Seabirds and Shorebirds	
Methodological approach	Monitoring design will be as follows: 1. Where long-term baseline data sites are contacted a control chart (time-series) design will be applied. 2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. Given the ease of survey establishment, post-spill pre-impact monitoring will be attempted wherever practicable in order to established pre-impact state. 3. Where no baseline data sites are involved a gradient approach to quantifying impacts will be applied (See **Appendix B** for detailed description of these approaches and **Figure 1,** detailed in Baseline Data Review (Astron Environmental Services 2019) (QE-00-BI-20001)). Monitoring for seabirds and shorebirds will measure abundance and diversity in key foraging/roosting areas with the timing of surveys to coincide with seasonal peaks in abundance. The seabird and shorebird roost count monitoring will follow current accepted survey methodology, such as Birdlife Australia's Australian Shorebird Monitoring Program and survey guidelines standardised by the DAWE (Department of the Environment and Energy 2017). Monitoring of seabirds to focus on nesting (burrow) density, breeding participation and breeding success, taking measurements of the number of adults, eggs and chicks with the timing of surveys to allow assessments immediately after egg laying and immediately prior to chick fledging. Bird mortality to be recorded during monitoring of seabirds and shorebirds with tissue samples taken from dead birds for hydrocarbon analysis in the laboratory. Necroscopies will follow the process of Gagnon and Rawson (2010).
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	+ Experienced seabird biologist + Experienced shorebird biologist + Personnel with pathology or veterinary skills + NATA accredited laboratory for sample analysis and necropsy + Available vessel and tender in operation + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	Service provider able to mobilise within 72 hours of the scope of work having been provided to them (this time allowing for costing, preparation of equipment and disposables and travel to site).

SMP7 – Seabirds and Shorebirds	
	Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and associated timing requirements.
Analysis and reporting	Data will be entered to spatially explicit database and analysed in order to determine significant differences between impacted and non-impacted assemblages. Data and conclusions will be summarised in an environmental report card. Draft annual report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP8 – Marine Mammals	
Rationale	At least 11 species of listed marine mammals are known to, or are thought to occur, in Australian waters within the environment that may be affected. These include cetaceans (whales and dolphins) and sirenians (dugong). Effects to marine megafauna due to presence of surface oil, entrained oil and dissolved aromatic hydrocarbons may include behavioural (e.g. deviation from migratory routes), physiological (e.g. disruption to digestion) or physical effects. Given large spatial variation in occurrence and broad scale movement, population estimates, and associated change are not often available. This plan will focus on assessing the extent of impacts to animals within the region, and where possible, the level of recovery. This will then be used to deduce potential impacts at a population level.
Aim	To monitor short and long-term environmental effects on marine mammals that may have resulted from the hydrocarbon spill and associated response.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). The Oil Spill Response Atlas (Australian Maritime Safety Authority (AMSA)), National Conservation Values Atlas (DAWE -http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) and local oiled wildlife response plans should also be consulted.
Initiation criteria	Operational monitoring indicates that marine mammals are contacted or predicted to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Restoration or resumption of key biological processes (e.g. abundance, distribution, breeding) necessary to ensure post-impact recovery is demonstrated. Specific criteria to be developed by Marine Scientist(s) with expertise in marine mammals of the region; AND No further instances of dead marine mammals with detectable levels of hydrocarbons attributable to the hydrocarbon spill; AND Monitoring is terminated in consultation with the relevant environmental authority (relevant regional authority and/or DAWE).

SMP8 – Marine Mammals	
Receptor impact	Impact to marine mammals from pressures including hydrocarbons is measured through observed injury and mortality. Other pressures to these states are: + Physical disturbance + Entanglement in fishing gear and litter + Accidental chemical spillage + Climate change + Over-exploitation.
Methodological approach	Aerial and marine surveys will be implemented to identify individuals in proximity of the spill and to quantify damage: + Aerial surveys will follow the protocols of Hedley et al. (2011), **Appendix C8** + Marine surveys will follow the protocols of Watson et al. (2009), **Appendix C8** Tissue sampling of dead or injured animals will follow the protocols of: + Department of Environment and Heritage (DEH) (2006) (Cetaceans) + Eros et al. (2000) (Dugongs).
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	**Aerial survey** + Senior Marine Scientist + Trained marine wildlife observers x 2 + Fixed wing aircraft (incl. pilot/s) + Refuelling facilities **Vessel-based survey** + Senior Marine Scientist + Trained marine wildlife observers x 2 + Personnel with pathology or veterinary skills + NATA accredited laboratory for sample analysis and necropsy + Available vessel in operation + Sample container and preservative + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby

SMP8 – Marine Mammals	
Implementation	Service provider able to mobilise within 72 hours of the scope of work having been approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and spill timing requirements.
Analysis and reporting	Data will be entered to spatially explicit database. Data and conclusions will be summarised in an environmental report card. Statistical power related to these receptors is likely to be low, due to observational data and small sample sizes. Therefore, the assessment of quantified impacts will be corroborated with marine scientist(s) with expertise in relevant fauna. Draft annual report to be prepared within one month of annual monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP9 – Marine Reptiles	
Rationale	At least 10 species of listed marine reptiles are known to, or are thought to occur, in Australian waters within the environment that may be affected. This includes six species of marine turtle that occur in, use the waters, and nest on sandy beaches, two species of sea snake and one species of estuarine crocodile found in most major rivers systems of the Kimberley region and in the Northern Territory. Impacts to marine reptiles due to presence of surface oil, entrained oil and dissolved aromatic hydrocarbons may include behavioural, physiological (e.g. disruption to digestion) or physical effects.
Aim	To observe and quantify the presence of marine reptiles in the spill and response areas, and broader regional areas. To assess and quantify lethal impacts or sub-lethal impacts of this exposure or interactions. To monitor changes in marine reptile populations in relation to an oil spill and associated activities.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). The Oil Spill Response Atlas (Australian Maritime Safety Authority (AMSA)), National Conservation Values Atlas (DAWE -http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) and local oiled wildlife response plans should also be consulted.
Initiation criteria	Operational monitoring indicates that marine reptiles or nesting sites are contacted or likely to be contacted by a hydrocarbon spill; OR Operational monitoring indicates that marine reptiles are contacted, or are predicted to be contacted, by a hydrocarbon spill as defined in **Table 1**.

<table>
<tr><th colspan="2">SMP9 – Marine Reptiles</th></tr>
<tr><td>Termination criteria</td><td>Detectable levels of hydrocarbons attributable to the hydrocarbon spill are no longer present in marine reptile tissues collected from live or dead individuals; AND

In the event that an impact attributable to the hydrocarbon spill is detected on marine reptiles, the measured parameters are not statistically significantly different from their baseline or pre-spill state (where these data exist) or from measured parameters at non impacted sites; AND

Monitoring is terminated in consultation with the relevant environmental authority (relevant regional authority and/or DAWE).</td></tr>
<tr><td>Receptor impact</td><td>Impact to marine reptiles from pressures including hydrocarbons is measured through change in:
+ Abundance
+ Health/condition
+ Nesting success (turtles and crocodiles).

Impact to other marine reptiles from pressures including hydrocarbons is measured through change in observed injury and condition.

Other pressures to these states are:
+ Lighting and flares causing disorientation (turtles)
+ Vessel strike
+ Physical disturbance of nesting sites
+ Predation
+ Entanglement in fishing gear and litter
+ Accidental chemical spillage
+ Habitat loss or change due to dredging
+ Climate change
+ Over-exploitation.</td></tr>
<tr><td>Methodological approach</td><td>Abundance
In-water impacts – aerial surveys.
Shoreline impacts – ground surveys (either rapid census survey or tagging program).
Health/condition
In-water impacts – vessel surveys (collecting observations on animal condition and collection of tissue samples or dead specimens for analysis).
Shoreline impacts – ground surveys (collecting observations on animal condition and collection of tissue samples or dead specimens for analysis).
Dead reptiles will be collected for autopsy following Gagnon (2009).</td></tr>
</table>

SMP9 – Marine Reptiles	
	Reproductive success Shoreline impacts – ground surveys (detailed tagging and/or nesting success studies). Design of ground surveys will be applied as follows: 1. Where long-term baseline data sites are contacted a control chart (time-series) design will be applied. 2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. 3. Where no baseline data sites are involved, and timing allows, a post spill pre-impact approach will be attempted. 4. If a post-spill pre-impact approach is not practicable, a gradient approach to quantifying impacts will be applied
Scope of work	Prepared by monitoring provider for issue within 24 hours of SMP being activated.
Resources	**Aerial survey** + Senior marine scientist + Trained marine wildlife observers x 2 + Fixed wing aircraft (incl. pilot/s) + Refuelling facilities **Vessel-based Survey** + Senior Marine Scientist + Trained marine wildlife observers x 2 + Personnel with pathology or veterinary skills + NATA accredited laboratory for sample analysis and necropsy + Available vessel in operation + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	Service provider to be able to mobilise within 72 hours of the scope of work having been approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and spill timing requirements.
Analysis and reporting	Data will be entered to spatially explicit database. Turtle data will be analysed in order to test for significant differences between impacted and non-impacted assemblages. Data and conclusions will be summarised in an environmental report card.

SMP9 – Marine Reptiles	
	Owing to their observational nature and potentially low sample size, observed impacts to other reptile fauna will be corroborated with marine scientist(s) with expertise in relevant fauna for the region. Draft annual report to be prepared within one month of annual monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP10 – Seafood Quality	
Rationale	Exposure of commercial and recreationally targeted demersal and pelagic fish species to entrained and dissolved aromatic hydrocarbons can cause flesh tainting and increase the levels of toxicants above human consumption guidelines. Aromatic hydrocarbons are carcinogenic to humans. This scope includes finfish, sharks and invertebrates (principally crustacea).
Aim	To identify potential human health risks due to the presence of hydrocarbon concentrations in the flesh of targeted seafood species for consumption.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). Human health benchmarks relating to the exposure of PAHs shall be used to determine health effects as per Yender et al. (2002). Flesh samples from non-impacted sites to be used as baseline for olfactory analysis for flesh taint.
Initiation criteria	+ Operational monitoring and results from SMP1 predict or observes contact of oil to target species for consumption as defined in **Table 1**.
Termination criteria	The following termination criteria will be adopted in consultation with responsible fisheries and human health agencies. Hydrocarbon concentrations in seafood tissues are not above levels considered a human health risk; AND Flesh taint is not detected from olfactory testing of seafood samples; AND Target species are no longer exposed to hydrocarbons in the water column.
Receptor impact	Impact to seafood quality from hydrocarbons is measured through change in: + Toxicity indicators + Olfactory taint. Other pressures to these states are: + Accidental chemical spillage + Disease.

SMP10 – Seafood Quality	
Methodological approach	Target fish species determined from water quality monitoring results and relevant and available commercial and recreational-fished species. Sampling of target species will follow a gradient design (Gagnon and Rawson 2012) ranging from impacted to non-impacted (or non-suspect) catches using commercial and recreational fishing techniques undertaken by commercial and recreational fishers. Sampling method (netting, trawling, baited fish traps, spear fishing, line fishing) will be determined by habitat, target species and spill location. If more than one target species is affected, replicate samples of each species shall be collected, with a minimum of five replicate samples. Olfactory testing will follow Rawson et al. (Rawson et al. 2011) in **Appendix C10**, following the duo-trio method (Standards Australia 2005).
Scope of work	Prepared by monitoring provider for issue within 24 hours of this SMP being activated.
Resources	+ Senior marine scientist + Marine vessel + Sample containers and preservative + NATA accredited laboratory for sample analysis + Decontamination/washing facilities
Implementation	Service provider to be able to mobilise within 72 hours of the scope of work having been approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and spill timing requirements.
Analysis and reporting	Laboratories will be NATA-accredited for food standards analyses. Data will be stored in spatially explicit database and analysed to test for significant differences between impacted and non-impacted seafood. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP11 – Fish, Fisheries and Aquaculture	
Rationale	Impacts to fisheries species due to presence of entrained hydrocarbons may include lethal and sub-lethal physiological effects (e.g. reduced growth) and physical effects. The region comprises the Indo-West Pacific area which consists of a high diversity of fish species and assemblages and provides important spawning and nursery grounds for several fisheries species. Fish are concentrated in a number of biodiversity hotspots. The environment is also conducive to aquaculture including pearl production. Fisheries species that spawn or

SMP11 – Fish, Fisheries and Aquaculture	
	inhabit near shore areas face a greater risk to an oil spill than finfish found in deeper waters.
Aim	To monitor changes in structure and distribution of fish assemblages in relation to an oil spill and associated activities. To monitor the effect of hydrocarbon exposure and physiological condition on fisheries and aquaculture species.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). In addition, available relevant survey databases shall be reviewed for applicable baseline data.
Initiation criteria	+ Operational monitoring indicates fish, fisheries or aquaculture are contacted or likely to be contacted by a hydrocarbon spill as defined in Table 1.
Termination criteria	Fish assemblages are not statistically significantly different than those of baseline or similar non-impacted assemblages; AND Hydrocarbon concentrations, physiological condition indices, and biomarker levels in affected fish and aquaculture species are not statistically significantly different from those of non-impacted samples; AND Termination of monitoring is done in consultation with the responsible fisheries agencies.
Receptor impact	Impact to fish, fisheries and aquaculture from pressures including hydrocarbon concentrations is measured through change in: + Species diversity + Abundance of indicator taxa + Assemblage structure + Health. Other pressures to these states are: + Accidental chemical spillage + Overfishing + Introduction of marine pests + Habitat disturbance + Climate change.
Methodological approach	Fish assemblages will be assessed using the stereo-baited remote underwater videos (BRUVs) following Shortis et al. (2009), **Appendix C11**. Fish assemblages will be randomly sampled within discrete habitats at cross-shelf impact areas and non-impact areas.

SMP11 – Fish, Fisheries and Aquaculture	
	Sampling design for fish assemblages will be as follows: 1. Where long-term baseline data sites are contacted a control chart (time-series) design will be applied. 2. Where appropriately matched baseline data sites are impacted and non-impacted, a BACI approach to monitoring will be applied. 3. If baseline data is not available, a gradient approach to quantifying impacts will be applied (See **Appendix B** for detailed description of these approaches and **Figure 1**). Where relevant, data available from responsible fisheries agencies including catch/effort data, will be assessed to determine potential changes from baseline levels in fishing grounds potentially affected by an oil spill compared to after the event. For fish and aquaculture species potentially exposed to an oil spill, species will be sampled across the contamination gradient as per Gagnon and Rawson (2012). Hydrocarbon concentrations (particularly PAH) within tissues of fish and aquaculture species will be determined. Exposure to hydrocarbons on fish health will also be determine through analysis of physiological indices and biochemical markers following Gagnon and Rawson (2012). If fish kills are observed, whole specimens will be obtained and preserved (frozen) for necropsy to determine the cause of death.
Scope of work	Prepared by monitoring provider for issue within 24 hours of this SMP being activated.
Resources	+ Senior marine scientist + Marine scientist trained in fish identification and necropsy + Marine scientist with BRUV experience + NATA accredited laboratory for sample analysis + Available vessel and tender in operation + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby + Resources to analyse BRUV data.
Implementation	Service provider to be able to mobilise within 72 hours of the scope of work having been approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and spill timing requirements.
Analysis and reporting	BRUV imagery will be processed using EventMeasure (SeaGIS) software. NATA-accredited laboratories will be employed for health analyses. Data will be entered to spatially explicit database and analysed to test for statistically significant differences between non-impacted and impacted fish assemblages.

SMP11 – Fish, Fisheries and Aquaculture	
	Data and conclusions will be summarised in an environmental report card. Final draft report to be prepared within one month of monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

SMP12 – Whale Sharks	
Rationale	The whale shark (*Rhincodon typus*) is known to occur within the region. One of the best known aggregation sites occurs along the central and north-west coast of Western Australia from March to July. Whale sharks are also known to be highly migratory and a biologically important area for foraging extending into the Kimberley region of Western Australia also overlaps with the environment that may be affected. Effects to the whale shark due to presence of surface oil, entrained oil and dissolved aromatic hydrocarbons may include behavioural (e.g. deviation from migratory routes), physiological (e.g. disruption to digestion) or physical effects. Given large spatial variation in occurrence and broad scale movement, population estimates and associated change are not often available. This plan will focus on assessing the extent of impacts to animals within the region, and where possible, the level of recovery. This will then be used to deduce potential impacts at a population level.
Aim	To quantify impacts of an oil spill on whale sharks within Biologically Important Areas (BIAs) along the north-west and north Western Australian coastline.
Baseline	Refer to the Baseline Data Review (Astron Environmental Services 2021) (SO-91-RF-20022 Rev 0). The Oil Spill Response Atlas (Australian Maritime Safety Authority (AMSA)), National Conservation Values Atlas (DAWE -http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf) and Pilbara Region Oiled Wildlife Response Plan (Department of Parks and Wildlife and Australian Marine Oil Spill Centre 2014) should also be consulted.
Initiation criteria	Operational monitoring indicates that whale shark aggregations are contacted or likely to be contacted by a hydrocarbon spill as defined in **Table 1**.
Termination criteria	Measured parameters of whale shark abundance and distribution are not significantly different to baseline levels; AND The water quality at feeding/aggregation sites has been measured as not significantly different to baseline levels.
Receptor impact	Impact to whale sharks from pressures including hydrocarbons is measured through observed injury and mortality. Other pressures to these states are: + Intentional and unintentional mortality from fishing outside Australian waters

SMP12 – Whale Sharks	
	+ Boat strike + Habitat disruption from mineral exploration, production and transportation + Marine debris + Climate change.
Methodological approach	During spill activities may require the following surveys and sampling: + Aerial surveys + Satellite tagging + Toxicology + Food chain studies + Photo-identification + Vessel and plane logs + Acoustic tagging. The methodologies adopted will follow the approaches of those baseline studies identified allowing consistency of data from baseline to impact and recovery phases.
Scope of work	Prepared by monitoring provider for issue within 24 hours of this SMP being activated.
Resources	+ Senior marine scientist + Trained marine wildlife observers x 2 + Fixed wing aircraft (incl. pilot/s) + Refuelling facilities + Personnel with pathology or veterinary skills + NATA accredited laboratory for sample analysis + Available vessel and tender in operation + Decontamination/washing facilities + Safety aircraft/rescue vessels on standby
Implementation	Service provider to be able to mobilise within 72 hours of the scope of work having been approved by Santos (this time allowing for costing, preparation of equipment and disposables and travel to site). Actual mobilisation time will depend on the decision to adopt post-spill pre-impact monitoring and spill timing requirements.
Analysis and reporting	Draft annual report to be prepared within one month of annual monitoring completion; external peer review of final draft within two weeks of report provision to reviewer; finalise report within two weeks of peer review having been completed.

3 References

Alongi, D. M. 2002. Present state and future of the world's mangrove forests. Environmental Conservation 29:331–349.

Astron Environmental Services. 2013. Apache OSMP - Desktop Mangrove Assessment. Unpublished report to Apache Energy Limited.

Astron Environmental Services. 2019. Scientific Monitoring Plan Baseline Data Review, July 2019. Unpublished report for Santos WA Energy Limited.

Australian and New Zealand Governments. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra.

Babcock, R., M. Haywood, M. Vanderklift, G. Clapin, M. Kleczkowski, D. Dennis, T. Skewes, D. Milton, N. Murphy, R. Pillans, and A. Limbourn. 2008. Ecosystem impacts of human usage and the effectiveness of zoning for biodiversity conservation: broad-scale fish census. CSIRO Marine and Atmospheric Research, Australia.

Bamford, M., and D. Moro. 2011. Barrow Island as an Important Bird Area for migratory waders in the East Asian-Australasian flyway. Stilt 60:46–55.

Barter, M. 2002. Shorebirds of the Yellow Sea: importance, threats and conservation status. Australian Government Publishing Service, Canberra, Australia.

Bennelongia Pty Ltd, A. 2010. Analysis of possible change in ecological character of the Roebuck Bay and Eighty Mile Beach Ramsar sites.

Carey, J., and M. Keough. 2002. Compositing and subsampling to reduce costs and improve power in benthic infaunal monitoring programs. Estuaries 25:1053–1061.

Cresswell, I., and V. Semeniuk. 2011. Mangroves of the Kimberley coast: ecological patterns in a tropical ria coast setting. Journal of the Royal Society of Western Australia 94:213–237.

Department of Environment and Conservation. 2009. Nature Conservation Service: Biodiversity Conservation Appraisal System: A Framework to Measure and Report on Biodiversity Outcome Based Conservation Achievements and Management Effectiveness. Perth.

Department of Parks and Wildlife, and Australian Marine Oil Spill Centre. 2014. Pilbara Region Oiled Wildlife Response Plan. Department of Parks and Wildlife and Australian Marine Oil Spill Centre, Western Australia.

Department of the Environment and Energy. 2017. EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species.

Department of the Environment and Heritage. 2006. Standardised protocols for the collection of biological samples from stranded cetacean. http://www.environment.gov.au/resource/standardised-protocols-collection-biological-samples-stranded-cetacean.

Duke, N. C., M. C. Ball, and J. C. Ellison. 1998. Factors influencing biodiversity and distributional gradients in mangroves. Global Ecology and Biogeography Letters 7:27–47.

Duke, N., A. Wood, K. Hunnam, J. Mackenzie, A. Haller, N. Christiansen, K. Zahmel, and T. Green. 2010. Shoreline ecological assessment aerial and ground surveys 7-19 November 2009. UniQuest PTY Ltd.

English, S., C. Wilkinson, and V. Baker. 1997. Survey Manual for Tropical Marine Resources. 2nd edition. Australian Institute of Marine Science, Townsville.

Eros, C., H. Marsh, R. Bonde, T. O'Shea, C. Beck, C. Recchia, K. Dobbs, M. Turner, S. Lemm, R. Pears, and R. Bowter. 2000. Procedures for the salvage and necropsy of the dugong (*Dugong dugon*) - Second Edition, Research Publication No. 85. Great Barrier Marine Park Authority, Townsville.

