PROPOSED BROWSE TO NORTH WEST SHELF PROJECT

ERD RESPONSE TO SUBMISSIONS

APPENDIX B.3 - Overview of Browse Hydrocarbon Spill Risk Management Approach

November 2023

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1 EXECUTIVE SUMMARY

In response to stakeholder comments on the proposed Browse to NWS Project draft EIS/ERD (draft EIS/ERD), this document has been prepared to outline the approach that will be applied on the proposed Browse to NWS Project to reduce the likelihood and consequence of unplanned hydrocarbon release events. This document has been prepared to provide a high-level overview of the key actions that will be implemented in order to reduce the likelihood and consequence of the worst case credible event associated with the proposed Browse to NWS Project, a well loss of containment event. It should be noted that measures pertaining to oil spill response are applicable to other hydrocarbon loss of containment events that were identified as credible within the draft EIS/ERD.

Woodside follows an industry leading process in the development of its oil spill prevention, preparedness and response position for its projects and activities. The objective of the process is to mitigate and manage the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, so that they are controlled to As Low As Reasonably Practicable (ALARP) and acceptable levels.

The outcomes of the process will be presented in an Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) which, together with the following 'secondary approval' documents, meet the requirements of the relevant regulatory regime governing hydrocarbon spill arrangements that is applicable to the proposed Browse to NWS Project, namely the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and the State Petroleum (Submerged Lands) (Environment) Regulations 2012:

- Activity specific environment plans required under the Commonwealth and State regulations
- Oil Pollution Emergency Arrangements (OPEA)
- Activity specific Oil Pollution Emergency Plans (OPEP) including:
  - First Strike Plans (FSP)
  - relevant Operations Plans
  - relevant Tactical Response Plans (TRPs)
  - relevant supporting plans.

The process of preparing this documentation will be conducted throughout the detailed design and planning phase of a project lifecycle, which the proposed Browse to NWS project has not yet commenced. These 'secondary approvals documents' that will be prepared in accordance with all applicable regulations, are not yet able to be prepared as many of the critical details required to prepare these documents has not yet occurred.

Noting that these detailed documents have not yet been prepared, in order to provide stakeholders a more detailed understanding of the measures that will be in place on the proposed Browse to NWS Project to reduce the likelihood and consequence of hydrocarbon releases, this document outlines the:

- Measures that will be applied to minimise the likelihood of a well loss of containment event
- Source control techniques to be applied and maximum response timeframes to be achieved to reduce the consequence (e.g. release duration) of a well loss of containment event
- Hydrocarbon spill response (remediation) techniques to be applied to reduce the consequence (spill response) of any hydrocarbon release event
- Process that will be followed as part of secondary approvals to ensure risks from hydrocarbon spills are acceptable and risks are ALARP including relevant approvals that must be obtained

- The Operational and Scientific Monitoring frameworks to be applied to inform response activities and monitor the effects of any spill.

A summary of each chapter of this Hydrocarbon Spill Risk Management Approach is provided below.

Reducing the likelihood of well loss of containment events.

A well loss of containment event is classified as any release of hydrocarbon (regardless of size or duration) from primary and secondary well control barriers. In undertaking this risk assessment of a potential major hydrocarbon release, the spill likelihood was evaluated using blowout and well release frequencies based on SINTEF offshore blowout database 2012 (Scandpower, 2013). This uses data from 1991-2010 to determine likelihood for well blowouts and releases. For a gas well, the SINTEF calculated probability of blowout during drilling and completion is 2.93 X 10-4 which means for any given well it is estimated that there is less than 0.000293% probability of a loss of well containment event occurring. The SINTEF data supports a likelihood of ‘highly unlikely’ for a well blowout with potential to result in the worst-case credible spill.

Furthermore, since the Gulf of Mexico Macondo event, significant improvements in engineering and management controls have been adopted by the industry, further reducing the likelihood of such an event occurring. This can be evidenced in the report by Exprosoft (2017) which reviewed all Loss of Well Control (LOWC) events reported in the SINTEF Offshore Blowout Database for the period 2000–2015. The report describes, categorizes, and analyzes the observed LOWC events for the period 2000–2015, and compares the LOWC frequencies in the US GoM with other regulated areas. For regulated areas (which includes Australia), the frequency of loss of well control events in deep zone of development or exploration wells was 0.25 per 1,000 wells drilled.

At Woodside, this process is managed through the Drilling and Completions (D&C) Management System. The D&C Management System Framework is based on international standards, codes and best practices. Woodside regularly conducts activities in Australia and internationally in accordance with this Framework. A description of this framework is provided in Section 2. In addition, Woodside has provided an overview of the measures that, at a minimum, will be implemented to minimise the likelihood of loss of well containment events from the proposed Browse to NWS Project.