Gagnon, M. M. 2009. Report on biopsy collection from specimens collected from surrounds of West Atlas oil leak–sea snake specimens. Curtin University, Perth.

Gagnon, M. M., and C. Rawson. 2012. Montara Well Release, Monitoring Study S4A Phase IV – Assessments of Effects on Timor Sea Fish. Curtin University, Perth.

Gagnon, M. M., and C. A. Rawson. 2010. Montara Well Release: Report on necropsies from birds collected in the Timor Sea. Curtin University, Perth, Western Australia.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68:1364–1372.

Gibson, L. E., and A. P. Wellbelove. 2010. Protecting critical marine habitats: The key to conserving our threatened marine species: a Humane Society International and WWF-Australia Report.

Gregory, R., L. Failing, M. Harstone, G. Long, T. McDaniels, and D. Ohlson. 2012. Structured decision making: a practical guide to environmental management choices. Wiley-Blackwell.

Grochowsi, A., and A. Stat. 2017. Water and Sediment Sampling for Environmental DNA Extraction, Joint Technical Memorandum. BMT Oceanica & Trace and Environmental DNA (TrEnD) Laboratory at Curtin University.

Gueho, R. 2007. Rhythms of the Kimberley: a seasonal journey through Australia’s north. Fremantle Press, Australia.

Hedley, S., J. Bannister, and R. Dunlop. 2011. Abundance estimates of Southern Hemisphere Breeding Stock ‘D’ Humpback Whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. Journal of Cetacean Research and Management:209–221.

Hilty, J., and A. Merenlender. 2000. Faunal indicator taxa selection for monitoring ecosystem health 92:185–197.

Hockings, M., S. Stolton, F. Leverington, N. Dudley, and J. Courrau. 2006. Evaluating Effectiveness: A Framework for Assessing Management Effectiveness of Protected Areas. 2nd edition. International Union for Conservation of Nature and Natural Resources.

Hook, S., G. Batley, M. Holloway, P. Irving, and A. Ross, editors. 2016. Oil Spill Monitoring Handbook. CSIRO Publishing.

Hurlbert, S. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54:187–211.

Jarman, S., and S. Wilson. 2004. DNA-based species identification of krill consumed by whale sharks. Journal of Fish Biology 65:586–591.

Kathiresan, K., and B. L. Bingham. 2001. Biology of mangroves and mangrove ecosystems. Advances in marine biology 40:81–251.

Kenkel N.C, Juhasz-Nagy P, and Podani J. 1989. On sampling procedures in population and community ecology. Vegetation 83:195–207.

Kobryn, H. T., K. Wouters, L. Beckley, and T. Heege. 2013. Ningaloo Reef: Shallow Marine Habitats Mapped Using a Hyperspectral Sensor. PLoS ONE 8:e70105.

Kohler, K. E., and S. M. Gill. 2006. Coral point count with Excel extensions (CPCe): A visual basic program for the determination of coral and substrate coverage using random point count methodology. Computers and Geosciences 32:1259–1269.

Legg, C. J., and L. Nagy. 2006. Why most conservation monitoring is, but need not be, a waste of time. Journal of Environmental Management 78:194–199.

Masini, R. J., C. B. Sim, and C. J. Simpson. 2009. Protecting the Kimberley: A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia. Department of Environment and Conservation.

Nagelkerken, I., G. van der Velde, M. W. Gorissen, G. J. Meijer, T. Van't Hof, and C. den Hartog. 2000. Importance of Mangroves, Seagrass Beds and the Shallow Coral Reef as a Nursery for Important Coral Reef Fishes, Using a Visual Census Technique. Estuarine, Coastal and Shelf Science 51:31–44.

National Offshore Petroleum Safety and Environmental Management Authority. 2016. Operational and Scientific Monitoring Programs Information Paper. Perth.

Pendretti, Y. M., and E. I. Paling. 2001. WA Mangrove Assesment Project 1999-2000. Perth Murdoch Univeristy.

Quadrant Energy Australia Limited. 2018. Quadrant Environmental Monitoring Program Mangrove Monitoring Method Statement, EA-00-RI-10058.06. Quadrant Energy Australia Limited, Perth.

Rawson, C., M. M. Gagnon, and H. Williams. 2011. Montara Well Release: Olfactory Analysis of Timor Sea Fish Fillets. Curtin University, Perth.

Reynolds, S. D., B. M. Norman, M. Berger, C. E. Franklin, and R. G. Dwyer. 2017. Movement, distribution and marine reserve use by an endangered migratory giant. Diversity and Distributions 2017:1–12.

Robson, B. J., M. A. Burford, P. C. Gehrke, A. T. Revill, I. T. Webster, and D. W. Palmer. 2008. Response of the lower Ord River and estuary to changes in flow and sediment and nutrient loads. Water for a Healthy Country Flagship Report, CSIRO.

Santos WA Energy Limited. 2018. Values and Sensitivities of the Western Australian Marine Environment, EA-00-RI-10062. Santos WA Energy Limited.

Shortis, M., E. Harvey, and D. Abdo. 2009. A review of underwater stereo-image measurement for marine biology and ecology applications. Pages 257–292 *in* R. Gibson, R. Atkinson, and J. Gordon, editors. Oceanography and Marine Biology: An Annual Review. CRC Press, Boca Raton, Florida USA.

Skalski, J. 1995. Statistical considerations in the design and analysis of environmental damage assessment studies. Journal of Environmental Management 43:67–85.

Sleeman, J. C., M. G. Meekan, G. Mark, B. J. Fitzpatrick, C. R. Steinberg, R. Ancel, and C. J. A. Bradshaw. 2010. Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. Journal of Experimental Marine Biology and Ecology 382:77–81.

Snedecor, G., and W. Cochran. 1989. Statistical methods. Iowa State University Press, Iowa.

Standards Australia. 2005. Australian Standard 2542: Sensory analysis - Method 2.4. Standards Australia, Sydney.

Stem, C., R. Margolius, N. Salafsky, and M. Brown. 2005. Monitoring and evaluation in conservation: A review of trends and approaches. Conservation Biology 19:295–309.

Thompson, A., and B. D. Mapstone. 1997. Observer effects and training in underwater visual surveys of reef fishes. Marine Ecology Progress Series 154:53–63.

Toft, C., and P. Shea. 1982. Detecting community-wide patterns: Estimating power strengthens statistical inference. The American Naturalist 122:618–625.

Underwood, A. J. 1991. Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. Australian Journal of Marine and Freshwater Research 42:569–587.

Underwood, A. J. 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. Journal of Experimental Biology and Ecology 161:145–178.

Underwood, A. J. 1994. On Beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecological Applications 4:3–15.

Varcoe, T. 2012. A park manager's perspective on ecological monitoring. Page *in* D. Lindenmayer and P. Gibbons, editors. Biodiversity Monitoring in Australia. CSIRO Publishing, Canberra.

Wade, S., and R. Hickey. 2008. Mapping Migratory Wading Bird Feeding Habitats using Satellite Imagery and Field Data, Eighty-Mile Beach, Western Australia. Journal of Coastal Research 243:759–770.

Waples, K. 2007. Kimberley Biodiversity Review. Department of Environment and Conservation.

Watson, J., L. Joseph, and A. Watson. 2009. A rapid assessment of the impacts of the Montara oil leak on birds, cetaceans and marine reptiles. Department of the Environment, Water, Heritage and the Arts, Canberra.

Wilson, B. 1994. A representative Marine Reserve System for Western Australia. Department of Conservation and Land Management.

Wilson, B. 2013. The Biogeography of the Australian North West Shelf: Environmental Change and Life’s Response. Elsevier.

Wilson, S., M. Meekan, J. Carleton, T. Stewart, and B. Knott. 2003. Distribution, abundance and reproductive biology of <i>Pseudeuphausia latifrons<i> and other euphausiids on the southern North West Shelf, Western Australia. Marine Biology 142:369–379.

Wilson, S., T. Pauly, and M. Meekan. 2001. Daytime surface swarming by *Pseudeuphausia latifrons* (Crustacea, Euphausiacea) off Ningaloo Reef, Western Australia. Bulletin of Marine Science 68:157–162.

Yender, R., J. Michael, and C. Lord. 2002. Managing Seafood Safety After an Oil Spill. Hazardous Materials Response Division, Office of Response and Restoration, National Oceanic and Atmospheric Administration, Seattle.

Zell, L. 2007. Kimberley Coast. Wild Discovery.

Appendix K: SMP activation process

Oil Spill Operational and Scientific Monitoring Activation Form

astron
astron.com.au

Instructions
In the event of a spill requiring a response from Astron follow these steps: **1. Activate a response – call 1300 902 700** **2. Immediately complete this Activation Form and email to spillresponse@astron.com.au** **You will receive a call back from the Monitoring Coordinator within 30 minutes. In the event that a call back is not received, please call 1300 902 700 again.** **Note:** If new information should become available after submitting this form, or the situation changes, please advise the Astron Monitoring Coordinator as soon as possible.

Section 1: Contact Details		
Name of notifying person		
Position in Incident Command Team		
Direct phone		
Mobile		
Email address		
Command centre location		
Command centre direct phone		
Date and time of notification	Click here to enter a date.	Enter time, i.e. 1400 WST

Section 2: Spill Details							
Date and time of spill		Click here to enter a date.			Enter time, i.e. 1400 WST		
Spill source location (GDA94, MGA Zone 50)		Insert coordinates in GDA94 MGA Zone 50 format (easting and northing).					
		Insert location description					
Source of spill							
Cause of spill (if known)							
Status of spill		☐ Secured	☐Uncontrolled	☐Unknown			
Release rate	Instantaneous release						**State units**
	OR						
	Continuous release		per hour for		☐Hours	☐Days	
Description of spill	Estimated quantity						**State units**
	Incident tier	☐1	☐2	☐3			
	Direction of travel						
	Trajectory						
Modelling provider log in details							

Oil Spill Operational and Scientific Monitoring Activation Form

Section 3: OMP/SMP activation	
SMPs to be activated. Where there is doubt whether an SMP should be activated the SMP should be selected. Refer to the Oil Spill Scientific Monitoring Plan (EA-00-RI-10099) for initiation criteria for SMPS.	☒SMP1 – Water quality ☒Operational water quality monitoring ☐SMP2 – Sediment quality ☐SMP3 – Sandy beaches and rocky shores ☐SMP4 – Mangroves ☐SMP5 – Intertidal mudflats ☐SMP6 – Benthic habitats ☐SMP7 – Seabirds and shorebirds ☐SMP8 – Marine megafauna ☐SMP9 – Marine reptiles ☐SMP10 – Seafood quality ☐SMP11 – Fish, fisheries and aquaculture ☐ Yet to be determined ☐ Other:________________________________

Section 4: Safety	
Detail any known safety or security risks	

Section 5: Approval	
I authorise the activation of a response by Astron Environmental Services Pty Ltd in connection with the above incident under the terms of Contract # [insert contract].	
Signature:	
Date and Time:	

Activate Our Team

In the event of a spill requiring scientific monitoring response call:

1300 902 700

Advise the operator:

1. **Your company**
2. **Your name and contact number**
3. **Brief reason for call (i.e. Exercise or Spill)**

A message will be relayed to our team to call you back.

Provide additional details as requested by the Monitoring Coordinator on call-back

Complete and submit the *Activation Form*

Astron initiates Oil Spill Scientific Monitoring Activation & Response Process – refer to next page

Oil Spill Scientific Monitoring Activation and Response Process

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
Phase 1 – Activation					
1	Santos IMT (Environmental Team Leader (ETL))	Astron Monitoring Coordinator notified of incident.	On approval from Santos Incident Commander	Astron oil spill response phone number and answering service	
2	Astron Monitoring Coordinator (MC)	Call back client for further details, request *Activation Form* if not received.	Within 30 minutes of receiving initial notification	Activation Form	
3	Astron MC	Call Planning & Logistics Officer to advise of incident.	Immediately following Step 2	n/a	
4	Santos IMT (ETL)	Complete *Activation Form* and submit to Astron via email.	Within one hour following initial notification (Step 2)	Activation Form	
5	Astron Planning & Logistics Officer (PLO)	Notify MCT, Technical Advisors and key subcontractors via SMS Global.	Within 30 minutes of Step 3	SMS Global Guidance	
6	Astron PLO	Notify all staff of incident via SMS Global.	Within one hour of receiving Activation Form	SMS Global Guidance	
Phase 2 – Response Planning					
7	Astron MC	Maintain verbal communication with Santos IMT (ETL).	At least twice daily (0800 and 1700)	n/a	

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
8	Astron MC Astron Operations Officer Astron PLO	Maintain Functional Log.	Daily	Functional Log	
9	Astron PLO	Set up Command Room.	Within 4 hours of activation (Step 5)	Command Room Resource Checklist	
10	Astron MC, PLO and BMT Oceanica Operations Officer	Attend Santos incident briefing and relay information to MCT.	As advised by the Santos IMT (ETL)	n/a	
11	Astron Operations Officer	MCT and Technical Advisors to meet at Royal St office, review personnel and equipment resource status.	Within 6 hours of activation (Step 5)	Capability report Training matrix Resource chart	
12	Astron PLO	Confirm availability of additional personnel and equipment resources.	Within 16 hours of activation (Step 5)	External Supplier Details Requisition Request Form	
13	Santos IMT (ETL)	Provide spill trajectory modelling and sensitive receptor information to Astron.	When available	APASA modelling Department of Transport database Santos GIS Mapping	
14	Astron MC in consultation with Santos ETL	Define the scale of response - identify which SMPs are activated. Identify if operational water quality monitoring is required.	Within 2 hours of receiving spill and receptor information (Step 13).	Scientific Monitoring Plan* Relevant OPEP Spill trajectory modelling Operational monitoring results	

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
15	Astron Technical Advisors in consultation with Santos ETL	**Determine monitoring locations for activated SMPs:** • Identify monitoring locations in order of priority for activated SMPs based on: o nature of hydrocarbon spill o spill trajectory modelling and time to shoreline impacts o sensitive receptors impacted or potentially at risk of being impacted o state of current baseline data o current environmental conditions o current results of operational monitoring. • Determine if post-spill pre-impact data is required to be collected from any locations. See SMP Work Method Statements for decision making process when considering availability of baseline data.	Within 6 hrs of relevant SMP activation (Step 14).	Relevant SMPs Information from Astron: • baseline information for relevant receptors. Information from Santos IMT: • sensitive receptor information (including relevant conservation/management plans) from relevant EP, Santos GIS mapping and online resources (DoT oil spill response atlas, DoE conservation values atlas, DoE species profile and threats database) • oil spill trajectory modelling • response strategies and priority protection areas • results from OMPs currently activated • baseline information for relevant receptors as reference in the relevant SMP.	
16	Astron Technical Advisors in consultation with Santos ETL	Submit Department of Parks and Wildlife Licence applications	Within 12 hrs of relevant SMP activation (Step 14)	• Proposed monitoring locations • SMP methods	

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
17	Astron Operations Officer, PLO & Technical Advisors in consultation with Santos ETL	**Determine personnel requirements:** • Identify number and competencies of personnel required for monitoring teams for each SMP based on: o activated SMPs o number of locations to be monitored o number of locations where pre-spill baseline data needs to be collected o timing of hydrocarbon spill and overlap with sensitive receptors in activated SMPs o logistical and equipment resource constraints. • Arrange additional personnel if required.	Within 12 hrs of activation if pre-impact data is needed.**	Information from Astron: • Capability report • Training matrix • Resource chart • relevant SMPs and WMS. Information from Santos IMT: • sensitive receptor information • oil spill trajectory modelling • response strategies and priority protection areas • equipment (i.e. vessels, aircraft) availability • logistics (availability of flights, accommodation, etc).	
18	Astron Operations Officer, PLO & Technical Advisors in consultation with Santos ETL	**Determine equipment requirements:** • Identify number and competencies of equipment required for each SMP based on: o activated SMPs o number of locations to be monitored o number of field teams and timing of mobilisation to the field o logistical and equipment resource constraints. • Arrange additional equipment resources if required.	Within 12 hrs of activation if pre-impact data is needed.**	Information from Astron: • Resource chart • relevant SMPs and WMS. Information from Santos IMT: • equipment (i.e. vessels, aircraft) availability • logistics (availability of flights, accommodation, etc).	

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
19	Astron MC, Operations Officer, PLO & Technical Advisors	**Prepare and submit Monitoring Action Plan** (mission, objectives, strategies, tactics, tasks), including scope of works. **Prepare and submit cost estimate.** **Prepare and submit logistics request:** • Allocate personnel and equipment resources to field teams for relevant SMPs. • Submit SOW and logistics request for each activated SMP to Santos IMT for approval.	Within 24hrs of request for SoW (Step 15) for relevant SMP if pre-impact data is needed.**	Information from Astron: • Resource chart • relevant SMPs and WMS • agreed monitoring locations • Mobilisation and Logistics Form (incorporating SOW) • Monitoring Action Plan. Information from Santos IMT: • request for SoW • agreed monitoring locations.	
20	Santos IMT (ETL)	Santos to approve SOW, provide purchase order and initiate logistical arrangements.	Within 24 hours of SOW submission (Step 19).	Astron Mobilisation and Logistics Request	
21	Astron MC	Advise field personnel by email meeting invite, or phone if not in office.	Within 24 hours of SOW approval (Step 20).	Field team allocation	
22	Astron	Conduct incident briefing with all available Astron personnel.	Within 24 hours of SOW approval (Step 22).	Briefing template Monitoring Action Plan	
Phase 3 – Mobilisation					
24	Astron PLO	GIS and device preparation requests (field maps, data capture) submitted, and discussed with Geospatial team.	Within 24 hours of SOW approval (Step 22).	https://voyager/	
25	Astron Operations Officer	Conduct field team overview briefing, allocate tasks.	Within 36 hours of SOW approval (Step 22).	Briefing Template	

Step	Responsibility	Action	Timeframe#	Resources	Date/Time Complete
26	Field Team Leaders	Compile SMP grab packs, GIS information, field equipment, and prepare and submit HSE documentation to Santos IMT.	Within 48 hours of SOW approval (Step 22).	Information from Astron • SoW • Grab packs, SMP WMS and HSE documentation • GIS information/field maps • field equipment. Information from Santos IMT: • booking and logistics confirmations.	
27	Astron Technical Advisors	Conduct scope specific pre-mobilisation briefings.	Prior to mobilisation.	Pre-mob Briefing Template	
28	Santos ETL	Santos to approve HSE plan.	Within 24 hours of receiving HSE Plan.	Mobilisation and Logistics Form HSE plan	
29	Astron PLO	Personnel mobilised to site.	Within 72 hrs of SOW approval (Step 22) if pre-impact data is needed.**	Approved SOW	
Phase 4 – Response Operations					
30	Astron MC	Conduct Monitoring Action Plan review with MCT and Technical Advisors and communicate to Santos IMT (ETL).	Daily	Monitoring Action Plan template	
31	Astron PLO	Hold post-demobilisation debrief with field teams.	Within 3 days of demobilisation.	Demob Meeting Template	
32	Santos ETL	Santos to arrange approval of Monitoring Action Plan revisions and any additional mobilisation/logistics requirements.	Daily or as required	Monitoring Action Plan Mobilisation and Logistics Form	
33	Astron Field Team Leaders	Provide activity reports to Santos ETL.	Daily	Daily Activity Report Template	

[#] Timeframes are indicative and may be require adjustment where activities are dependent on information availability or affected by logistical constraints

*The Scientific Monitoring Plan (EA-00-RI-10099) provides the most up to date list of SMPs and activation criteria. Refer to the OPEP for operational water quality monitoring requirements.

**If post-spill, pre-impact data is not required then timeframes will be specific to each SMP. The lead times for resourcing, preparation of SoW and mobilisation of field teams may be longer depending on the timing of the spill, likely trajectory and life stages of receptors present or likely to be impacted.

For example, in SMP4 if post-spill, pre-impact data collection is not required then mangrove decline is likely to take several weeks to occur and there is lower priority for mobilisation of field teams for this SMP within the 72 hr timeframe. In this case, mobilisation within 30 days may be more appropriate.

Abbreviations

EMBA – Environment that May Be Affected
IMT – Incident Management Team
OMP – Operational Monitoring Program
OPEP – Oil Pollution Emergency Plan
Santos – Santos Energy Australia Limited
SMP – Scientific Monitoring Plan/Program
SoW – Scope of Works
WMS – Work Method Statement

Appendix L: Scientific monitoring capability

Scientific Monitoring Assurance and Capability Assessment

Assurance arrangements

Astron Environmental Services (Astron) is currently Santos' primary Monitoring Service Provider for the implementation of SMPs 1-11. A contractual arrangement exists with Astron to maintain standby arrangements as per the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162) and have the resourcing capability to implement a first-strike response at all times. Astron maintains a relationship with a primary sub-contractor (BMT) for the provision of scientific monitoring for those SMPs where Astron does not have the required capability. Between Astron and BMT, capability exists to deliver first-strike resourcing against SMPs 1-11.

Assurance on the continued maintenance of capability is provided through the delivery of monthly capability reports. These reports are generated by the Astron and BMT Planning and Logistics Officers and delivered to the Santos Spill Response Adviser along with a summary of any changes in resourcing or, and if required, how gaps in resourcing have been managed. Since the establishment of the scientific monitoring contract in 2015 Astron has always demonstrated through this process that it has the required capability to meet first-strike resourcing as per the standby services contract.

Santos ensures that Astron/BMT standby arrangements are adequate through its exercise and auditing program. Santos regularly conducts exercises and tests with Astron and BMT to ensure that Santos IMT roles and Astron/BMT monitoring roles are familiar with the SMP activation arrangements while providing spot checks on resource availability. Santos has previously also undertaken an audit of Astron against its Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162). Assurance activities to date have demonstrated a high degree of compliance with standby service requirements.

Continuous improvement

Santos is committed to further improving its oil spill scientific monitoring capability. To that end, Santos is participating in a Joint Industry Operational and Scientific Monitoring Plans project, governed through an APPEA-Industry Steering Committee. This project, being progressed throughout 2021, is working towards a joint-industry capability for implementing a common suite of oil spill operational and scientific monitoring plans. The project aims to deliver efficiencies in implementing and testing oil spill scientific monitoring arrangements while increasing the level of resourcing and capability available to participating companies.

Baseline data assessment

Santos is currently committed to undertaking a review of the status, availability, currency and suitability of existing baseline data for oil spill scientific monitoring sources every 2 years. A review for this project was undertaken in June 2021 and looked at all high biodiversity value receptors in the Barossa EMBA.

The assessment of baseline data included:

1. A review of the following parameters for each program identified:
   - Integrated Marine and Coastal Regionalisation of Australia
   - Custodian- contact point for data
   - Spatial extent
   - Variables available for monitoring
   - Methods applied to monitoring
   - Year of most recent data capture
   - Total duration of monitoring program

- Data completeness (number of years monitored as proportion of program duration)
- How often data is captured
- Appropriateness of variables (Judgement as to whether variables are appropriate for future oil spill monitoring)
- Is there any clear indication that the monitoring will continue?

2. The quality of the following parameters were then ranked as high, medium, low or unknown:
    I. Year of most recent capture:
        - 2017-2021 (if a single data capture has occurred in the last two years, then the overall program can be considered of high quality) = high
        - 2011-2016 = medium
        - <2011 = low
    II. Duration:
        - >4 years = high
        - 2-4 years = medium
        - 1 year = low
    III. Data completeness:
        - 100% = high
        - 75-99% = medium
        - <75% = low
    IV. Frequency of capture
        - Annually = high
        - Bi-annually = medium
        - <Bi-annually = low
    V. Appropriateness of parameters
        - High/medium/low

        Appropriateness of parameters was based on reference to the Scientific Monitoring Plan's targeted states for each receptor and considering whether the monitoring parameters were sufficient to compare against these states. Parameters were considered highly appropriate if all targeted states for a receptor could be quantified, of medium appropriateness if only some states could be quantified and low if the monitored parameters had little relevance to the targeted states of an individual receptor.

3. An overall assessment of each study program was then made as follows:
    - All parameters rated high = overall 'good'
    - At least one parameter rated medium = overall 'fair'
    - At least one parameter rated low = overall 'poor'
    - Unknown = overall not enough data to rate

The above assessment process was also performed across monitoring programs which specified at least one of the priority protection areas within their monitoring sites. For Priority Protection Areas, the above assessment was then used to determine if 1) the baseline data available could be used to detect change in the state in the event of a significant impact - Classified as 'good' in the above assessment (i.e., data was current, of reasonable duration and frequency, and employed appropriate methodologies) or 2) the existing baseline data is unlikely to be suitable to detect change in state – classified as 'fair' or 'poor' by the above assessment (i.e., the data was dated, infrequent, of limited duration and/or relied on inappropriate methodologies).

To assess the capability to meet the first-strike scientific monitoring resourcing requirements, the assessment of baseline data focussed on those Priority Protections Areas with less than seven days before exposure from floating oil (>1 g/m2) and entrained oil (10 ppb) at any depth (**Table L-1**), as indicated by stochastic spill modelling. The two key ecological features (KEFs) listed (Shelf break and slope of the Arafura Shelf and carbonate bank and terrace system of the Van Diemen Rise) occur within the Northern Marine Region and a component of both also occur within the Oceanic Shoals AMP (**Figure L-1**). Some of the banks and shoals listed also occur within the two KEFs and the Oceanic Shoals AMP (**Figure L-1**).

A Protection Priority Area by SMP matrix summarising recommendations on baseline data status and recommendations for further action was then developed (**Table L-2**) based on three categories:

- Not applicable – SMP is not applicable to the priority protection area as sensitive receptor does not occur.
- Survey - current monitoring/knowledge is considered sufficient (i.e., could be used to detect change in state in the event of a significant impact) and is considered a lower priority for post-spill pre-impact data collection.
- Priority survey – current monitoring is not in place or not practicable; post-spill pre-impact baseline data collection should be prioritised.

The assessment determined for the majority of sensitive receptors within the priority protection areas post-spill pre-impact monitoring should be prioritised. It should be noted that given the Protection Priority Areas that could be contacted within 7 days is based on stochastic modelling data, a single spill will not contact all locations and receptors listed in **Table L-2.**

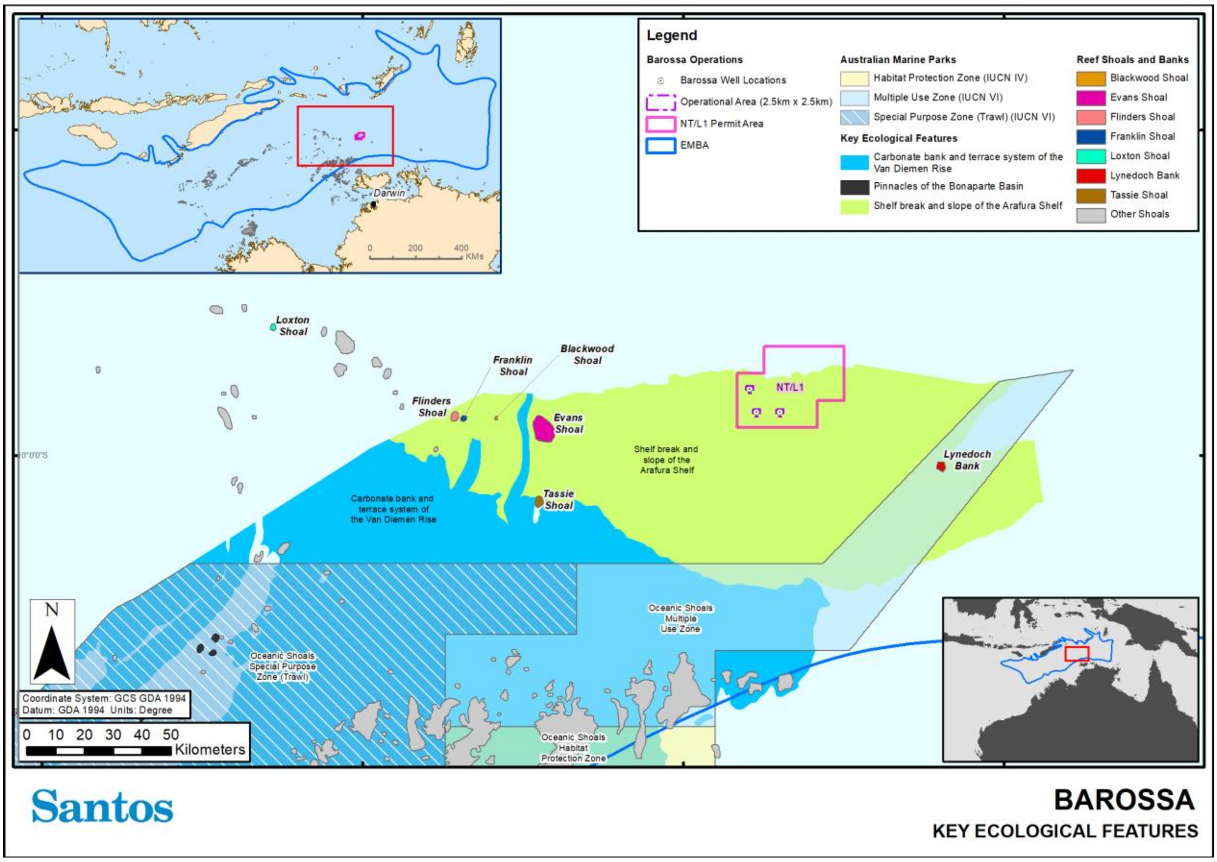


Figure L-1: Barossa KEFs

Table L-1: Minimum time to contact for loss of well control (subsea) of 129,000 m³ Barossa condensate scenario over 90 days

Location	Approximate distance from Barossa Operation Area	Probability (%) floating oil (>1 g/m²) on sea surface	Minimum arrival time floating oil (>1 g/m²) (days)	Probability (%) entrained (10ppb) in the 0-10 m depth layer	Probability (%) entrained (10ppb) in the 10-20 m depth layer	Minimum time entrained oil (10 ppb) at any depth (days)
Oceanic Shoals AMP		52 (transitional)	10.1	94 (summer)	14 (transitional)	3.6 (summer) 6 (transitional)
Shelf break and slope of the Arafura Shelf KEFs	Within the operation areas	100 (all)	0.04	100 (all)	97 (summer)	-
Carbonate bank and terrace system of the Van Diemen Rise KEFs	65 km	74 (transitional)	2.7	100 (transitional & winter)	27 (winter)	3.1 (transitional) 2.6 (winter)
Unnamed Shoal		66 (transitional)	4.7		-	
Evans Shoal	81 km	67 (transitional)	2.3	100 (transitional & winter)	15 (summer)	6.9 (summer) 2.9 (transitional) 3.6 (winter)
Franklin Shoal	111 km	44 (transitional)	3.6	100 (winter)	-	4 (transitional) 4.2 (winter)-
Flinders Shoal	109 km	36 (transitional)	3.8	100 (transitional & winter)	-	4 (transitional) 4.3 (winter)-
Blackwood Shoal	97 km	53 (transitional)	3.0	100 (transitional & winter)	-	5.8 (transitional) 4.2 (winter)-
Tassie Shoal	89 km	40 (transitional)	4.8	99 (transitional & winter)	12 (summer)	8.3 (summer) 4.4 (transitional) 4.1 (winter
Loxton Shoal	174 km	24 (transitional)	6.8	95 (winter)	-	6.9 (transitional) 8 (winter)
Lynedoch Bank	56 km (south-east)			75 (summer)	-	6.6. (summer)

Table L-2: Summary of recommendations for further action based on review of available baseline data

SMP	Priority Protection Areas										
	Oceanic Shoals AMP	Shelf break and slope of the Arafura Shelf KEFs	Carbonate bank & terrace system of the Van Diemen Rise KEFs	Unnamed Shoal	Evans Shoal	Franklin Shoal	Flinders Shoal	Blackwood Shoal	Tassie Shoal	Loxton Shoal	Lynedoch Bank
Water Quality (SMP1)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Sediment Quality (SMP2)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Sandy Beaches/Rocky Shorelines (SMP3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mangroves (SMP4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Intertidal Mudflats (SMP5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benthic Habitats (SMP6)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Seabirds/ shorebirds (SMP7)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Marine megafauna (SMP8) (includes whale sharks)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Marine reptiles (SMP9)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey

SMP	Priority Protection Areas										
	Oceanic Shoals AMP	Shelf break and slope of the Arafura Shelf KEFs	Carbonate bank & terrace system of the Van Diemen Rise KEFs	Unnamed Shoal	Evans Shoal	Franklin Shoal	Flinders Shoal	Blackwood Shoal	Tassie Shoal	Loxton Shoal	Lynedoch Bank
Seafood Quality (SMP10)	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey	Priority survey
Fish, Fisheries & Aquaculture (SMP11)	Survey	Survey	Survey	Survey	Survey	Survey	Survey	Survey	Survey	Survey	Survey
Whale sharks (SMP12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Capability assessment

Based on the assessment of priority survey areas/receptors outlined in **Table L-1,** a capability assessment was undertaken to understand whether existing scientific monitoring capability would be sufficient to mount a first-strike monitoring program to gather baseline data within a short-timeframe (<7 days); this capability is outlined in **Table L-3**. As demonstrated, Santos has excess capability than the expected requirement.

The mobilisation of SMP teams and monitoring equipment to deployment locations will be within 96 hours (72 hours from monitoring plan approval). Most of the SMP activities will be vessel based (apart from aerial surveillance of wildlife), and the approximate steam time to the Barossa operational area is 20 hours. In consideration of these timeframes, mobilisation of scientific monitoring teams to some priority receptor sites may not be possible within contact timeframes and in such instances experimental designs not relying on pre-impact baseline would have to be employed (these experimental design approaches are described within the Oil Spill Scientific Monitoring Plan (EA-00-RI-10099)).

The results of the baseline and capability assessment of protection priority areas summarised herein has been provided within the Environment Functional Team Folder on the Emergency Response Intranet page so that this information is accessible to guide Santos IMT Environmental roles and monitoring provider roles in the event of activating oil spill scientific monitoring.

Table L-3: Assessment for rapid sampling of protection priority areas within seven days

<table>
<tr><th>Receptors</th><th>Survey Prioritisation</th><th>Required capability for rapid response (per Priority Protection Area)</th><th>Actual Team Capability</th></tr>
<tr><td>Water Quality (SMP1)</td><td>Priority survey</td><td rowspan="2">1 team of 2 personnel
at least one member in team to have experience in water sampling
at least one member in team to have experience in deep sea sediment sampling</td><td rowspan="2">3 teams of 2 personnel</td></tr>
<tr><td>Sediment Quality (SMP2)</td><td>Priority survey</td></tr>
<tr><td>Sandy Beaches/Rocky Shorelines (SMP3)</td><td>Not applicable</td><td rowspan="3">No shoreline contact expected</td><td rowspan="2">3 teams of 2 personnel</td></tr>
<tr><td>Intertidal Mudflats (SMP5)</td><td>Not applicable</td></tr>
<tr><td>Mangroves (SMP4)</td><td>Not applicable</td><td>Not required[1]</td></tr>
<tr><td>Benthic Habitats (SMP6)</td><td>Priority survey</td><td>1 team of 2 personnel
at least one team member with experience in benthic habitat assessment
ROV operator or divers</td><td>2 teams of 2 personnel
at least one team member with experience in benthic habitat assessment
ROV operator or divers</td></tr>
<tr><td>Seabirds/ shorebirds (SMP7)</td><td>Priority survey</td><td rowspan="3">1 team of 2 personnel (aerial)
both experienced wildlife observers

1 team of 2 personnel (vessel)
both experienced wildlife observers (including birds)</td><td>4 teams of 2 personnel
at least one member of each team is an experienced ornithologist)</td></tr>
<tr><td>Marine megafauna (SMP8)</td><td>Priority survey</td><td>2 teams of 2 personnel (aerial)[2]
both experienced wildlife observers
2 teams of 2 personnel (vessel)[2]
both experienced wildlife observers</td></tr>
<tr><td>Marine reptiles (SMP9)</td><td>Priority survey</td><td>2 teams of 2 personnel (aerial)[3]
both experienced wildlife observers
3 teams of 2 available (vessel)[3]
both experienced wildlife observers

3 teams of 2 personnel (ground-based)[4]
at least one member with experience in turtle survey techniques</td></tr>
<tr><td>Seafood Quality (SMP10)</td><td>Priority survey</td><td>1 team of 3 personnel</td><td>3 teams of 3 personnel</td></tr>
</table>

Receptors	Survey Prioritisation	Required capability for rapid response (per Priority Protection Area)	Actual Team Capability
Fish, Fisheries & Aquaculture (SMP11)	Survey	at least one member to have experience in fish identification and necropsy at least one member to have BRUV experience	
Whale sharks (SMP12)	Not applicable		Not Required

[1]Remote sensing data would be collected for mangroves, with no field team required to be mobilised.

[2]Aerial and vessel surveys could be conducted by the same team. The aerial-based surveys would be conducted first and then this would help inform target areas for vessel-based surveys.

[3]Two of these teams are those also assigned to SMP8

[4]One of these teams is also assigned to vessel-based surveys for the same SMP. They can be moved according to priority for either vessel-based or ground survey.

Santos

Appendix M: Forward operations guidance

Forward Operating Base (FOB)

For a significant Level 2/3 response requiring coordination of resources to be deployed to the field, Santos will establish a FOB. For a level 2/3 spill crossing from Commonwealth to WA State waters (cross-jurisdictional spills) DoT will establish a FOB.

For a Barossa development activity spill response, Santos will establish a FOB at the Santos Logistics and Supply Base, located at East Arm Wharf, Darwin Harbour. These facilities are also available to the NT IMT to establish a FOB for Territory based response. The Santos Logistics and Supply Base at East Arm Wharf is connected to the Santos internet and telephone system.

Additional FOBs may be set up as operational requirements dictate. **Tables 1 and 2** list regional facilities with operational value for response.

The IMT will develop a communication strategy to support the FOB/s and forward staging areas.

Santos

Table 1: Darwin facilities with operational value for response

Facility	Owner/Operator	Potential Uses
Port of Darwin	Darwin Port	Staging area for vessel loading for spill response and equipment and waste management Storage of oil spill response equipment Vessel loading for spill response equipment and waste management Office facilities for Marine-based Command Centre
Darwin International Airport	Australian Government	Air freight spill response equipment Storage sheds for oil spill response equipment Office facilities for Aviation-based Command Centre
Batchelor Airfield	NT Government	Air freight spill response equipment Storage sheds for oil spill response equipment Office facilities for Aviation-based Command Centre
Mantra Pandanas Double Tree by Hilton Esplanade Darwin Double Tree by Hilton Darwin Mantra on the Esplanade Others	Various (independent)	Spill responders and IMT accommodation Accommodation and messing for clean-up personnel
Santos Logistics and Supply Base, East Arm Wharf	Santos	FOB OCC Office Transfer yard for truck-based equipment deliveries and waste management, Maintenance and Cleaning Facility Materials consolidation Marine equipment storage, staging and repairs Oiled wildlife response centre Laydown / storage area Bunded washing facility for oil booms Staging area for vessel loading for spill response and equipment and waste management Storage of oil spill response equipment Vessel loading for spill response equipment and waste management Office facilities for Marine-based Command Centre
Toll Darwin Logistics Supply Base	Toll	Transfer yard for truck-based equipment deliveries and waste management, Maintenance and Cleaning Facility Materials consolidation Laydown / storage area
Local boat ramps in Darwin Harbour	Broome Council	Load out for near-shore marine-based operations Boat launching

Santos

Table 2: Broome facilities with operational values for response

Facility	Owner/Operator	Potential Uses
Port of Broome	Kimberley Ports Authority	Staging area for vessel loading for spill response and equipment and waste management Storage of oil spill response equipment Vessel loading for spill response equipment and waste management Office facilities for Marine-based Command Centre
Broome International Airport	Australian Government	Air freight spill response equipment Storage sheds for oil spill response equipment Office facilities for Aviation-based Command Centre
Broome Heliport	Australian Government	Air freight spill response equipment Storage sheds for oil spill response equipment Office facilities for Aviation-based Command Centre
Seashells Broome Moonlight Bay Suites Bayside Holiday Apartments Mangrove Hotel Blue Seas Resort Others	Various (independent)	Spill responders and IMT accommodation Accommodation and messing for clean-up personnel
Toll Mermaid Supply Base 1 Toll Mermaid Supply Base 2	Toll and Mermaid	FOB OCC Office Transfer yard for truck-based equipment deliveries and waste management, Broome Maintenance and Cleaning Facility Materials consolidation Marine equipment storage, staging and repairs Oiled wildlife response centre Laydown / storage area Bunded washing facility for oil booms
Civmec Logistics Supply Base	Civmec	Transfer yard for truck-based equipment deliveries and waste management, Boom maintenance and Cleaning Facility Materials consolidation Marine equipment storage, staging and repairs Oiled wildlife response centre Laydown / storage area Bunded washing facility for oil booms
Quest Marine Services	QMS	Marine-based response Command Centre and Staging Area
Toll offices	Toll	FOB OCC Offices
Local boat ramp at Broome Town Jetty	Broome Council	Load out for near-shore marine-based operations Boat launching

Forward Staging Areas

Staging areas for shoreline operations will be set up at shoreline response locations under the direction of the Control Agency for shoreline response activities. Wildlife treatment facilities may also be set-up under the direction of the Control Agency to clean and rehabilitate oiled wildlife.

Transport

Transportation on shoreline locations will be supported by 4x4 vehicles and all-terrain vehicles. These can be supplied by locally and nationally through hire/purchase 3rd parties.

Mobile plant

Mobile plant and equipment for mechanical clean-up can be provided from suppliers in Darwin, Broome, Exmouth, Port Hedland or Perth as required.

Decontamination

Decontamination areas (HDPE lining provided through the provider of PPE) will be constructed for maintaining the integrity of the 'Zones' at shoreline Staging Areas, location and terrain permitting and as directed by the Control Agency for the shoreline response. Contaminated water from the decontamination areas will be regularly pumped out. All contaminated wastewater will be decanted into suitable transportable medium provided by Santos' WSP for removal.

Ablutions

Staging Areas may be supported by toilet/ablution solutions; these solutions will be dictated by the location and terrain of the clean-up operations. Available facilities include:

+ Portable Toilets;
+ Trailer Mounted Toilets; and
+ Transportable Toilets.

These solutions are chemical and fresh water based and supported by weekly/fortnightly flushing servicing. The requirement of the situation will dictate if this service is supplied out of Karratha or Perth. Santos' WSP can provide disposal as required of wastewater from ablutions.

Security

To ensure that Staging Areas are secure, Santos can provide temporary fencing to contain operations/equipment during the clean-up; suppliers of temporary fencing are available in Darwin, Broome, Port Hedland and Dampier, or larger quantities may need to be sourced from Perth. If required, the specialist services of security providers will be engaged.

Messing

Messing and catering facilities can be provided through one of Santos' current service providers, under local arrangements as determined by capacity and facilities geographically available.

Freight movement

The transportation of all equipment and service from all stockpiles and centres can be facilitated through Santos' third-party logistics providers.

Cleaning and repair

Cleaning and repair of booms and other operational equipment this can be carried out in bunded areas at the forward staging area or supply base facilities.

Suppliers

All material, associated equipment and services will be sourced, where possible, through existing Santos suppliers. Service Orders will be raised if other/new suppliers are to be engaged to provide services etc. in the event of an oil spill.

Accommodation

Accommodation options for field responders and FOB personnel will be dictated by proximity to their respective activity areas, to ensure maximum utilisation of the shift time available.

Mainland accommodation is available at Darwin, Port Hedland, Dampier and Karratha. Santos' Devil Creek accommodation close to Karratha may also be used.

Where possible local facilities will be utilised to accommodate response personnel, however transportable accommodation and messing facilities can be supplied through contract suppliers if required.

Transportation to respective work sites would be facilitated via modal and multimodal transport solutions, dictated by the geographical constraints of each site. Under current contractual arrangements, Santos has access to transportation providers for Land, Air and Marine operations. In general, from accommodation locations to operational areas transport would be via road using the services of our third-party supplier. Should additional services be required to meet the demand, this would be engaged under a Service Agreement as determined and authorised by the IMT.

Providoring

Providoring arrangements, when utilising local facilities would be covered under Service Orders/Purchase Order Terms and Conditions, however if required Santos has existing contracts with local who could be used for additional providoring support. These supplies would be transported to the respective spill response staging area by one of Santos' third-party logistics providers.

The providoring requirements for transportable and remote messing would be provided directly through contracted service providers, including the transportation thereof.

PPE

Santos would utilise the services of specialist providers of PPE for clean-up operations. All PPE would be sourced in Perth and transported by one of Santos' third-party logistics providers to the forward operating centres.

In the event of a spill incident Santos would engage the services of a third party to provide and maintain inventory for the duration of oil spill operations.

The disposal of contaminated PPE is provided by Santos' WSP.

PPE requirements for spill responders is detailed in the Santos Oil Spill Response Health and Safety Manual (SO-91-RF-10016).

Radio communications

Santos will utilise the services of a specialist communication provider to hire hand-held and vehicle mounted UHF radios to support response and clean-up personnel. Portable deployed repeater stations (battery or mains powered) can be positioned along the shoreline to provide a 'voting' system for transmitting and receiving during the clean-up operation. Communication equipment will be supplied through local, national, and international suppliers as the operational situation dictates.

Appendix N: IMT resourcing

IMT Resourcing

Santos manages its IMT capability through a range of arrangements including internal Santos personnel and external support. Santos internal capability includes competent personnel available for incident management from various Santos business units in Australia. Santos also has access to IMT support personnel through a range of external arrangements consisting of:

- AMOSC Member Agreement
- Industry Mutual Aid /Core Group Personnel
- OSRL Member Agreement
- Specialist Service providers including;
  - WWC: for Source Control support
  - RPS: For oil spill modelling/visualisation support
  - BMT/Astron: Monitoring Service provider
  - NWA: Waste Management Contractor
  - TOLL: Logistics Services Contractor
  - Aspen: Medical Services Provider
  - Recruitment Servicer provider/ Labour Hire Companies

Santos's Master Services Contract with AMOSC gives access to 80–120 oil spill trained personnel through industry core group. The Expanded IMT Resourcing Plan below (**Table N-1**) assumes about 25% of this capability available for IMT support and the remaining 50–90 personnel available for field response team roles. Santos has guaranteed access to 18 Response Specialists from OSRL for any incident under the Associate Membership Agreement. OSRL has about 150 oil spill technical personnel available across their global bases. Santos may request for additional resources from OSRL for major oil spill events and the resources will be available on a best endeavour basis. The Expanded IMT Resourcing Plan below (**Table N-1**) assumes about 30% of this capability available for IMT support. Santos also has in place arrangements with specialist service providers for roles which apply non-oil-spill expertise in a response context, such as Logistics, Finance, Waste Management, Source Control etc. The IMT capability for these roles is established through the specialist service providers as listed above.

Santos will work closely with relevant government authorities (e.g., DoT, DBCA) for incident management aspects related to shoreline response and oiled wildlife response. The capability available under the SRT/NRT (~150 IMT personnel / 40 SRT personnel) is not included in the expanded IMT resourcing plan.

The WCD Response timeline is estimated to be 23–25 weeks. This is estimated based on the timeline for relief well drilling (11 weeks) and shoreline clean-up activities (with Outer Shark Bay Coast estimated to have the longest shoreline clean-up time of 21 weeks). Response termination and demobilisation will follow a phased approach and additional 2–4 weeks is added to account for the final response termination and demobilisation phase once the shoreline clean-up activities for Outer Shark Bay Coast is completed. Peak resourcing requirements for IMT is anticipated between week 3 and week 11 and thereafter to gradually decline until the response is terminated.

Assuming a protracted response requiring two rotational IMT teams with a day and night shift for each team, the total resourcing requirement for the expanded IMT is estimated to be 136 persons. Santos internal resourcing (Including support from other business units in Australia) provides access to 172 personnel for IMT support and an additional 119 personnel is estimated to be available through external arrangements. The predicted allocation of resources to the expanded IMT roles is shown in **Table N-1**.

Table N-1: Expanded IMT Resourcing Plan

#	IMT POSITION		Required	Available Resources: Santos	Available Resources: Total Allocated personnel available via Contracting Arrangements	Total Personnel Available through internal/external Arrangements
1	INCIDENT COMMANDER		2	14	NA	14
	DEPUTY IC		2			
2	Safety Officer		2	10	NA	10
3	Public Information Officer		2	6	NA	6
4	DoT LO		2	2	NA	2
	Media LO		2	2	NA	2
5	HR		3	10	NA	10
6	PLANNING SECTION CHIEF		2	8	NA	8
	Deputy Planning Section Chief		2			
	Situation Unit Lead		2	7	2	9
		COP Display Processor/GIS Specialist	2	2		2
	Resources Unit Lead		2	4	2	6
	Documentation Unit Lead		2	3	NA	3
	Environment Unit Lead		2	5	NA	5
	Technical Specialists	Modelling Specialist	2		5	5
		Sampling/Monitoring Specialist	2		3	3
		Waste Management Specialist	2		2	2
		Wildlife Specialist	2	4	4	8
		Response Specialists (as required for branches)	10		10	10
	Shoreline Response Programme Manager		2		4	4
		STR Manager	2	4	6	10
		SCAT Programme Coordinator	2	2	6	8
		SCAT Data Manager	2	2	2	4
		SCAT Field Coordinator	2	2	5	7
7	OPERATION SECTION CHIEF		3	13	NA	13
	Deputy Operations Section Chief		3			
	Source Control Branch Director		2	4		4
		Relief Well Team Lead	2	2		2
		Subsea Intervention Team Lead	2	2		2
	Staging Branch Director		2	2		2
	Monitoring Branch Director		2		3	3
	Wildlife Response Branch Director		2		2	2
	Air Operations Branch Director		2	4	1	5
	Offshore Response Branch Director		2	2	3	5
		Dispersant Operations Group Lead	2		5	5
		Recovery & Protection Group Lead	2		5	5
	Shoreline Clean-Up Branch Director		2		5	5
		Geographical Division Supervisors	12	15	6	21
8	LOGISTICS SECTION CHIEF		3	12	NA	12
	Logistics Specialists (as required for branches)		7		8	8
	Support Branch Director		3	7		7
		Supply Unit Lead Lead	2		2	2
		Facilities Unit Lead	2		2	2
		Ground Support Unit Lead	2		2	2
		Vessel Support Unit Lead	2	1	2	3
	Service Branch Director		3	8		8
		Communications Unit Lead	2		2	2
		Medical Unit Lead	2		6	6
		Food Unit Lead	2		2	2
9	FINANCE SECTION CHIEF		3	13	NA	13
		Procurement Unit Lead	2		4	4
		Claims Unit Lead	2		4	4
		Cost Unit Lead	2		4	4
	NA = Not Applicable					
		Sub-total	*136*	*172*	*119*	291

Santos

Barossa Development OPEP Addendum: Drilling and Completions

PROJECT / FACILITY	Barossa Development
REVIEW INTERVAL	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s Managerial/Technical/Site	Approver
0	Senior Oil Spill Response Coordinator	Team Leader – Barossa HSE	Manager – HSE Offshore Division

Any hard copy of this document, other than those identified above, are uncontrolled. Please refer to the Santos Offshore Document Management System for the latest revision.

Distribution	Oil Pollution Emergency Plan – Addendum	
	Electronic	Hardcopy
Intranet – Emergency Preparedness	link only	
Manager – HSE Offshore Division	link only	
Drilling Superintendent	link only	
Drilling Supervisor	link only	
Senior Oil Spill Response Coordinator	link only	
Santos Company Site Representative (CSR)	link only	
IMT Room – Perth office		● x 4
AMOSC	●	
DoT	●	
AMSA	●	
OSRL	●	

Contents

List of tables

List of figures

Acronyms and abbreviations

Abbreviation	Description
ALARP	as low as reasonably practicable
AMP	Australian Marine Park
EEZ	Exclusive Economic Zone
EMBA	Environment That May Be Affected
EP	Environment Plan
IAP	Incident Action Plan
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMT	Incident Management Team
KEF	Key Ecological Feature
LOWC	loss of well control
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine diesel oil
MODU	mobile offshore drilling unit
NEBA	net environmental benefit analysis
NT	Northern Territory
OIE	Offset Installation Equipment
OPEP	Oil Pollution Emergency Plan
OSC	on-scene commander
OWR	oiled wildlife response
SFRT	Subsea First Response Toolkit
SIMA	spill impact mitigation assessment
SIMAP	Spill Impact Mapping and Analysis Program
SMP	Scientific Monitoring Plan
SOPEP	Shipboard Oil Pollution Emergency Plan
SSDI	Subsea Dispersant Injection
VOC	volatile organic compound
WA	Western Australia

1 Quick reference information

<table>
<tr><th>Parameter</th><th colspan="6">Description</th><th>Further information</th></tr>
<tr><td>Petroleum Activity</td><td colspan="6">Barossa Development Drilling and Completions</td><td>Section 2 of Barossa Development Drilling and Completions Environment Plan (EP) (BAD-200 0003)</td></tr>
<tr><td>Location (Lat/Long)</td><td colspan="6">Up to 8 production wells will be drilled around three manifold locations within the Bonaparte Basin in Commonwealth waters approximately 300 km north-northwest of Darwin</td><td>Section 2.1.1 of EP</td></tr>
<tr><td>Petroleum title/s (blocks)</td><td colspan="6">NT/L1 (Production Licence)</td><td>N/A</td></tr>
<tr><td>Facilities/vessels</td><td colspan="6">MODU – semi-submersible
Light well intervention vessel
Support vessels</td><td>Section 2.2 of EP</td></tr>
<tr><td>Water Depth</td><td colspan="6">204- 376 m</td><td>N/A</td></tr>
<tr><td rowspan="4">Worst-case spill scenarios</td><td colspan="2">Scenario</td><td colspan="2">Hydrocarbon</td><td colspan="2">Worst-case volume (m^3)</td><td rowspan="4">Section 3.1</td></tr>
<tr><td colspan="2">Bunkering incident</td><td colspan="2">MDO (Group II)</td><td colspan="2">10 m^3</td></tr>
<tr><td colspan="2">Vessel collision</td><td colspan="2">MDO (Group II)</td><td colspan="2">250 m^3</td></tr>
<tr><td colspan="2">Loss of well control (LOWC) (subsea)</td><td colspan="2">Barossa Condensate</td><td colspan="2">129,000 m^3</td></tr>
<tr><td>Hydrocarbon properties</td><td colspan="3">MDO:
Density at 25 °C = 829 kg/m3
Dynamic viscosity = 4 cP @ 25° C
API Gravity = 37.6°
Wax content = 1%
Pour point = -14 °C
Oil property classification = Persistent (medium)</td><td colspan="3">Barossa condensate:
Density at 16 °C = 782 kg/m3
Dynamic viscosity = 1.35 cP @ 10° C
API Gravity = 50.6°
Wax content = 3.6%
Pour point = -6 °C
Volatile components = 93%
Oil property classification = non-persistent (Group I)</td><td>Appendix A – Barossa Development OPEP</td></tr>
</table>

Parameter	Description		Further information
Weathering potential	MDO is a mixture of volatile and persistent hydrocarbons with low viscosity. It will spread quickly and thin out to low thickness levels, thereby increasing the rate of evaporation. Up to 60% will generally evaporate over the first two days. Approximately 5% is considered "persistent", which are unlikely to evaporate and will decay over time.	Barossa Condensate is a low viscosity, non-persistent hydrocarbon that if spilt on the sea surface, would rapidly spread and thin out resulting in a large surface area available for evaporation. The fate of the condensate will depend greatly on the proportion that reaches the surface after rising through the water column. Hence, discharge conditions will have a strong influence on exposure risks for surrounding resources.	**Appendix A – Barossa Development OPEP**
Protection priorities	Based on the hydrocarbon spill modelling, hydrocarbons are expected to remain in the upper water column with the probability of contact above the moderate impact thresholds decreasing with water depth. Consequently, areas at greatest risk are the benthic habitats present on some of the shallower offshore banks and shoals, where the moderate exposure thresholds are predicted to be exceeded, including: + Tassie Shoal + 'Unnamed' Shoal The following key ecological features and Australian Marine Parks are predicted to be contacted above the moderate exposure threshold: + Oceanic Shoals Australian Marine Park + Carbonate bank and terrace system of the Van Diemen Rise + The shelf break and slope of the Arafura Shelf		**Section 3.3**

2 Introduction

2.1 Summary of proposed activity

This OPEP Addendum supports the Barossa Development OPEP (BAA-200 0314) and is applicable for drilling and completions activities associated with the Barossa Development in Commonwealth permit area NT/L1 in the Bonaparte Basin, located in the Timor Sea. The drilling and completions activities include the use of a semi-submersible MODU to drill up to eight production wells. Additional detail on the activity, project timing and duration, and equipment to be used are included are outlined in **Section 2.2** of the Barossa Development Drilling and Completions Environment Plan (BAD-200 0003).

The location of the activity covered by this OPEP Addendum is shown in **Figure 2-1**. While all activities for the Barossa Development Drilling and Completions Campaign are being undertaken entirely within Commonwealth waters, a spill from the activity may enter into Indonesian and/or Timor-Leste waters. Modelling does not predict any spills entering into Northern Territory (NT) or Western Australian (WA) waters.

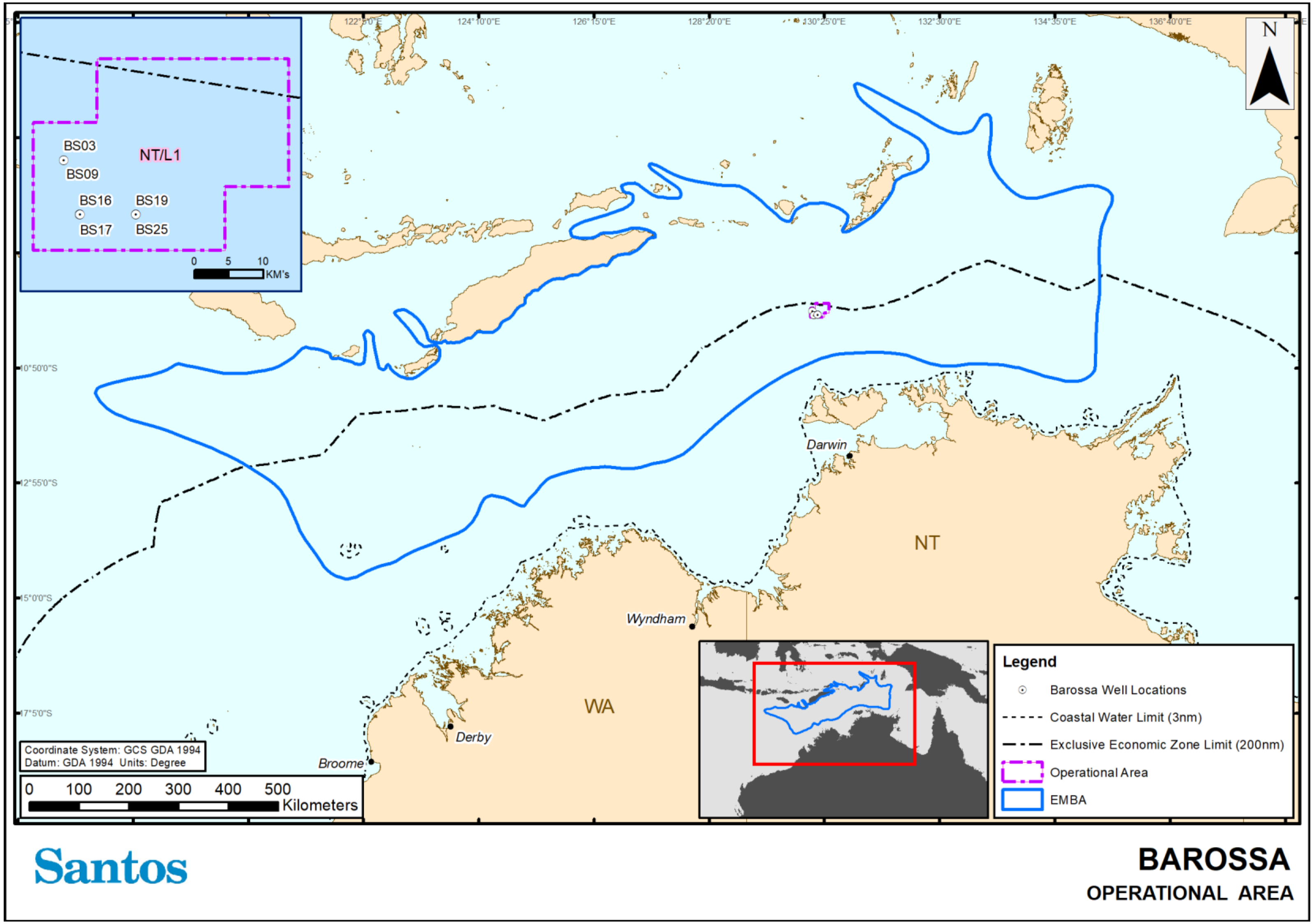


Figure 2-1: Barossa drilling and completions location map and Environment that May be Affected (EMBA) extent (at 1g/m^2)

3 Description of spills and protection priorities

3.1 Spill scenarios

This OPEP Addendum outlines the credible oil spill scenarios associated with the Barossa Development Drilling and Completions activities. Of the credible spill scenarios identified in the Barossa Development Drilling and Completions EP (BAD-200 0003), all have been selected to represent worst case spills from a response perspective, taking into account the following characteristics:

+ They represent all hydrocarbon types that could be spilt during Barossa Development Drilling and Completions activities.
+ They represent maximum credible release volumes.
+ Those scenarios that represent the greatest spatial extent from a response perspective based on surface oil and shoreline accumulation as these are the key factors contributing to response.
+ Proximity to sensitive receptors, shorelines, State/Territory and Commonwealth boundaries etc.

The worst-case credible spill risks selected to inform this OPEP Addendum are presented in **Table 3-1**. Detail on the derivation of these maximum credible spills is provided within the Barossa Development Drilling and Completions EP (BAD-200 0003).

For a description of the characteristics and behaviour associated with hydrocarbons that may unintentionally be released refer to **Appendix A** of the Barossa Development OPEP (BAA-200 0314).

Table 3-1: Maximum credible spill scenarios for Barossa Development Drilling and Completions activities

Worst-case credible spill scenario	Hydrocarbon type	Maximum credible volume released (m^3)	Release duration	Maximum extent of surface hydrocarbons
Bunkering incident	MDO	10	Instantaneous	Within the extent of the worst-case spill trajectory of diesel from a vessel collision
Vessel collision	MDO	250	6 hours	Approx. 368 km (at 1 g/m^2)
LOWC – subsea release	Barossa Condensate	129,000	90 days	Approx. 370 km (at 1 g/m^2)

3.2 Spill modelling results

Spill modelling was conducted for the LOWC (subsea) (129,000 m^3 Barossa Condensate) and vessel collision scenario (250 m^3 MDO). These scenarios represent the worst-case volumes for Barossa Condensate and MDO for the Barossa Development Drilling and Completions activities and are presented in **Table 3-2**.

Stochastic oil spill modelling was performed using a three-dimensional spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program). This model is designed to simulate the drifting, spreading, weathering and fate of specific oil types under the influence of changing meteorological and oceanographic forces.

A stochastic modelling approach was followed for each of the scenarios. The stochastic model involves the repeated application of SIMAP (100 simulations for each season; summer, transitional and winter) to simulate the defined spill scenarios using different samples of current and wind data. The model results were then combined to provide a summary of each season.

The modelling outputs do not represent the potential behaviour of a single spill (which would have a much smaller area of influence) but provides an indication of the probability of any given area of the sea surface being contacted by hydrocarbons above impact thresholds.

For the purpose of spill response preparedness, outputs relating to floating oil and oil accumulated on the shoreline are most relevant (i.e. oil that can be diverted, contained, collected or dispersed through the use of spill response strategies) for the allocation and mobilisation of spill response resources. Results for the worst-case credible scenarios have only been included if there was a floating hydrocarbon concentration greater than 1 g/m^2 at >5% probability.

Modelling results for dissolved and entrained oil for the worst-case scenarios have not been included in the OPEP given there are limited response strategies that will reduce subsurface impacts. However, these modelling results inform the EMBA and are presented in Section 7.6 and 7.7 of the Barossa Development Drilling and Completions EP (BAD-200 0003).

Table 3-2: Worst-case spill modelling results for Barossa Development Drilling and Completions activities

Location	Probability (%) floating oil (>1 g/m²) on sea surface	Minimum arrival time floating oil (>1 g/m²) (days)	Probability (%) floating oil (>10 g/m²) on sea surface	Minimum arrival time floating oil (>10 g/m²) (days)	Total probability (%) shoreline oil accumulation>10 g/m²	Minimum arrival time shoreline oil accumulation >10 g/m² (days)
Scenario: Vessel collision of 250 m³ over 6 hours						
Flinders Shoal	14 (transitional)	3.5	NC	NC	N/A	N/A
Evans Shoal	22 (transitional)	2.4	NC	NC	N/A	N/A
Franklin Shoal	13 (transitional)	3.5	NC	NC	N/A	N/A
Blackwood Shoal	12 (transitional)	3.0	NC	NC	N/A	N/A
Oceanic Shoals Australian Marine Park (AMP)	6 (summer)	3.6	NC	NC	N/A	N/A
Shelf break and slope of the Arafura Shelf Key Ecological Feature (KEF)	100 (summer)	0.04	100 (summer)	0.04	N/A	N/A
Carbonate bank and terrace system of the Van Diemen Rise KEF	16 (transitional)	2.4	1 (transitional)	3.3	N/A	N/A
Scenario: Loss of well control (subsea) of 129,000 m³ over 90 days						
Oceanic Shoals IMCRA	79 (transitional)	2.6	47 (transitional)	9.1	N/A	N/A
Indonesian EEZ	98 (summer)	2.5	24 (summer)	18.3	N/A	N/A
Oceanic Shoals AMP	52 (transitional)	10.1	12 (transitional)	19.5	N/A	N/A
Shelf break and slope of the Arafura Shelf KEF	100 (all)	0.04	100 (all)	0.04	N/A	N/A
Carbonate bank and terrace system of the Van Diemen Rise KEF	74 (transitional)	2.7	39 (transitional)	10.2	N/A	N/A
Margaret Harries Bank	23 (transitional)	16	NC	NC	N/A	N/A

Location	Probability (%) floating oil (>1 g/m²) on sea surface	Minimum arrival time floating oil (>1 g/m²) (days)	Probability (%) floating oil (>10 g/m²) on sea surface	Minimum arrival time floating oil (>10 g/m²) (days)	Total probability (%) shoreline oil accumulation>10 g/m²	Minimum arrival time shoreline oil accumulation >10 g/m² (days)
'Unnamed' Shoal	66 (transitional)	4.7	17 (transitional)	12.3	N/A	N/A
Evans Shoal	67 (transitional)	2.3	NC	NC	N/A	N/A
Franklin Shoal	44 (transitional)	3.6	NC	NC	N/A	N/A
Flinders Shoal	36 (transitional)	3.8	NC	NC	N/A	N/A
Blackwood Shoal	53 (transitional)	3.0	NC	NC	N/A	N/A
Tassie Shoal	40 (transitional)	4.8	17 (transitional)	12.3	N/A	N/A
Loxton Shoal	24 (transitional)	6.8	NC	NC	N/A	N/A

3.3 Protection/monitoring priorities

When dealing with oil spills in remote environments, it is not always realistic or feasible to protect all receptors. Therefore, prioritising receptors helps identify where available resources (for response and/or monitoring) should be directed for the best effect. It enables the control agency to make informed decisions, and ultimately in the development and execution of an effective response strategy.

Results from hydrocarbon spill modelling were compared against the location of key sensitive receptors with high conservation valued habitat or species or important socio-economic/heritage value within the EMBA. Sensitive receptors within the EMBA with shortest potential timeframes to contact with hydrocarbons above the following moderate impact thresholds were identified (Note: more information on the development of the moderate impact thresholds is provided in Section 7.5.4 of the Barossa Development Drilling and Completions EP (BAD-200 0003)):

+ Floating oil: 10 g/m^2
+ Shoreline accumulation: 100 g/m^2 (note: no shoreline contact is predicted).

Based on the hydrocarbon spill modelling, hydrocarbons above these thresholds are expected to remain in the upper water column with probability of contact decreasing with water depth. Consequently, areas at greatest risk are the shallower offshore banks and shoals, while impacts are not predicted for benthic habitats in deeper waters, including in the Oceanic Shoals and Arafura Marine Parks and in the KEFs present in the EMBA.

Table 3-3 outlines the list of priority response and monitoring areas that may be impacted above these thresholds in the event of a spill associated with the drilling and completion activities.

It should be noted that the implementation of scientific monitoring is dependent upon the initiation criteria in Barossa Development OPEP (BAA-200 0314) **Appendix N** being met. In some cases, scientific monitoring will be triggered when aerial, visual or florescence observation reports submitted to the IMT show presence or likely presence of oil; or spill fate modelling predicts oil at sensitive receptors of > 1g/m^2 for surface oil, and >10 ppb for entrained and dissolved oil. This then activates the relevant Scientific Monitoring Plan (SMP), which determines if any impact has occurred based upon applicable thresholds.

Table 3-3: Priority response and monitoring areas in the EMBA

Priority protection area	Description
Offshore banks and shoals	Areas at greatest risk are the benthic habitats present on some of the shallower offshore banks and shoals, which include: + 'Unnamed' Shoal + Tassie Shoal. Surveys of Tassie Shoal recorded coral and algae species, filter-feeder communities, sponges, demersal fish and pelagic fish. It is expected that Unnamed Shoal would be characterised by similar communities.
Oceanic Shoals AMP	The Oceanic Shoals Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Transition.
KEFs	Carbonate bank and terrace system of the Van Diemen Rise The shelf break and slope of the Arafura Shelf.

4 Applicable response strategies

4.1 Evaluation of applicable response strategies

Based on the nature and scale of the credible spill scenarios outlined in **Section 3.1** and spill modelling results (**Section 3.2**) the following spill response strategies have been assessed as potentially applicable for combatting a spill (**Table 4-1**).

Table 4-1: Evaluation of applicable response strategies

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Source control	Spill kits	✓ 1	✓ 1	Relevant for containing spills that may arise on board a vessel or MODU.
	Secondary containment	✓ 1	✓ 1	Relevant for spills that may arise due to stored hydrocarbons, and from spills arising from machinery and equipment on board a vessel or MODU. Bunded areas will contain hydrocarbons reducing the potential for a spill escaping to marine waters. Where applicable open deck drainage will be closed to prevent hydrocarbon draining into the marine environment.
	Shipboard Oil Pollution Emergency Plan	✗	✓ 1	MARPOL requirement for applicable vessels. In the event a vessel hydrocarbon storage tank is ruptured, applicable strategies for reducing the volume of hydrocarbon releases will be contained within the vessel Shipboard Oil Pollution Emergency Plan (SOPEP). This may include securing cargo via transfer to another storage area on-board the vessel, transfer to another vessel, or through pumping in water to affected tank to create a water cushion (tank water bottom). Trimming the vessel may also be used to avoid further damage to intact tanks. These actions will aim to minimise the volume of fuel spilled.
	Surface well kill	✓ 1	✗	Considered during relief well planning but may not be possible depending upon technical and safety constraints. Surface well kill is only considered when the estimated leak rate is small enough not to generate an explosive gas cloud and access to the MODU is still preserved. This methodology would not be considered should safe access to the MODU or ability to operate a vessel alongside the MODU not be achievable.
	Blowout preventer – emergency activation	✓ 1	✗	A blow-out preventer (BOP) stack will be installed onto the wellhead prior to drilling of the reservoir well sections. The purpose of a BOP is to provide a secondary barrier to hydrocarbons by providing a mechanical means of shutting in the well if primary well control is lost, and hydrocarbons enter the wellbore.

Santos

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
	Capping stack	✓ 2	✗	A Capping Stack may be a viable option for controlling a subsea well drilled using a semi-submersible drilling rig. A Capping Stack installed onto a subsea wellhead can be used to divert the flow of hydrocarbons and potentially reduce the release rate of hydrocarbons prior to well kill via a relief well. Capping stack is a secondary response measure with deployment limited to appropriate conditions (e.g., blowout rates within safe operating limits, safe vertical access) and when operating conditions permit (wind speed, wave height, current and plume radius). Debris clearance using the Subsea First Response Toolkit (SFRT) would be implemented prior to Capping Stack installation.
	Relief well drilling	✓ 1	✗	Relevant to LOWC. Relief well drilling is the primary method for killing the well if access to the MODU is not preserved. To be conducted as per the Source Control Emergency Response Plan (DR-00-OZ-20001) and Well-specific or Campaign Source Control Plan.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
	Subsea dispersant injection (SSDI)	✓ 2	✗	SSDI is known to reduce VOC levels at the sea surface and is shown to be effective at dispersing condensates when applied subsea (RPS, 2019), making conditions safer for responders and source control personnel. SSDI is shown to reduce surface concentrations of hydrocarbons, thereby reducing the exposure of seabirds and surfacing marine fauna to hydrocarbons. It also disperses hydrocarbons into a larger volume of water, reducing concentrations and enhances biodegradation (French McCay *et al.*, 2018). A potential drawback of this response tactic is that it will result in smaller droplet sizes and entrainment of hydrocarbons into the water column, which may affect some oceanic and benthic organisms (e.g. fish, plankton). However, this is likely to be temporary and restricted to the top ~3 m of the water column whilst SSDI is being used (RPS, 2019). This increase in entrainment is partially offset by significant increases in biodegradation rates. SSDI is only suitable for subsea LOWC scenarios. Barossa condensate is considered a Group 1 oil (non-persistent) hydrocarbon that has rapid evaporation rates (57% within a few hours to a day – refer to Barossa Development OPEP [BAA-200 0314] – Appendix A: Hydrocarbon characteristics and behaviour). There is therefore little to no direct environmental benefit from SSDI and potential drawbacks associated with the enhancement of entrainment. However SSDI would be employed as a secondary strategy and only if it was necessary to use to reduce VOCs in the atmosphere, improving the safety of response personnel working close to the well site. In this case, SSDI may have an overall environmental benefit, as enabling source control personnel access to the site to bring the release under control (e.g. for BOP intervention and/or deployment of Capping Stack) may reduce the overall volume of hydrocarbons being released into the environment.
In-Situ burning	Controlled burning of oil spill	✗	✗	Not applicable to condensate wells due to safety hazards. Not applicable to diesel spills due to inability to contain marine diesel making it very difficult to maintain necessary slick thickness for ignition and sustained burning.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Monitor and evaluate plan (operational monitoring)	Vessel surveillance	✓ 1	✓ 1	Provides real-time information on spill trajectory and behaviour (e.g., weathering). Informs implementation of other response strategies. Vessel personnel may not be trained observers. Observers on leaking vessel may not have capacity to observe oil during emergency response procedure implementation. Constrained to daylight. Limited to visual range from the vessel. Limited capacity to evaluate possible interactions with sensitive receptors.
	Aerial surveillance	✓ 1	✓ 1	Provides real-time information on spill trajectory and behaviour (e.g., weathering). May identify environmental sensitivities impacted or at risk of impact (e.g., seabird aggregations, other users such as fishers). Provides information on the effectiveness of response strategies. Informs implementation of other response strategies.
	Tracking buoys	✓ 1	✓ 1	Can be implemented rapidly. Can provide indication of near-surface entrained/dissolved hydrocarbons (most other monitor and evaluate techniques rely on the hydrocarbon being on the surface or shoreline).

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
	Trajectory modelling	✓ 1	✓ 1	Can be implemented rapidly. Predictive – provides estimate of where the oil may go, which can be used to prepare and implement other responses. No additional field personnel required. Not constrained by weather conditions. Can predict floating, entrained, dissolved and stranded hydrocarbon fractions. May not be accurate. Requires in-field calibration.
	Satellite imagery	✓ 1	✓ 1	Can work under large range of weather conditions (e.g., night time, cloud cover, etc). Mobilisation likely to be more than 24 hours. Requires processing. May return false-positives.
	Operational water quality monitoring	✓ 1	✓ 1	Fluorometry surveys are used to determine the location and distribution of the entrained oil and dissolved aromatic hydrocarbon components of a continuous subsea spill and validate the spill fate modelling predictions.
	Shoreline and coastal habitat assessment	N/A	N/A	Modelling indicates no probability of shoreline contact.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Chemical dispersion	Vessel application	✗	✗	Neither Barossa condensate or MDO are persistent hydrocarbons, both having high natural spreading, dispersion and evaporation rates in the marine environment. Surface chemical dispersants are most effective on hydrocarbons that are at a thickness of 50–100g/m^2 on the sea surface. EMSA (2010) recommends thin layers of spilled hydrocarbons should not be treated with dispersant. This includes Bonn Agreement Oil Appearance Codes (BAOAC) 1–3 (EMSA, 2010). Barossa Condensate and MDO would rapidly spread and thin out on the sea surface, so it is unlikely to reach this required thickness. Therefore, considering the rapid evaporation rates (57% within a few hours to a day – refer to Barossa Development OPEP (BAA-200 0314) – Appendix A: Hydrocarbon characteristics and behaviour) of this Group I hydrocarbon, the inability to achieve the required thicknesses for application to be effective and the remoteness of the spill location, the addition of chemical dispersants would have little to no environmental benefit.
	Aerial application	✗	✗	
Offshore containment and recovery	Use of offshore booms/skimmers or other collection techniques deployed from vessel/s to contain and collect oil	✗	✗	*Barossa condensate and MDO* Not suitable for Barossa condensate or marine diesel given their rapid weathering nature. These hydrocarbons spread quickly to a thin film, making recovery via skimmers difficult and ineffective. The ability to contain and recover rapidly weathering hydrocarbons on the sea surface is extremely limited due the very low viscosity of these hydrocarbons.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Mechanical dispersion	Vessel prop-washing	✓ 2	✓ 2	Safety is a key factor and slicks with potential for high volatile organic compound (VOC) emissions are not suitable. Mechanical dispersion may be applicable for the localised entrainment of surface oil but is not considered to have a significant effect on removing oil from the surface. Mechanical dispersion will entrain surface oil into the top layer of the water column. The aim of mechanical dispersion is to reduce the concentration of oil floating at the surface which could potentially contact receptors at the sea surface (e.g., sea birds) or shoreline receptors (e.g. mangroves). Once dispersed in the water column the smaller droplet sizes enhance the biodegradation process. Marine diesel is a light oil that can be easily dispersed in the water column by running vessels through the plume and using the turbulence developed by the propellers to break up the slick. Mechanical dispersion may be considered for targeted small breakaway patches of condensate but may have limited effectiveness. The potential disadvantage of mechanical dispersion is that it could temporarily increase the concentration of entrained and dissolved oil in the vicinity of submerged shallow water receptors (e.g., corals, seagrass ad macroalgae). This is most likely in shallow water of a few metres deep. The suitability of mechanical dispersion as a response measure would consider the prevailing environmental conditions (it mimics the action of wave induced entrained so is most beneficial in calm conditions) and the type, proximity and depth (as applicable) of sensitivities in the area. Mechanical dispersion will be considered for petroleum activity sourced spills at the discretion of the On-Scene Commander (OSC)/ Incident Management Team (IMT) or by the relevant control agency. It is unlikely that vessels would be specifically allocated for mechanical dispersion but vessels undertaking primary strategies may be used opportunistically.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Protection and deflection	Booming in nearshore waters and at shorelines	N/A	N/A	Modelling indicates no probability of shoreline contact.
Shoreline clean-up	Activities include physical removal, surf washing, flushing, bioremediation, natural dispersion	N/A	N/A	Modelling indicates no probability of shoreline contact.
Oiled wildlife response (OWR)	Activities include hazing, pre-emptive capture, oiled wildlife capture, cleaning and rehabilitation	✓ 1	✓ 1	Can be used to deter and protect wildlife from contact with oil. Mainly applicable for marine and coastal fauna (e.g., birds) where oil is present at the sea surface or accumulated at coastlines. Surveillance can be carried out as a part of the fauna specific operational monitoring. Wildlife may become desensitised to hazing methods. Hazing may impact upon animals (e.g., stress, disturb important behaviours such as nesting or foraging). Permitting requirements for hazing and pre-emptive capture.

OSR strategy	Tactic	Applicability and designated primary (1) or secondary (2) response strategy		Considerations/limitations
		Barossa condensate	MDO	
Scientific monitoring	The monitoring of environmental receptors to determine the level of impact and recovery form the oil spill and associated response activities	✓ 1	✓ 1	Monitoring activities include: + water and sediment quality + biota of shorelines (sandy beaches, rocky shores and intertidal mudflats) + mangrove monitoring + benthic habitat monitoring (seagrass, algae, corals, non-coral benthic filter feeders) + seabirds and shorebirds + marine megafauna (incl. whale sharks and mammals) + marine reptiles (incl. turtles) + seafood quality + fish, fisheries and aquaculture. The type and extent of scientific monitoring will depend upon the nature and scale of oil contact to sensitive receptor locations as determined through operational monitoring. Pre-defined initiation criteria exist for scientific monitoring plans associated with marine and coastal sensitivities.

4.2 Net environmental benefit analysis

The IMT uses a net environmental benefit analysis (NEBA), also referred to as a spill impact mitigation assessment (SIMA), to inform the incident action planning process (Section 8 of the Barossa Development OPEP (BAA-200 0314)), so the most effective response strategies with the least detrimental environmental impacts can be identified, documented and executed.

The Environmental Team Lead will use the information in **Section 3.3** to identify and prioritise initial response and/or monitoring priorities and apply the NEBA to identify which response strategies are preferred for the situation, oil type and behaviour, environmental conditions, direction of plume and locations.

As a component of the incident action planning process, NEBA is conducted by the control agency with responsibility for the spill response activity. Where there are different activities controlled by different IMTs, as in a cross-jurisdictional response, consultation will be required during the NEBA process so that there is consistency in the sensitivities prioritised for response across the Control Agencies.

A strategic NEBA has been developed for all response strategies identified as applicable to credible spills identified in this OPEP Addendum, with the benefit or potential impact to each sensitivity identified (refer to **Table 4-2** and **Table 4-3**).

In the event of a spill, NEBA is applied with supporting information collected as part of the Operational Monitoring Plan (Section 10 of the Barossa Development OPEP (BAA-200 0314)) to achieve the following:

+ Identify sensitivities within the area potentially affected by a spill at that time of the year (noting that the sensitivity of some key receptors, such as birdlife and turtles, varies seasonally).
+ Assist in prioritising and allocating resources to sensitivities with a higher protection and response priority.
+ Assist in determining appropriate response strategies with support of real time metocean conditions, oil spill tracking and fate modelling.

When a spill occurs, NEBA is applied to the current situation, or operationalised. Operational NEBA Templates are filed within the Environment Team Leader folder on the Santos Emergency Response Intranet site. To complete the Operational NEBA:

+ all ecological and socioeconomic sensitivities identified within the spill trajectory area are recorded
+ potential effects of response strategies on each sensitivity are assessed in terms of their benefit or otherwise to the socio-economic sensitivities
+ all persons involved and data inputs have been considered for the analysis.

The Operational NEBA Form documents the decisions behind the recommendation to the Incident Commander on which resources at risk to prioritise, and the positives and negatives of response strategies to deploy. The Operational NEBA provides guidance to the Incident Action Plan (IAPs) and is revisited each Operational Period.

Table 4-2: Strategic net environmental benefit analysis matrix – Barossa condensate loss of well control (all scenarios)

Priority for protection area	No controls	Source control	Monitor and evaluate	Mechanical dispersion	Oiled wildlife response	Scientific monitoring
Tassie and 'Unnamed' Shoal (submerged receptor)						
Coral and other subsea benthic primary producers					N/A	
Important fish communities					N/A	
Oceanic Shoals Marine Park (submerged receptor)						
Turtle habitat – flatback, olive ridley, loggerhead						
Coral and other subsea benthic primary producers					N/A	
Important fish communities					N/A	
Carbonate bank and terrace system of the Van Diemen Rise (submerged receptor)						
Coral and other subsea benthic primary producers – soft corals, sponges, epifauna					N/A	
Important fish communities					N/A	
Turtle habitat – flatback, olive ridley, loggerhead						
The shelf break and slope of the Arafura Shelf (submerged receptor)						
Phytoplankton and invertebrates					N/A	
Important fish communities					N/A	

Key:

	Beneficial impact		Possible beneficial impact depending on the situation (e.g. timeframes and metocean conditions to dilute entrained oil)		Negative impact	N/A	Not applicable for the environmental value or not applicable for hydrocarbon type

Table 4-3: Strategic net environmental benefit analysis matrix – marine diesel oil spills (all scenarios)

Priority for protection area	No controls	Source control	Monitor and evaluate	Mechanical dispersion	Oiled wildlife response	Scientific monitoring
Tassie and Unnamed Shoal (submerged receptor)						
Coral and other subsea benthic primary producers					N/A	
Important fish communities					N/A	
Oceanic Shoals Marine Park (submerged receptor)						
Turtle habitat – flatback, olive ridley, loggerhead						
Coral and other subsea benthic primary producers					N/A	
Important fish communities					N/A	
Carbonate bank and terrace system of the Van Diemen Rise (submerged receptor)						
Coral and other subsea benthic primary producers – soft corals, sponges, epifauna					N/A	
Important fish communities					N/A	
Turtle habitat – flatback, olive ridley, loggerhead						
The shelf break and slope of the Arafura Shelf (submerged receptor)						
Phytoplankton and invertebrates					N/A	
Important fish communities					N/A	

Key:

	Beneficial impact		Possible beneficial impact depending on the situation (e.g., time frames and met-ocean conditions to dilute entrained oil)		Negative impact	N/A	Not applicable for the environmental value or not applicable for hydrocarbon type

5 Spill response ALARP assessment

ALARP assessment summary – source control (refer worksheet for further detail)
The Control Measures in place for emergency BOP activation represent industry best practice and are considered to reduce the timeframe for BOP activation to ALARP in the context of a LOWC incident. The use of a BOP is considered to be an effective source control and the emergency BOP activation procedures ensure timely activation of the BOP. No additional or alternative control measures were identified. The Control Measures in place for relief well drilling represent industry best practice and are considered to reduce the timeframe for drilling a relief well to as low as reasonably practicable in the context of the risk of an uncontrolled well leak from a production well. Potential Control Measures were identified and assessed by the Santos WA Drilling & Completions Department representatives. The drilling of a relief well is considered to be an effective control and relief well planning conducted in the area has demonstrated that relief well drilling within 90 days can be implemented using MODUs, equipment and specialist personnel that Santos has arrangements to gain access to. Santos has arrangements in place to enable access to a Capping Stack as a secondary source control strategy and would only be used where there is suitable vertical access over the wellhead. These arrangements also include trained personnel for the mobilisation, deployment and operation of the Capping Stack. Limiting factors for the deployment of a Capping Stack involve safety and technical constraints, metocean conditions, location of Capping Stacks and access to a suitable Capping Stack capable vessel. Santos assessed the feasibility of maintaining its own Capping Stack and having suitable deployment vessel/crew on standby to deploy Capping Stack. Given the low likelihood of a blowout event, the significant upfront costs involved and the presence of a more effective primary control strategy (relief well drilling) the costs are considered disproportionate to the level of risk reduction.
Thirteen potential additional Control Measures were identified and assessed.
One additional Control Measures were accepted as reasonably practicable. Accepted Control Measure was: + Pre-purchase of relief well drilling supplies.
Twelve Control Measures were rejected as grossly disproportionate. Rejected response strategies were: + Have dedicated BOP Intervention vessel equipped with ROV tooling package in field. + Purchase and maintain own Capping Stack in Darwin. + Incentivise a vendor to set up a Capping Stack in Darwin. + Purchase and maintain own Capping Stack and have suitable deployment vessel/crew on standby with pre-approved Safety Case to deploy Capping Stack. + Transport WWC Capping Stack via air. + Use lightweight Rapid Cap to be mobilised via air from Houston, USA. + Preposition WWC Capping Stack standby crew in Perth. + Have MODU on standby at activity location.

+ Schedule drilling campaign to avoid cyclone season. + Contract source control personnel through a provider in addition to existing arrangements. + Have Wild Well Control on standby in Perth during drilling operations in order to respond immediately to a LOWC. + Pre-drill riserless intervals for a potential relief well before drilling the main well. Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the Barossa Development OPEP. For the Capping Stack the key areas of effectiveness for the identified Control Measures are around the maintenance of contracts for the Capping Stack equipment, deployment of personnel, and the tracking of suitable vessels. The key performance requirements for relief well drilling are the maintenance tracking, access and relief well planning arrangements (during times of maintaining preparedness) and the timely mobilisation of resources (during a response). These key areas of effectiveness are reflected in the Performance Standards.
ALARP assessment summary – subsea dispersant (refer worksheet for further detail)
For a Barossa subsea LOWC, SSDI application is considered a secondary response strategy and is included for its potential to reduce VOC exposure to response personnel working close to the well site (e.g. to deploy a Capping Stack). To assess the effectiveness of dispersant application, Santos will use the Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020). Control Measures are in place for a rapid mobilisation of the SFRT, personnel and dispersants to Darwin; it is estimated that it will be ready to commence operations by day 11 to 12. A Control Measure involving the positioning of an SFRT on standby at a regional port in order to reduce deployment time was assessed but was found to be disproportionate in terms of costs to the reduction in risk gained. Dispersant volumes available within Australia and the mobilisation of these stocks exceed worse case requirements, hence dispersant is not a limiting factor to the SSDI operation.
Seven additional potential Control Measures were identified and assessed.
No additional Control Measures were accepted as reasonably practicable.
All seven additional Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: + Purchase Santos SFRT to be located in Darwin. + Relocate AMOSC SFRT to Darwin. + Position subsea bladder dispersant system next to well site. + Transport WWC SSDI system from Singapore as a back-up unit. + Enable improved vessel access by contracting a suitable, dedicated vessel on standby. + Gain access to additional dispersant stockpiles owned by Santos. + Rent dispersants and position in Darwin. Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around the maintenance of contracts for the SFRT equipment, dispersants and deployment personnel and the tracking of suitable SFRT vessels. In the event of a response, the key areas for ensuring effectiveness are the mobilisation of requirements to commence

subsea dispersant operations, the subsea monitoring of dispersant efficacy by ROV and the consideration of this information together with other operational monitoring information within an operational NEBA for the activity. These key areas of effectiveness are reflected in the performance standards.
ALARP assessment summary – monitor and evaluate (refer worksheet for further detail)
Various, independent inputs from multiple service providers are used to build a detailed Common Operating Picture in the event of an incident. Eight additional potential Control Measures were identified and assessed. Three additional Control Measures were accepted as reasonably practicable. The accepted measures were: + Have two tracking buoys available in Darwin. + Require that vessel specifications be included in Vessel Tracking System. + Maintain a list of providers that could assist with fauna aerial observations. Five Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: + Purchase oil spill modelling system and internal personnel trained to use system. + Have trained water monitoring specialists available in Darwin. + Have trained aerial observers based in Darwin. + Ensure trained marine mammal/fauna observers based at strategic locations such as Darwin. + Possibly use for surveillance purposes two vessels servicing Bayu-Undan operations in response to a spill. Performance Standards and Measurement Criteria that have been developed for the in-effect and accepted Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures, during times of preparedness, focus on maintaining access to equipment and personnel through contractual arrangements with vessel providers, aircraft providers, aerial observers, UAV providers, tracking buoys, oil spill trajectory modelling providers, satellite imagery providers, water quality monitoring providers, and spill responders. Additional key areas for effectiveness during preparedness are following relevant procedures such as the Protected Marine Fauna Interaction and Sighting Procedure, and limiting environmental impacts from response activity through personnel and vehicle management. During response, a key area for ensuring effectiveness is the mobilisation of requirements in order to commence monitor and evaluate operations. These key areas of effectiveness have been represented in Performance Standards for monitor and evaluate operations.

ALARP assessment summary – mechanical dispersion (refer worksheet for further detail)
Mechanical dispersion is a secondary strategy that could be undertaken by vessels undertaking primary response strategies without the requirement for additional equipment, and no areas of improvement were identified. The use of mechanical dispersion in a response would be assessed as part of an operational NEBA. No potential additional Control Measures were identified and assessed. Performance standards and measurement criteria that have been developed for the in-effect control measures are shown in the OPEP. The key areas of effectiveness for the identified control measures during a response are around the development of an operational NEBA to confirm suitability and environmental benefit, and the mobilisation of vessels. These key areas of effectiveness are reflected in the performance standards.

ALARP assessment summary – oiled wildlife (refer worksheet for further detail)
The worst-case scenario associated with this OPEP Addendum does not include shoreline contact and consequently only low numbers of oiled wildlife are anticipated. Santos has developed a Santos Wildlife Framework Plan (SO-91-BI-20014) as a Control Measure to ensure that a procedure is in place for OWR, where they are the control agency or Support Organisation, in order to provide an effective and coordinated OWR. Santos has access to the indicative resource requirements for the worst-case scenario in this OPEP Addendum as per the NT Oiled Wildlife Response Plan and WA Oiled Wildlife Response Plan. Including mobilisation of AMOSC oiled wildlife equipment and industry OWR team to a forward staging area within 48 hours. AMSA also maintains an oiled wildlife washing container in Darwin. Potential Control Measures around additional responders through pre-hiring or contracts with additional service providers were investigated but were found to be not beneficial and/or the cost was grossly disproportionate to risk reduction. Three potential Control Measures were identified and assessed. All were rejected as grossly disproportionate. Rejected response strategies were: + Have additional Santos OWR trained personnel positioned in Darwin. + Pre-hire and/or preposition staging areas and responders. + Use direct contracts with service providers. Performance Standards and Measurement Criteria that have been developed for the in-effect Control Measures are shown in the Barossa Development OPEP (BAA-200 0314). The key areas of effectiveness for the identified control measures, during times of preparedness, are around maintaining access to equipment and personnel through contractual arrangements. During response, the mobilisation of requirements for initial oiled wildlife response operations and the management of the oiled wildlife response in accordance with the WA Oiled Wildlife Response Plan and NT Oiled Wildlife Response Plan are both key elements for achieving this strategy and they are represented as Performance Standards.

ALARP assessment summary – waste (refer worksheet for further detail)
The Santos contract with the waste service provider has provisions for waste management operations of the scale estimated to be required in worst case scenarios detailed in the OPEP Addendum. Further detail is captured in the Waste Management Plan – Oil Spill Response Support (QE-91-IF-10053). The waste service provider can mobilise waste receptacles to Darwin Port within 12–24 hrs. Given the waste service provider arrangements and preplanning already undertaken, waste storage facilities, road transport and logistics are not expected to be limiting factors in the response. For these components, potential Control Measures were identified and evaluated but were found to either make no improvement in capability or cost was grossly disproportionate. An area of improvement is the availability of vessels required for waste transport at sea. One potential Control Measure to address this area of improvement was identified and accepted: + Maintain contracts with multiple service providers to cover new geographic location. Two potential Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: + Procure temporary waste storage for Santos stockpile. + Contract additional vessels on standby for waste transport. Performance Standards and Measurement Criteria that have been developed for the in-effect Control Measures are shown in the Barossa Development OPEP (BAA-200 0314). The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around maintaining access to waste management equipment and services through contractual arrangements. During response, a key area for increasing effectiveness is the timely mobilisation of requirements for initial response operations and defining critical management and reporting services to be provided by the waste service provider. These key areas of effectiveness are captured in the Performance Standards.
ALARP assessment summary – scientific monitoring (refer worksheet for further detail)
Oil spill scientific monitoring will be conducted on behalf of Santos by a contracted monitoring service provider as detailed in the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162) and the relevant Scientific Monitoring Programs. An area of improvement is the availability of vessels in the initial stages of response. To address this area of improvement, a potential Control Measure around more detailed vessel tracking was assessed and accepted. Additionally, three potential Control Measures were identified and assessed. One Control Measure, having trained scientific monitoring personnel and equipment on standby in Darwin was considered disproportionate. Two potential Control Measures relating to maintaining equipment and lists of monitoring providers and the provision of water quality sampling kits to be located at strategic regional locations were both found to be reasonable and practicable, both were adopted. Four additional potential Control Measures were identified and assessed. Three additional Control Measures were accepted as reasonably practicable. The accepted Control Measures were: + Maintain equipment list and list of suppliers for implementation of Scientific Monitoring Plans. + Position oil sampling kit for scientific monitoring personnel at Darwin.

- Determine required vessel specifications required for scientific monitoring implementation and improve accuracy of Vessel Tracking System.

One Control Measure was rejected as grossly disproportionate. The rejected Control Measure was:

- Have scientific monitoring personnel and equipment on standby in Darwin.

Performance Standards and Measurement criteria that have been developed for the in effect and accepted Control Measures are shown in the Barossa Development OPEP (BAA-200 0314). The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around maintaining access to equipment and personnel through contractual arrangements, regular reviews of monitoring service provider capability and reviews of existing baseline data. During response, a key area for effectiveness is the mobilisation of requirements to commence scientific monitoring, and ensuring that relevant approved manuals and plans are followed. These key areas of effectiveness are reflected in the Performance Standards.

6 References

European Maritime Safety Agency (EMSA) 2010. Manual on the Applicability of Oil Spill Dispersants – Version 2. Accessed 4th June 2019 - http://www.emsa.europa.eu/opr-documents/opr-manual-a-guidelines/item/719-manual-on-the-applicability-of-oil-spill-dispersants.html.

French McCay, D., Crowley, D., 2018. Sensitivity Analysis for Oil Fate and Exposure Modelling of a Subsea Blowout – Data Report. Prepared for American Petroleum Institute. API Project 2015-110161.

RPS. 2019. Inpex VOC & SSDI Modelling: Near-field to far-field investigation stages. Report prepared for INPEX.

ALARP ASSESSMENT SUMMARY

ALARP Assessment Summary - Source Control

The Control Measures in place for emergency BOP activation represent industry best practice and are considered to reduce the timeframe for BOP activation to ALARP in the context of a LOWC incident. The use of a BOP is considered to be an effective source control and the emergency BOP activation procedures ensure timely activation of the BOP. No additional or alternative control measures were identified.

The Control Measures in place for relief well drilling represent industry best practice and are considered to reduce the timeframe for drilling a relief well to as low as reasonably practicable in the context of the risk of an uncontrolled well leak from a production well. Potential Control Measures were identified and assessed by the Santos WA Drilling & Completions Department representatives. The drilling of a relief well is considered to be an effective control and relief well planning conducted in the area has demonstrated that relief well drilling within 90 days can be implemented using MODUs, equipment and specialist personnel that Santos has arrangements to gain access to.

Santos has arrangements in place to enable access to a Capping Stack as a secondary source control strategy and would only be used where there is suitable vertical access over the wellhead. These arrangements also include trained personnel for the mobilisation, deployment and operation of the Capping Stack. Limiting factors for the deployment of a Capping Stack involve safety and technical constraints, metocean conditions, location of Capping Stacks and access to a suitable Capping Stack capable vessel. Santos assessed the feasibility of maintaining its own Capping Stack and having suitable deployment vessel/crew on standby to deploy Capping Stack. Given the low likelihood of a blowout event, the significant upfront costs involved and the presence of a more effective primary control strategy (relief well drilling) the costs are considered disproportionate to the level of risk reduction.

Thirteen additional potential Control Measures were identified and assessed.

One additional Control Measure was accepted as reasonably practicable. Accepted Control Measures were:
- Pre purchase of relief well drilling supplies

Twelve Control Measures were rejected as grossly disproportionate. Rejected response strategies were:
- Dedicated BOP Intervention vessel equipped with ROV tooling package in field
- Purchase and maintain own Capping Stack in Darwin
- Incentivise a vendor to set up a Capping Stack Darwin
- Purchase and maintain own Capping Stack and have suitable deployment vessel/crew on standby with pre -approved Safety Case to deploy Capping Stack
- Transport WWC Capping Stack via air
- Use of lightweight Rapid Cap to be mobilised via air from Houston, USA.
- Preposition WWC Capping Stack standby crew in Perth
- MODU on standby at activity location
- Schedule drilling campaign to avoid cyclone season
- Contract source control personnel through a provider in addition to existing arrangements
- Wild Well Control on standby in Perth during drilling operations in order to respond immediately to a LOWC
- Pre-drill riserless intervals for a potential relief well before drilling the main well

Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the Barossa Development OPEP. For the Capping Stack the key areas of effectiveness for the identified Control Measures are around the maintenance of contracts for the Capping Stack equipment, deployment of personnel, and the tracking of suitable vessels. The key performance requirements for relief well drilling are the maintenance tracking, access and relief well planning arrangements (during times of maintaining preparedness) and the timely mobilisation of resources (during a response). These key areas of effectiveness are reflected in the Performance Standards.

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
Subsea First Response Toolkit (SFRT) - refer to SSDI tab.							
Blowout Preventer - Emergency Activation	Access to ROV capability for BOP hot-stab intervention maintained with MODU ROV contractor throughout the	In effect	Equipment	Controlling flow of hydrocarbons as quickly as possible will reduce environmental impacts. BOP closed	Provides functionality, availability, reliability, survivability, compatibility and independence.	Cost of contract	In effect
	Dedicated BOP Intervention vessel equipped with ROV tooling package in field	Alternative	Equipment	BOP closed within 1-2 days (depending upon daylight hours available) reducing release of hydrocarbons by 2-3 days.	Provides functionality, availability, reliability, survivability, compatibility and independence.	Costs associated with having an additional dedicated BOP intervention vessel on contract $50-60K USD/day.	Reject Removes limitation of having to wait 2-3 days for a suitable vessel. However, the cost of having a vessel on standby is a fixed cost, regardless of if a spill were to occur or not. The time saving of 2-3 days is not proportionate to the expense incurred.
Capping Stack	Capping Stack is applicable as a secondary strategy for subsea wells and BOPs to be used. Santos has access to two Wild Well Control Capping Stacks (Singapore and Aberdeen). Singapore Capping Stack- Assembly and ready to mobilise will take approximately 6 days + 9 days to mobilise to incident (total= 15 days)	In effect	Equipment	Controlling flow of hydrocarbons as quickly as possible will reduce environmental impacts.	Provides functionality, availability, reliability, survivability, compatibility and independence. Would only be used where there is suitable vertical access over the wellhead	Cost of contract	In effect
	Santos to purchase and maintain its own Capping Stack in Darwin	Alternative	Equipment	This is unlikely to provide any reduction in timeframes due to vessel access being the key time driver. In order for this to be effective, a suitable vessel would need to be on standby (with personnel) to realise benefit of Capping Stack in Darwin.	A Capping Stack positioned in Darwin would need to be disassembled and stored at a suitable location as there is no suitable locations to store a fully assembled Capping Stack. Unpacking the containers, assembly and testing of the Capping Stack is estimated to take 4-5 days, but the limiting factor will be the availability of a suitable vessel.	USD20 million to procure and USD 2.8 million per year to maintain	Reject Given access to the Capping Stack is in Singapore, there is no significant benefit in having a dedicated Capping Stack available in Darwin. Critical path time will most likely be sourcing and the availability of a suitable vessel, which is most likely to be in SE Asia i.e. the vessel would have to be made available and mobilised to Australia for any response regardless of Capping Stack location. Therefore, the additional cost in owning and maintaining a dedicated stack is unlikely to provide any significant environmental benefit.
	Incentivise a vendor to set up a Capping Stack Darwin	Alternative	Equipment	This is unlikely to provide any reduction in timeframes due to vessel access being the key time driver. In order for this to be effective, a suitable vessel would need to be on standby (with personnel) to realise benefit of Capping Stack in Darwin	This would result in needing to moving an existing stack away from a shared logistics hub, such as Singapore. This could potentially affect other operators sharing this contracted resource. In addition, there is no local expertise available on standby in Darwin to conduct maintenance or commence assembly operations if the Capping Stack was required.	Pay full time rental as a sole beneficiary.	Reject Critical time path will be sourcing and availability of a suitable vessel, which I most likely to be in SE Asia. Therefore, the additional cost in requesting a vendor to set up an existing Capping Stack in Singapore is unlikely to provide any significant environmental benefit.

	Purchase and maintain own Capping Stack and have suitable deployment vessel/crew on standby with pre - approved Safety Case to deploy Capping Stack	Alternative	Equipment People	Some debris removal may be required prior to Capping Stack installation. The SFRT would not be onsite until day 11-12 and then debris removal may take 1-2 days (depending on extent of damage). This option would therefore reduce Capping Stack deployment time by 1-2 days and only marginally reduce volume of oil contacting sensitive receptors.	A Capping Stack positioned in Darwin would need to be disassembled and stored at a suitable location as there is no suitable locations to store a fully assembled Capping Stack. Unpacking the containers, assembly and testing of the Capping Stack is estimated to take 4-5 days, but the limiting factor will be the availability of a suitable vessel. Purchasing a Capping Stack would also require training of personnel to maintain and install the stack, if it was required to be used. However, these personnel may not have the depth of experience that existing specialist personnel have whom are available through WWC, reducing the reliability and compatibility of this alternative.	Costs in addition to Capping Stack purchase/ maintenance costs are $80k USD per day for vessel/crew plus training costs for personnel.	Reject Based on drilling ~90 day well the costs of vessel/crew hire would be in the order of $5M additional to Capping Stack purchase/maintenance costs and not including for mobilisation costs. Capping Stack deployment is a secondary source control strategy, is contingent on safety and technical considerations, and may not be effective in controlling the source. Given the low likelihood of a blowout event, the significant upfront costs involved and the presence of a more effective primary control strategy (relief well drilling) the costs are considered disproportionate to the level of risk reduction.
	Transport WWC Capping Stack via air	Alternative	Equipment	The mobilisation time of the Capping Stack intervention system via airfreight is unlikely to provide a significant reduction in arrival time of the stack. The Capping Stack would need to be mobilised and flown into Darwin (3-5 days) and then assembled and tested (3-4 days). It would then need to be transferred and fastened on to the deployment vessel (1-2 days) and mobilised to the well site (1 day). This results in a total of 12 days. Therefore, this option is not expected to result in a significant improvement in arrival time of the Capping Stack, thus not resulting in any significant environmental benefit.	Air transportation of the Capping Stack requires it to be disassembled, which may affect the functionality of the stack if any components are damaged. The process of disassembly, packing, transport, unpacking and reassembly introduces a risk of damage to equipment, especially the metal pressure sealing surfaces associated with the high pressure connections of Capping Stacks. While the metal sealing rings have the strength to withstand very high pressures, they require a very smooth sealing surface to form a pressure seal. Mechanical handling of sealing components during Capping Stack disassembly risks damage to the smooth sealing surfaces and could result in additional time necessary to prepare the Capping Stack for deployment. Individual pressure sealing equipment elements must be packed separately. Damage to sealing surfaces may render the Capping Stack unusable until repairs can be undertaken at a certified machine	Cost of contracting Boeing 747 or Antonov 124 to transport the containers to Darwin.	Reject The risk associated with damaging equipment from airfreighting the Capping Stack and the minimal improvement in mobilisation time (12 days v's 15 days) is considered disproportionate to the incremental environmental benefit.
	Use of lightweight Rapid Cap to be mobilised via air from Houston, USA.	Additional	Equipment	The mobilisation time of the rapid cap would take approximately 10+ days, not resulting in any significant environmental benefit.	Airfreighting this cap in from Houston would not lead to any significant reduction in the estimated response time (10 days v's 15 days for preferred alternative of shipping Singapore stack). This is due to debris clearance taking 10+ days. Use of the Rapid Cap would only mitigate very specific cases (e.g. no debris) and industry experience indicates debris removal is likely for catastrophic failures. Although this lightweight cap only requires a lighter construction vessel with lesser specification on the crane and heave compensation, it is most likely this vessel will still need to be sourced from SE Asia.	Cost of having an additional contract for another Capping Stack.	Reject The mobilisation time of the rapid cap would take approximately 10+ days as the critical time path is likely to be debris clearance. The cost of having another contract with another equipment provider is disproportionate to the minimal environmental benefit gained.
	The location of suitable vessels (required vessel specs and Safety Case approval) for Capping Stack deployment are monitored monthly.	In effect	Procedure	Timely access to a suitable vessel could reduce mobilisation times for the Capping Stack thus reducing volume of hydrocarbon released to the environment.	Provides functionality, availability, reliability, survivability, compatibility and independence	Effort spent monitoring	In effect
	Wild Well Control staff available via contract to assist with the mobilisation, deployment, and operation of the Capping Stack and well intervention equipment	In effect	People	Controlling flow of hydrocarbons as quickly as possible will reduce environmental impacts.	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of contract	In effect
	Preposition WWC Capping Stack standby crew in Perth	Additional	People	No environmental benefit as WWC personnel are available to provide support within 72 hours.	No change to effectiveness or reliability as WWC personnel available within a rapid timeframe under existing arrangements.	Significant additional costs in having WWC personnel on standby in Perth. Locating personnel with specialised expertise in Perth may also create issues for other	Reject No environmental benefit in having access to personnel surplus to requirements
Relief well drilling	Santos Drilling and Completions Source Control Team mobilised within 24 hours. Well Control Specialists mobilised within 72 hours. Contract/ MOUs for source control personnel. APPEA MoU for mutual assistance for relief well drilling.	In effect	People	Controlling flow of hydrocarbons as quickly as possible will reduce environmental impacts.	This control measure provides functionality, availability, reliability, survivability, compatibility and independence Area for improvement; none identified	Cost of contracts/ MOUs	In effect
	Source Control Planning and Response Guideline (DR-00-OZ-20001).	In effect	Procedure	Provides a set process top follow in the planning and mobilisation for relief well drilling by Santos WA Source Control Team thereby reducing the timeframe and increasing the effectiveness of relief well drilling.	Provides functionality, availability, reliability, survivability, compatibility and independence	Effort in updating and maintaining document	In effect

	MODU Capability Register is monitored monthly	In effect	Procedure	By monitoring MODU, it will be possible to gain an understanding of which MODU may be rapidly available for relief well operations. This could reduce mobilisation times for MODU thus reducing volume of hydrocarbon released to the environment.	Provides functionality, availability, reliability, survivability, compatibility and independence	Effort spent monitoring	In effect
	MODU on standby at activity location	Improved	Equipment	Reduce mobilisation times of MODU to drill relief well thus reducing hydrocarbon released to the environment. Instead of base timeframe for the drilling of a relief well of 90 days, relief well potentially could be drilled in 49 days (77 days less the 41 days required for MODU to be ready to spud/commence relief well operations).	Improved availability	The cost of having a MODU on standby is approximately $600,000 per day. If adopted this cost is paid regardless if there is a loss of containment or not.	Reject Likelihood of LOWC is considered rare and the cost of having a second MODU on standby at location is considered grossly disproportionate to the environmental benefit.
	Schedule drilling campaign to avoid cyclone season	Alternative	Procedure	Drilling the well in cyclone season does not increase the likelihood of a loss of containment. This will be verified by NOPSEMA in the accepted WOMP, where the plan to suspend the well during a cyclone will be assessed.	Does not alter the effectiveness of the response strategy.	Having to mob and de-mob a MODU to guarantee the well could be drilled outside of cyclone season would be a >5MM USD cost increase.	Reject There are no additional risks associated with cyclone season on a loss of well control. The barriers installed for cyclone suspension are independent of metocean conditions. Adjusting the timing would preclude the ability to drill for 6 months of the year, materially reducing the MODUs available to do the work. Having to mobe and de-mobe a MODU to guarantee the well could be drilled outside of cyclone season would be a >5MM USD cost increase, which is disproportionate to the benefit gained.
	Pre purchase of relief well drilling supplies	Additional	Equipment	Relief well drilling supplies such as casings and well head equipment could potentially reduce relief well drilling times	Increase in availability	Cost of purchase, maintenance and storage of supplies	Accept Offshore D&C commit to having long lead equipment for a relief well at our disposal as part of WOMP commitments for each well drilled.
	Direct Surface Intervention Via Well Control Experts	In effect	Procedure	Reduce time taken to control source and reduce environmental impacts	1) Effectiveness of intervention of this type needs to be assessed at the time given that personnel safety considerations may preclude this control measure. 2) Mobilisation procedure for personnel as per SCERP 3-4) Contracts and MoUs for well control personnel (WWC)	Ability to implement and effectiveness of this control can only be determined at the time of an incident.	In effect
	Relief well design assessment to identify and screen relief well spud locations prior to drill campaign	In effect	Procedure	Reduce time taken to plan and execute relief well, and reduce environmental impacts	Improved availability and reliability	Effort required to conduct relief well assessment	In effect
	Contract source control personnel through an alternative provider in addition to existing arrangements	Alternative	People	No environmental benefit if existing service provider is adequate to fulfil requirements.	Improved availability and reliability	Significant additional cost in maintaining two contracts for the same service	Reject No environmental benefit in having an additional service provider
	Wild Well Control personnel on standby in Perth during drilling operations in order to respond immediately to a LOWC	Additional	People	No environmental benefit as WWC personnel are available to provide support within 72 hours which will coincide with starting to commence sourcing of relief well MODU	No change to effectiveness or reliability as WWC personnel available within a rapid timeframe under existing arrangements.	Significant additional costs in having WWC personnel on standby in Perth. Locating personnel with specialised expertise in Perth may also create issues for other operators, as WWC offer this service to multiple operators. Locating them in remote locations may increase travel times to other global locations if they are required	Reject No environmental benefit in having access to personnel surplus to requirements
	Pre-drill riserless intervals for a potential relief well before drilling the main well	Additional	Equipment Procedure	Could reduce relief well drill duration by 10 days. However, this activity would result in drill cuttings/discharges being released to the marine environment and noise emissions regardless if a LOWC were to occur or not.	Detailed relief well designs will be re-evaluated and revised for an actual LOWC event. There will be several locations for the relief well identified before an incident, with the optimal location selected after a LOWC incident, based on real-time information (i.e. prevailing weather). A pre-drilled relief well top-section might result in having to use a sub-optimal design and location. It is not industry practice, and such a pre-drilled riseless interval may adversely affect functionality and reliability of this response strategy.	The pre-drilling activity itself would require approximately 10 days and a complete rig move to perform, costing approximately 6-7MM USD. Once the main well was completed, the partially completed relief well would need to be abandoned, at a further cost of 6-7MM USD.	Reject This option may result in a sub-optimal relief well location being used. There is minimal environmental benefit gained for the grossly disproportionate costs associated with this option.
Source Control - Vessel Collision	Vessel Spill Response Plan (SOPEP/SMPEP)	In effect	Procedure	Provides a set process to follow in the planning and mobilisation for spill response actions by the Vessel Contractor thereby reducing the timeframe and increasing the effectiveness of spill response.	Provides functionality, availability, reliability, survivability, compatibility and independence.	Effort required in contractor procedure due diligence.	In effect
No alternate, additional or improved control measures identified							

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
ALARP Assessment Summary - SSDI For a Barossa subsea LOWC, SSDI application is considered a secondary response strategy and is included for its potential to reduce VOC exposure to response personnel working close to the well site (e.g. to deploy a Capping Stack). To assess the effectiveness of dispersant application, Santos will use the Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020). Control Measures are in place for a rapid mobilisation of the SFRT, personnel and dispersants to Darwin; it is estimated that it will be ready to commence operations by day 11-12. A Control Measure involving the positioning of an SFRT on standby at a regional port in order to reduce deployment time was assessed but was found to be disproportionate in terms of costs to the reduction in risk gained. Dispersant volumes available within Australia and the mobilisation of these stocks exceed worse case requirements, hence dispersant is not a limiting factor to the SSDI operation. Seven additional potential Control Measures were identified and assessed. No additional Control Measures were accepted as reasonably practicable. All seven additional Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: - Purchase of Santos SFRT to be located in Darwin - Relocate AMOSC SFRT to Darwin - Subsea bladder dispersant system positioned next to well site - Transport WWC SSDI system from Singapore as a back-up unit - Enable improved vessel access by contracting a suitable, dedicated vessel on standby - Access to additional dispersant stockpiles owned by Santos - Rent dispersants and position in Darwin Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around the maintenance of contracts for the SFRT equipment, dispersants and deployment personnel and the tracking of suitable SFRT vessels. In the event of a response, the key areas for ensuring effectiveness are the mobilisation of requirements to commence subsea dispersant operations, the subsea monitoring of dispersant efficacy by ROV and the consideration of this information together with other operational monitoring information within an operational NEBA for the activity. These key areas of effectiveness are reflected in the performance standards.							
ROV survey	ROV Survey conducted at the release point to determine the nature of the release. This information will inform the applicability of subsea chemical dispersion and initial choice of dispersant injection methods (e.g., number of nozzles, nozzle sizes) and DOR.	In effect	Procedure, equipment	SSDI can break-up oil droplets forcing greater entrainment of the oil into the water column below the sea surface. Has ability to reduce volatile organic compounds in the vicinity of a spill, making the area safer for responders. It typically requires smaller volumes of dispersant to be used as it has a higher encounter rate with the hydrocarbons than surface application.	Provides functionality, availability, reliability, survivability, compatibility and independence.	Costs associated with vessel contract	In effect
No alternate, additional or improved control measures identified							
Subsea First Response Toolkit (SFRT) The SFRT includes debris clearance equipment and subsea dispersant equipment, including a dedicated dispersant stockpile (500 m³ of Dasic Slickgone NS) and ancillary equipment (e.g., pumps, flying leads, coiled tubing head, dispersant wands).	AMOSC SFRT stored at Oceaneering yard in Jandakot and can be transported to Darwin. It is estimated this would take 10 hours to arrange and up to 7 days to load and transport to Darwin, depending on the time of the year. A suitable vessel would be acquired by Santos during this timeframe and arrive in Darwin within 8 days of call-out. Once the equipment is loaded, the vessel will mobilise to site and be ready to commence operations by day 11-12 from call out.	In effect	Equipment	May improve capability to perform subsequent source control measures (e.g. capping stack) by reducing VOCs in the vicinity of the spill site. Equipment needed to clean the area around the wellhead, enable intervention and prepare for relief well drilling and safe installation of a well capping or containment device.	Provides functionality, availability, reliability, survivability, compatibility and independence. Availability - whilst the SFRT takes several days to mobilise to site and conduct initial surveys, this timeframe is considered reasonable given the technical nature of this equipment.	Cost of AMOSC membership for SFRT	In effect
	Purchase of Santos SFRT to be located in Darwin	Improved	Equipment	Reduces mobilisation time between storage and port of deployment	Improved availability however limited by vessel availability to deploy	Cost of SFRT purchase, storage and maintenance	Reject SFRT is estimated to arrive in Darwin only one day before vessel. Taking into account the significant costs of purchasing and maintaining a Santos-owned SFRT, an improvement of 2-3 days mobilisation time is not considered to provide a proportionate benefit.
	Relocate AMOSC SFRT to Darwin	Improved	Equipment	Reduces mobilisation time between storage and port of deployment (Darwin) by approx. 5 days	Improved availability however limited by vessel and personnel availability to deploy	AMOSC unable to alter storage location of SFRT as this could negatively impact other members	Reject Positioning of SFRT in Darwin in order to reduce deployment time was assessed but was found to be disproportionate in terms of costs to the reduction in risk gained and may adversely affect other SFRT members and their committed deployment times
	Subsea bladder dispersant system positioned next to well site	Alternative	Equipment	Subsea dispersant bladder system can be prepositioned and operate remotely if SSDI is determined a suitable strategy via an operational NEBA. Bladder systems are positioned in framed housings on the seafloor. Autonomous application could commence by Day 1-2, reducing application times by 7-8 days.	Possible improved availability and independence, however technical development and procurement would be required as existing components in the market would need to be combined to develop this system. Placing bladders on the seabed adjacent to the BOP exposes them to risk of damage from debris in the event of a loss of well control. Additionally, bladder systems require extensive equipment and fluid deployment/recovery operations at each wellsite, exposing personnel to significant additional HES risks. Therefore, the design and development of this technology includes a high degree of uncertainty. Subsea bladders also have limited volume capacity, meaning this alternative would offer a short term application option until SSDI arrives via	Purchase of bladder system on top of SFRT membership as both systems would still be required.	Reject Subsea bladder systems are a unproven technology and bring additional risks to the environment and personnel. In addition, the cost of having a subsea bladder system in place is a fixed cost, regardless of if a spill were to occur or not.
	Transport WWC SSDI system from Singapore	Additional	Equipment	No change as AMOSC SFRT system will arrive before WWC system.	Would provide a back-up system, however, the complexity of the SFRT is such that backup system is not required.	WWC SSDI system could be transported in tandem with WWC capping stack.	Reject AMOSC SFRT system is considered adequate and a back up system is not required.
No alternate, additional or improved control measures identified							
Subsea dispersant injection - planning	Source Control Planning and Response Guideline (DR-00-OZ-20001).	In effect	Procedure	Provides a detailed process to follow for the mobilisation of SFRT and suitable vessel by Santos Source Control Team thereby reducing the timeframe and increasing the effectiveness of SFRT.	Provides functionality, availability, reliability, survivability, compatibility and independence	Effort in updating and maintaining document	In effect

No alternate, additional or improved control measures identified							
Dispersant supply vessels	Level 2: Suitable vessel sourced through Santos contractors. Vessel requirements outlined in Santos Source Control Planning and Response Guideline (DR-00-ZF-1001).	In effect	Equipment	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; early vessel availability	Cost of existing contracts with vessel providers	In effect
	Level 2: Suitable vessel sourced through any regional contractors and monitored through Santos Vessel Tracking System.	In effect	Equipment	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; early vessel availability	Cost of vessel monitoring. Cost of contracts at the time of requirement.	In effect
	Level 3: Suitable vessel sourced as Vessels of Opportunity.	In effect	Equipment	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; early vessel availability	Cost of contracts at the time of requirement.	In effect
	Enable improved vessel access by contracting a suitable, dedicated vessel on standby	Improved	Equipment	This alternative would result in SSDI commencing on Day 5-6, instead of Day 11-12 as vessel would be in Darwin on standby. Although this would treat released hydrocarbons for an additional 6-7 days, this would have a negligible reduction in shoreline accumulation volumes at protection priorities.	Improved availability and reliability	Costs associated with having a suitable vessel on contract and standby in Darwin - $50-60K USD/day.	Reject Removes bottleneck of having to wait for a suitable vessel. However, the cost of having a vessel on standby is a fixed cost, regardless of if a spill were to occur or not. The time saving of 6-7 days is not proportionate to the expense incurred, especially as SSDI is not anticipated to significantly reduce shoreline accumulation volumes if it were applied for an additional 6-7 days.
Subsea dispersant injection - personnel	Oceaneering personnel for the deployment of the SFRT and SSDI application	In effect	People	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants. May improve capability to perform subsequent source control measures (e.g. capping stack).	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of Oceaneering contract for personnel	In effect
No alternate, additional or improved control measures identified							
Subsea dispersant injection - dispersant stocks	Level 2: Dedicated SFRT dispersant stockpile stored with SFRT at Jandakot (AMOSC, 500m3 Dasic Slickgone NS). Additional dispersant stocks stored at Darwin (AMSA, 10m3 Slick Gone EW, 10m3 Slick Gone NS); Exmouth (AMOSC, 75 m3 Slickgone NS); Karrath (AMSA, 10m3 Slick Gone EW, 10m3 Slick Gone NS); Fremantle (AMOSC, 27m3 Corexit, 8 m3 Slickgone NS) (AMSA, 52 m3 Slick Gone EW, 48 m3 Slick Gone NS). Available within 24	In effect	Equipment	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants	Provides functionality, availability, reliability, survivability, compatibility and independence Availability exceeds requirements	Costs of contracts, MOU with AMOSC, AMSA	In effect
	Level 3: Dispersant stocks stored at national stockpiles (AMOSC, 747m3 including 500 m3 associated with the SFRT) (AMSA, 355 m3) OSRL dispersant stocks available in Singapore (50% of 779m3 as SLA and 5000m3 as a subscriber to the Global Dispersant Stockpile) Mobilisation times depend on	In effect	Equipment	Enhance subsea dispersion and biodegradation of hydrocarbons. Consideration given to harmful impacts of chemical dispersants	Provides functionality, availability, reliability, survivability, compatibility and independence Availability exceeds requirements	Costs of contracts, MOUs with AMOSC, AMSA, OSRL	In effect
	Access to additional dispersant stockpiles owned by Santos	Additional	Equipment	No additional environmental benefit if surplus to requirements	Improved availability and reliability	Additional cost for purchase and maintenance of stockpiles	Reject Analysis indicates that dispersant supplies sufficient. Santos is already subscribing to OSRL stockpiles in excess of 5,000m3.
	Rent dispersants and position in Darwin	Additional	Equipment	No additional environmental benefit as existing dispersant stockpiles can be relocated to Darwin and dispersant manufacture can commence in a timeframe where dispersant demand does not exceed supply.	Availability already meets requirements	Additional cost for renting dispersant stockpiles	Reject Analysis indicates that timeframes for mobilising and relocating dispersant supplies are sufficient.
Dispersant effectiveness monitoring	To assess the effectiveness of dispersant application, Santos will use the Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020) to determine the efficacy of subsea dispersant application.	In effect	Procedure	The Industry Recommended Subsea Dispersant Monitoring Plan (API, 2020) to assist in characterising the nature and extent of subsea or near surface dispersed oil, aid in the validation and accuracy of plume trajectory models and allow for rapid quantification of data to enable the IMT to make decisions about continuation of dispersant application. The IMT assesses the effectiveness of continued dispersant use against an operational NEBA assessment.	Provides functionality, availability, reliability, survivability, compatibility and independence	Cost of contracts to provide monitoring capability	In effect

No alternate, additional or improved control measures identified

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
ALARP Assessment Summary - Monitor and Evaluate Various, independent inputs from multiple service providers are used to build a detailed Common Operating Picture in the incident. Eight additional potential Control Measures were identified and assessed. Three Control Measures were accepted as reasonably practicable. The accepted Control Measures were: - 2 tracking buoys available in Darwin during activity - Required vessel specifications included in Vessel Tracking System - Maintain a list of providers that could assist with fauna aerial observations Five Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: - Purchase of oil spill modelling system and internal personnel trained to use system - Trained water monitoring specialists available in Darwin - Trained aerial observers based in Darwin - Ensure trained marine mammal/fauna observers based at Darwin - Two vessels are in use by Santos servicing the Bayu-Undan operations could be used for surveillance purposes in response to a spill. Performance Standards and Measurement Criteria that have been developed for the in-effect and accepted Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures, during times of preparedness, focus on maintaining access to equipment and personnel through contractual arrangements with vessel providers, aircraft providers, aerial observers, UAV providers, tracking buoys, oil spill trajectory modelling providers, satellite imagery providers, water quality monitoring providers, and spill responders. Additional key areas for effectiveness during preparedness are following relevant procedures such as the Protected Marine Fauna Interaction and Sighting Procedure, and limiting environmental impacts from response activity through personnel and vehicle management. During response, a key area for ensuring effectiveness is the mobilisation of requirements in order to commence monitor and evaluate operations. These key areas of effectiveness have been represented in Performance Standards for monitor and evaluate operations.							
Oil Spill Trajectory Modelling	Maintain contract with Oil Spill Trajectory Modelling service provider. The service provider will be contacted immediately (within 2 hours) upon notification of a level 2 or 3 spill. Upon activation, the service provider will provide trajectory models within: - 2 hours for OILMAP model for offshore and open ocean; - 4 hours for OILMAP operations for near-shore; and - Detailed modelling service is available for the duration of the incident.	In effect	System	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of contract	In effect
	Access to additional spill modelling capability through OSRL	In effect	System	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	An additional service provider ensures redundancy (independence) if for some reason the other service provider was unable to fulfil the function. There is also the possibility of increased functionality associated with improved certainty of the modelling results if both service providers are activated.	Cost of membership	In effect
	Purchase of oil spill modelling system and internal personnel trained to use system	Alternative	System, people	This could result in the faster generation of the initial model which may result in an environmental benefit as a consequence of the IMT making operational decisions quicker	Potentially increases availability Decrease in functionality- in house service may not be across technical advances to same extent as contracted service providers	Purchase of system, training of personnel, and on-call roster	Reject The cost of purchasing the system, training and having personnel on-call is disproportionate to any potential gains from potentially being able to deliver initial results quicker than the 2 hour turn-around currently guaranteed by the service provider
Tracking buoy	Level 1: Two tracking buoys available on MODU. Ready for deployment 24/7. Ability to deploy tracking buoys within 2 hrs.	In effect	Equipment	Tracking buoys provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance)	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of equipment	In effect
	Level 2: two tracking buoys available in Darwin during activity. Darwin to Barossa is 20 hrs pending vessel (pending vessel availability)	Additional	Equipment	Tracking buoys provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance)	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of equipment	Accept
	Level 2/3: Ten tracking buoys mobilised from Varanus Island, Dampier Supply Base or Exmouth Freight and Logistics. Mobilisation timeframe- 48-72 hrs	In effect	Equipment	Tracking buoys provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance)	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of equipment	In effect
	Level 2/3: tracking buoys available from AMOSC and through AMOSC Mutual Aid Mobilisation timeframe- 42-72 hrs	In effect	Equipment	Tracking buoys provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance)	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership	In effect
	Level 3: tracking buoys available from OSRL. Transit times (air) UK to Darwin = ?	In effect	Equipment	Tracker buoys provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance)	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership	In effect
Aerial surveillance - aircraft and crew	Maintain contract with service provider for dedicated aerial platform operating out of Darwin (Helicopter services available through Santos primary contracted suppliers. Wheels up within 1 hr for emergency response. Spill surveillance < 10 hrs (daylight dependent). Surveillance and recording using helicopter pilots is considered adequate for situational awareness.)	In effect	System	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area for improvement - availability - rapid mobilisation of aerial observers in initial 24 hours of incident	Cost of contract	In effect
	Level 2/3: Drones available via AMOSC. Mobilisation timeframe: < 48 hrs	In effect	System	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact Drones may be necessary for some sensitive environments and where personnel safety is at risk	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership	In effect
	Level 2/3: Drones available via OSRL.- Third Party provider Mobilisation timeframe: depending on the port of departure, one to two day if within Australia	In effect	System	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact Drones may be necessary for some sensitive environments and where personnel safety is at risk	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership	In effect

No alternate, additional or improved control measures identified							
Aerial surveillance - observers	Level 2: Trained Santos observers will be mobilised to airbase within 24 hrs, following activation	In effect	People	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area for improvement - availability - rapid mobilisation of aerial observers in initial 24 hours of incident	Cost of training and maintaining trained staff	In effect
	Level 2: Access to additional aerial observers through AMOSC Staff and Industry Mutual Aid Core Group Responders	In effect	People	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of AMOSC membership	In effect
	Level 3 : Access to additional aerial observers through OSRL (18 people). OSRL staff initial 5 technical advisors available from 2 to 3 days of activation in Darwin, remaining personnel available from 4 to 5 days in Darwin, subject to approvals/ clearances.	In effect	People	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of OSRL membership	In effect
	Level 1: Ensure trained aerial observers based at Darwin for duration of activity.	Additional	People	Current capability meets need and therefore environmental benefit would be incremental. Having trained observers living locally and on short notice to mobilise ensures trained aerial observers available from Day 2, and potentially from Day 1 (current arrangements are that the pilot would provide the initial observations and recording on Day 1).	Improved availability and reliability	Costs associated with staff employment and training	Reject Cost is considered disproportionate to the incremental benefit given surveillance on Day 1 by pilots is considered sufficient
Aerial surveillance - unmanned aerial vehicles	Level 2: Unmanned Aerial Vehicles for aerial surveillance available through AMOSC (UAVs and pilots can be accessed through AMOSC with a mobilisation time of < 48 hrs)	In effect	Equipment	Use of UAVs may provide an environmental benefit compared to alternative options (such as helicopters and fixed wing aircraft) given shorter deployment time and ability to assess difficult areas.	Provides functionality and availability Area of improvement; none identified	Cost of membership with AMOSC	In effect
	Level 3: Unmanned Aerial Vehicles for aerial surveillance available through OSRL	In effect	Equipment	Use of UAVs may provide an environmental benefit compared to alternative options (such as helicopters and fixed wing aircraft) given shorter deployment time and ability to assess difficult areas.	Provides functionality and availability Area of improvement; none identified	Cost of membership with OSRL	In effect
No alternate, additional or improved control measures identified							
Vessel surveillance	Level 1: vessels in use by Santos could be used for surveillance purposes in the event of a spill.	In effect	People	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact. In comparison to aerial surveillance, vessel surveillance provided limited information.	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of existing contracts with vessel providers	In effect
	Level 2: vessels sourced through Master Service Agreement, located in region and tracked by Santos Vessel Monitoring System.	In effect	Equipment	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact. In comparison to aerial surveillance, vessel surveillance provided limited information.	Improves availability and reliability Area of improvement; none identified	Cost of vessel monitoring. Cost of contracts at the time of requirement.	In effect
	Level 3: vessels sourced without existing contracts from any location	In effect	Equipment	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact. In comparison to aerial surveillance, vessel surveillance provided limited information.	Improves availability and reliability Area of improvement; none identified	Cost of contracts at the time of requirement.	In effect
	Two vessels are in use by Santos servicing the Bayu-Undan operations could be used for surveillance purposes in response to a spill.	Additional	Equipment	Knowledge of the spill, provided in a short-time frame, will inform the IMT decisions with the aim of reducing and mitigating environmental impact. In comparison to aerial surveillance, vessel surveillance provided limited information.	Improves availability and reliability	Cost of existing contract with vessel contractors.	Rejected One vessel is required to be on station at the Bayu-Undan facilities at all the time. The second vessel preforms critical in-field activities such as methanol bunkering and assisting with off take tanker activities. Therefore, neither vessel could be considered to be reliably available to undertake vessel surveillance activities.
No alternate, additional or improved control measures identified							
Water Quality Monitoring (operational and scientific)	Maintain monitoring service provider contract for water quality monitoring services. Water quality monitoring personnel, equipment and vessel mobilised to Darwin within 72 hrs of notification.	In effect	System	This monitoring will confirm the distribution and concentration of oil, validating spill trajectory modelling and inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; availability of vessels	Cost of contracts	In effect
	Access to additional water quality monitoring services through OSRL	In effect	System	This monitoring will confirm the distribution and concentration of oil, validating spill trajectory modelling and inform the IMT decisions with the aim of reducing and mitigating environmental impact	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; availability of vessels	Cost of OSRL membership	In effect
	Required vessel specifications included in Vessel Tracking System	Improved	Procedure	Improve mobilisation time	Improved availability and reliability	Cost to maintain and operate vessel tracking system	Accept
	Trained monitoring specialists in Darwin	Additional	People	Ensure sampling is conducted correctly	Improves reliability	Costs associated with staff employment	Reject This is not necessary as a good procedure for sample collection is already in place
Satellite Imagery	Maintain membership with AMOSC provider to enable access and analysis of satellite imagery.	In effect	Systems	Satellite imagery is considered a supplementary source of information that can improve awareness but is not critical to the response and usage is at the discretion of the IMT	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership with AMOSC	In effect

	Maintain membership with OSRL to enable access to and analysis of satellite imagery	In effect	System	Satellite imagery is considered a supplementary source of information that can improve awareness but is not critical to the response and usage is at the discretion of the IMT	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership with OSRL	In effect
No alternate, additional or improved control measures identified							
Wildlife Reconnaissance (aerial/ vessel surveillance. Shoreline and coastal habitat assessment)	Maintain contract with scientific monitoring service provider for access to fauna aerial observers and personnel experienced in conducting relevant fauna surveys.	In effect	People, procedures	Wildlife reconnaissance aids the IMT to plan and make decisions for executing an oiled wildlife response and for minimising impacts to wildlife associated with the clean-up response	Provides functionality, availability and compatibility Area for improvement; availability - reduce time to mobilise personnel to strategic locations	Cost of contract	In effect
	Maintain a list of providers that could assist with fauna aerial observations	Additional	People	Wildlife reconnaissance aids the IMT to plan and make decisions for executing an oiled wildlife response and for minimising impacts to wildlife associated with the clean-up response	Improves availability and reliability Area of improvement; none identified	Cost of maintaining list	Accept
	Ensure trained marine mammal/fauna observers based in Darwin	Additional	People	Having trained marine mammal/fauna observers living locally and on short notice to mobilise would result in trained aerial observers available from Day 1	Improved availability and reliability	Costs associated with staff employment and training	Reject Maintaining trained fauna observers at location is considered grossly disproportionate as they are required only for the initial stages of the response until observers from scientific monitoring provider can be mobilised.

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
ALARP Assessment Summary - Mechanical Dispersion Mechanical dispersion is a secondary strategy that could be undertaken by vessels undertaking primary response strategies without the requirement for additional equipment, and no areas of improvement were identified. The use of mechanical dispersion in a response would be assessed as part of an operational NEBA. No potential Control Measures were identified and assessed. Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures during a response are around the development of an operational NEBA to confirm suitability and environmental benefit, and the mobilisation of vessels. These key areas of effectiveness are reflected in the Performance Standards.							
Mechanical Dispersion	Use of vessel crews, contract vessels and vessels of opportunity to disperse small areas of amenable hydrocarbon types such as marine diesel.	In effect	People, equipment	Enhanced dispersion and biodegradation of released hydrocarbons	Provides availability, reliability, survivability, compatibility and independence. Limited functionality as mechanical dispersion is secondary response strategy limited by weather conditions, hydrocarbon type, hydrocarbon volume.	Cost of vessel time	In effect

ALARP Assessment Summary - Oiled Wildlife

The worst case scenario associated with this OPEP does not include shoreline contact and consequently only low numbers of oiled wildlife are anticipated. Santos has developed a Santos Wildlife Framework Plan as a Control Measure to ensure that a procedure is in place for OWR, where they are the Control Agency or Support Organisation, in order to provide an effective and coordinated OWR. Santos has access to the indicative resource requirements for the worst case scenario in this OPEP as per the WA Oiled Wildlife Response Plan. Including mobilisation of AMOSC oiled wildlife equipment and industry OWR team to a forward staging area within 48 hours. AMSA also maintains an oiled wildlife washing container in Darwin. The availability of trained personnel in the initial stages of an incident is a limiting factor for this response strategy. Potential Control Measures around additional responders through prehiring or contracts with additional service providers were investigated but were found to be not beneficial and/or the cost was grossly disproportionate to risk reduction.

Three potential Control Measures were identified and assessed. All were rejected as grossly disproportionate. Rejected Control Measures were:
- Additional Santos OWR trained personnel positioned in Darwin
- Prehire and/or prepositioning of staging areas and responders
- Direct contracts with service providers

Performance Standards and Measurement Criteria that have been developed for the in effect and accepted Control Measures are shown in the OPEP. The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around maintaining access to equipment and personnel through contractual arrangements. During response, the mobilisation of requirements for initial oiled wildlife response operations and the management of the oiled wildlife response in accordance with the WA Oiled Wildlife Response Plan and NT Oiled Wildlife Response Plan are both key elements for achieving this strategy and they are represented as Performance Standards.

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
Oile wildlife response - planning	Level 1/2: Santos Oiled Wildlife Response Framework which will set the corporate guidance for OWR preparedness and response and define how Santos will integrate with Control Agencies to provide a coordinated response	Additional	Procedure	The framework will facilitate a rapid coordinated response, and the provision of resources by Santos in order to increase the likelihood of success of the OWR (success in terms of wildlife survivorship and rates for release back into the wild).	Improved functionality and reliability.	Cost of document maintenance	Accept
	Implementation of the Western Australian Oiled Wildlife Response Plan (WAOWRP) and Northern Territory Oiled Wildlife Response Plan (NTOWRP)	In effect	Procedure	Working within the guidelines of the WAOWRP and NTOWRP will ensure a coordinated response and that the expectations of the Control Agency are met with the overall aim to increase the likelihood of success of the OWR (success in terms of wildlife survivorship and rates for release back into the wild).	Provides functionality, availability, reliability, survivability, compatibility and independence	Effort and time involved in maintaining OWR implementation plan within OPEP	In effect
No alternate, additional or improved control measures identified							
Oiled wildlife response - equipment	Level 2: OWR kits and containers available from AMSA in Darwin	In effect	Equipment	Timely access to appropriate equipment is needed for the effective treatment of wildlife in order to increase the likelihood of success of the OWR	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement: none identified	Cost of membership with AMOSC	In effect
	Level 3: OWR kits and containers available for AMOSC, AMSA and DoT: Broome, Fremantle, Exmouth, Geelong, Dampier, Devonport and Townsville Mobilisation to Darwin within 2-7 days	In effect	Equipment	Appropriate equipment is needed for the effective treatment of wildlife in order to increase the likelihood of success of the OWR	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership with OSRL	In effect
	Level 3 OWR equipment available from OSRL. Transit times (road/ air) Singapore to Darwin = 3–5 days of activation	In effect	Equipment	Appropriate equipment is needed for the effective treatment of wildlife in order to increase the likelihood of success of the OWR	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership with OSRL	In effect
No alternate, additional or improved control measures identified							
Oiled wildlife response - personnel	Level 1/2 Santos personnel trained in OWR. OWR trained personnel mobilised to Darwin within 48 hrs.	In effect	People	Timely access to skilled personnel will enhance the likelihood of success of an OWR.	Provides functionality, availability, reliability, survivability, compatibility and independence	Cost of training and maintaining training	In effect
	Level 2 OWR personnel from AMOSC, AMOSC-activated Wildlife Response contractors, and Industry Mutual Aid. Mobilisation of OWR personnel to Darwin will start to occur in 24-48 hours following notification of actual or imminent impact to wildlife.	In effect	People	Timely access to skilled personnel will enhance the likelihood of success of an OWR.	Provides functionality, availability, reliability, survivability, compatibility and independence Area for improvement - availability - rapid mobilisation of personnel in initial 48 hours of incident	Cost of membership with AMOSC	In effect
	Level 3 OWR personnel available through OSRL. OSRL staff initial 5 technical advisors available in Darwin from 2 to 3 days of activation, remaining personnel available from 4 to 5 days, subject to approvals/ clearances.	In effect	People	Access to skilled personnel will enhance the likelihood of success of an OWR.	Provides functionality, availability, reliability, survivability, compatibility and independence Area of improvement; none identified	Cost of membership with OSRL	In effect
	Maintain labour hire arrangements for access to untrained personnel. Untrained personnel accessed through labour-hire arrangements would receive an induction, on-the-job training and work under the supervision of an experienced supervisor.	In effect	People	During a large scale OWR the ability to access large numbers of personnel through labour hire arrangements is imperative in terms of capability for conducting an OWR.	Provides functionality, availability, reliability, survivability, compatibility and independence	Cost of labour hire at time of incident	In effect
	Additional Santos OWR trained personnel positioned in Darwin	Additional	People	Additional personnel trained in OWR will enhance the first strike capability of Santos and therefore enhance the likelihood of success of the OWR, particularly for those instances where oil is ashore within 48 hours	Improved functionality, availability, reliability and independence.	Cost of training staff	Reject Santos has recently trained additional staff for OWR. Existing OWR personnel capability meets the need.
	Prehire and/or prepositioning of staging areas and responders	Additional	System	This may enhance response times and first strike capability and hence improve the likelihood of success of the OWR. Conversely, prepositioned personnel and staging areas may result in negative impacts to the environment and wildlife.	Improved functionality, availability, reliability and independence.	Additional wildlife resources could total $1500 per operational site per day. This is a guaranteed cost regardless of whether a spill occurs or not.	Reject- the cost of setting up staging areas and having responders on standby is considered disproportionate to the environmental benefit gained. Further, prepositioned personnel and staging sites may have negative impacts on the environment and wildlife. The overall OWR capability Santos can access through Santos staff, AMOSC, AMOSC mutual aid, Santos labour force hire arrangements, DBCA and wildlife carer network are considered adequate, with further advice and international resources available through OSRL.
	Direct contracts with service providers	Alternative	System	This option duplicates the capability accessed through AMOSC and OSRL and would complete for the same resources without providing a significant environmental benefit	Does not improve effectiveness	Cost of contract	Reject- this option is not adopted as the existing capability meets the need.

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcome	Effectiveness	Feasibility	Accept/ Reject
ALARP Assessment Summary - Waste The Santos contract with the waste service provider has provisions for waste management operations of the scale estimated to be required in worst case scenarios detailed in the OPEP Addendum. Further detail is captured in the Waste Management Plan - Oil Spill Response Support (QE-91-IF-10053). The waste service provider can mobilise waste receptacles to Darwin within 12-24 hrs. Given the waste service provider arrangmeents and preplanning already undertaken, waste storage facilities, road transport and logistics are not expected to be limiting factors in the response. For these components, potential Control Measures were identified and evaluated but were found to either make no improvement in capability or cost was grossly disproportionate. An area of improvement is the availability of vessels required for waste transport at sea. One potential Control Measure to address this area of improvement was identified and assessed but cost was grossly disproportionate to risk. No other potential control measures were identified. Three potential Control Measures were identified and assessed. One additional Control Measure was accepted as reasonably practicable: - Maintain contracts with multiple service providers to cover new geographic location Three Control Measures were rejected as grossly disproportionate. Rejected Control Measures were: - Maintain contracts with multiple service providers - Procure temporary waste storage for Santos stockpile - Contract additional vessels on standby for waste transport Performance Standards and Measurement Criteria that have been developed for the in effect Control Measures are shown in the Barossa Development OPEP (BAA-200 0314). The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around maintaining access to waste management equipment and services through contractual arrangements. During response, a key area for increasing effectiveness is the timely mobilisation of requirements for initial response operations and defining critical management and reporting services to be provided by the waste service provider. These key areas of effectiveness are captured in the Performance Standards.							
Waste Management	Waste management sourced through contract with waste service provider. Contract with waste service provider to be maintained and periodically reviewed. Waste service provider waste receptacles mobilised to Darwin within 12 hrs of activation for containment and recovery, protection and deflection and shoreline clean-up response strategies.	In effect	System	Timely and efficient handling of waste will reduce environmental impacts of waste and waste management. Consideration given to risks of secondary contamination.	Provides functionality, availability, reliability, survivability, compatibility and independence. Area of improvement; none identified	Cost of contract	In effect
	Maintain contracts with multiple service providers to cover new geographic location	Additional	System	Contract with existing waste service provider not sufficient to cover new geographic region (NT) as they are not located in Darwin and may not be able to service the location within the required timeframe	Improves functionality, availability, reliability, survivability, compatibility and independence.	Additional cost in maintaining two contracts for the same service	Accepted
	Temporary waste storage capacity available through waste service provider, AMOSC, AMSA, OSRL stockpiles	In effect	Equipment	Timely and efficient handling of waste will reduce environmental impacts of waste and waste management. Consideration given to risks of secondary contamination.	Provides functionality, availability, reliability, survivability, compatibility and independence. Area of improvement; none identified	Costs of contracts, MOU with waste service provider, AMOSC, AMSA and OSRL	In effect
	Procure temporary waste storage for Santos stockpile	Additional	Equipment	Additional storage available if required. Tanks may be stored in geographic locations that may reduce mobilisation times and allow faster collection and storage of waste. Additional storage may facilitate continuous collection operations to occur.	Provides functionality, availability, reliability, survivability, compatibility and independence	Additional cost in purchase and maintenance of tanks	Reject Purchasing this equipment for Santos stockpile is surplus to Santos requirements as AMOSC, AMSA, OSRL provides this equipment in strategic locations. Reduced mobilisation time is not an advantage, as waste storage can be mobilised at the same time as collection response strategies, and no waste needs to be stored prior to collection commenced.
	Vessels for waste transport through Santos contracted providers.	In effect	Equipment	Timely and efficient handling of waste will reduce environmental impacts of waste and waste management. Consideration given to risks of secondary contamination.	Provides functionality, availability, reliability, survivability and compatibility. Area of improvement; dependence and availability of vessels	Contract with vessel contractors to be maintained and periodically reviewed	In effect
	Contract additional vessels on standby for waste transport	Additional	Equipment	Reduce delays in transportation of wastey in the initial 2-5 days of response	Provides functionality, availability, reliability, survivability, compatibility and dependence	Cost in contracting vessels to remain on standby for incident waste requirements	Reject Expense of maintaining vessels on standby that are surplus to day to day requirements is disproportionate to environmental benefit. Santos is accustomed to coordinating logistics for tasks around finite resources. Santos monitors vessel availability through Santos Vessel Tracking System. Regularly contracted vessels could be supplemented with vessels of opportunity
	Vessel to vessel waste transfer plan gives details of waste storage requirements and procedures	In effect	Procedure	Allows effective use of available vessels and minimises vessel decontamination requirements	Provides functionality, availability, reliability, survivability, compatibility and independence.	Cost of documentation development, implementation, maintenance and exercising	In effect

Strategy	Control Measure	Alternative, Additional, Improved	Control Measure Category	Environmental Outcomes	Effectiveness	Feasibility	Accept/ Reject
ALARP Assessment Summary - Scientific Monitoring Oil spill scientific monitoring will be conducted on behalf of Santos by a contracted monitoring service provider as detailed in the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162) and the relevant Scientific Monitoring Programs. An area of improvement is the availability of vessels in the initial stages of response. To address this area of improvement, a potential Control Measure around more detailed vessel tracking was assessed and accepted. Additionally, three potential Control Measures were identified and assessed. One Control Measure, having trained scientific monitoring personnel and equipment on standby in Darwin was considered disproportionate. Two potential Control Measures relating to maintaining equipment and lists of monitoring providers and the provision of water quality sampling kits to be located at strategic regional locations were both found to be reasonable and practicable, both were adopted. Four additional potential Control Measures were identified and assessed. Three additional Control Measure were accepted as reasonably practicable. The accepted Control Measures were: - Maintain equipment list and list of suppliers for implementation of Scientific Monitoring Plans - Oil sampling kits for scientific monitoring personnel to be positioned at Darwin - Determine required vessel specifications required for Scientific Monitoring implementation and improve accuracy of Vessel Tracking System. One potential Control Measure was identified and rejected as grossly disproportionate. Rejected Control measure was: - Scientific monitoring personnel and equipment on standby at Darwin Performance Standards and Measurement Criteria that have been developed for the in effect and accepted Control Measures are shown in the Barossa Development OPEP (BAA-200 0314). The key areas of effectiveness for the identified Control Measures, during times of preparedness, are around maintaining access to equipment and personnel through contractual arrangements, regular reviews of monitoring service provider capability and reviews of existing baseline data. During response, a key area for effectiveness is the mobilisation of requirements to commence scientific monitoring, and ensuring that relevant approved manuals and plans are followed. These key areas of effectiveness are reflected in the Performance Standards.							
Scientific Monitoring - monitoring service provider and equipment	Maintenance of Monitoring Service Provider contract for scientific monitoring services and annual review of standby manual. SMP provider and monitoring equipment mobilised to site within 72 hrs of activation.	In effect	System	This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill and allows operators to determine whether their environmental protection outcomes have been met (via scientific monitoring activities). It is used to inform areas requiring rehabilitation. This strategy also evaluates the recovery from the spill.	Provides functionality, availability, reliability, survivability, compatibility and independence Area of potential improvement; none identified	Cost of contract with Scientific Monitoring Service Provider	In effect
	Regular capability reports from Monitoring Service Provider shows personnel availability and annual reviews of standby manual	In effect	System	This ensures the Monitoring Service Provider has the capability to undertake Scientific Monitoring, including, post-spill preimpact surveys within the EMBA of receptors with deficient baseline data	Improves functionality, availability and reliability	Cost of contract with Scientific Monitoring Service Provider	In effect
	Conduct periodical review of existing baseline data sources across the Santos combined EMBA	In effect	System	This ensures that receptors within the EMBA with deficient baseline data are identified	Improves functionality and provides compatibility	Cost of contract with Scientific Monitoring Service Provider	In effect
	Maintain equipment list and list of suppliers for implementation of Scientific Monitoring Plans	Improved	Procedure	Improve response time	Improved functionality, availability and reliability	Cost of contract with Scientific Monitoring Service Provider	Accept
	Purchase of oil sample kits for scientific monitoring personnel to be positioned at Darwin	Improved	Equipment	Improve response time	Improved availability and reliability	Cost associated with purchase of equipment and maintenance	Accept
Scientific Monitoring - vessels	Level 2: vessels sourced through Master Service Agreement, located in region and tracked by Santos Vessel Monitoring System. Santos to mobilise monitoring vessels to deployment location within 72 hrs.	In effect	Equipment	Improve response time	Provides availability and reliability	Effort associated with maintaining MSA	In effect
	Level 3: vessels sourced without existing contracts from any location	In effect	Equipment	Reduce the volume of surface hydrocarbons to reduce contact with protection priorities.	Provides survivability, compatibility and independence. Area of improvement; functionality, availability and reliability of tow vessels.	Cost of contracts at the time of requirement.	In effect
	Required vessel specifications included in Vessel Tracking System	Improved	Procedure	Improve mobilisation time	Improved availability and reliability	Cost to maintain and operate vessel tracking system	Accept
Scientific monitoring - personnel	Scientific monitoring personnel and equipment on standby at Darwin	Additional	Personnel, equipment	Improve mobilisation time	Improved availability and reliability	The cost of training and employing dedicated pre-positioned monitoring personnel is disproportionate to the potential benefit	Reject - Cost of permanently employing personnel is grossly disproportionate to benefits of availability in initial phase of response.
	No alternate, additional or improved control measures identified						