These measures are the minimum that will be applied and have been identified very early in the lifecycle of the proposed Browse to NWS Project, as part of the environmental impact assessment. As project design and planning develops, and as part of the secondary approvals required under the Commonwealth and State regulations, further measures will be identified and assessed to ensure the risk of a significant unplanned hydrocarbon release is reduced to ALARP in accordance with the regulations. The remainder of this Section describes the process that will be undertaken as part of the development of the activity specific Environment Plans (EPs) that will be prepared in accordance with the regulations for acceptance by the Commonwealth and State regulators.

Source control techniques to be applied on the proposed Browse to NWS Project to reduce the consequence of a well loss of containment event.

In the highly unlikely event of a well loss of containment event, source control techniques will be applied to stop the flow of hydrocarbons to the environment from the well.

At all times when drilling is occurring, the capacity and capability to implement the following source control techniques, in the specified timeframes, will be maintained.

- A ROV capable of manually operating the Blow Out Preventor (BOP) (in the event of automatic systems failing) will be available in field for immediate response when determined safe to do so.
- A subsea first response tool kit to remove debris and facilitate installation of a capping stack will be available for deployment at the well loss of containment event site within 11 days of any event.
- Access to a suitable capping stack (either through ownership or membership to a response organisation) will be maintained. The capping stack (on a suitable vessel for deployment) will be

mobilised to site and the capping stack will be available for deployment at the well loss of containment event site within 11[1]-16[2] days of event, with a target of 13 days.

- Relief well capability will be monitored and at all times during the proposed Browse to NWS Project D&C activities, a suitable MODU capable of commencing relief well activities will be able to be mobilised and arrive in the field within 16 days of any well loss of containment event.

This document outlines the presents a level of minimum capability and commitment in relation to source control activities, including maximum response times to enacting particular response techniques. The provision of such detailed commitments at such an early stage in the project development lifecycle demonstrates the commitment to ensuring global best practice to minimising the risk to Scott Reef and surrounding environment. The techniques to be applied and response timeframes are considered to be in alignment with industry best practice.

These measures were identified in the context of the environmental impact assessment and primary approval process for the proposed Browse to NWS Project. As project design and planning matures, and as part of the secondary environmental plans required under the Commonwealth and State regulations, further measures will be identified and assessed to ensure the risk of a significant unplanned hydrocarbon release is reduced to ALARP in accordance with the regulations.

New, emerging and innovative hydrocarbon spill response techniques to be considered for implementation on the proposed Browse to NWS project

Woodside continually reviews the latest emerging technical in relation to hydrocarbon spill management and appraises them for applicability to our operations. This document outlines a series of new or emerging techniques that while currently not considered feasible, may be applicable to the proposed Browse to NWS Project in the future. In relation to a well loss of containment event, these techniques include (but are not limited to):

- Kinetic blow out stopper (KBOS) shut in device, which may have the capability to immediately seal off the flowing well
- Use of an offset capping installation technique or dual vessel capping stack deployment to improve operability of capping installation activities
- The use of a subsea containment system as an alternative to capping stack deployment
- The use of subsea well kill spools to enhance relief well drilling activities.

Further detail on these techniques and their advantages are described in further described in Section 3.2.

Woodside is committed to ongoing monitoring and evaluation of source control technologies and methodologies to ensure it is continually aligned to best practice. Therefore, prior to the submission of environment plan for any drilling activities, which have a maximum duration of five years. Woodside will review best practice spill response techniques including a review of latest standards published by API, IPIECA, IOGP or and relevant regulatory guidelines.

Hydrocarbon Spill Response Techniques to be utilised on the proposed Browse to NWS Project

Available spill response techniques available for use on the proposed Browse to NWS Project will include:

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[1] 11 days is the mobilisation timeframe for the Singapore-based Wild Well Control Inc. capping stack to Port Hedland as calculated in the Australian oil and gas industry response time model (OSRL-APPEA, June 2021). This timeframe assumes the availability of a suitable vessel in Singapore within 24 hours.

[2] 16 days is the estimated mobilisation timeframe based on the OSRL-APPEA response time model (11 days) plus transit time to the spill location and contingency if a suitable vessel is not available within 24 hours.

- Capability for monitoring of spill (and receiving environment) and evaluation of appropriate response techniques to be applied
- Mechanical dispersion
- Containment and recovery
- Shoreline protection and deflection
- In-situ burning*
- Subsea dispersant application*
- Surface dispersant application*
- Shoreline clean-up
- Oiled wildlife response.

*The use of any particular response technique would be subject to a Spill Impact Mitigation Assessment (SIMA) prior to implementation, specifically for in-situ burning or dispersant application which may have larger impacts than the initial spill in some circumstances. Dispersant application is typically not possible without specific regulatory approval (e.g. by NOPSEMA or DMIRS, depending on nature of the spill). The hydrocarbon spill risk management framework outlined in this document provides only a high level summary of the response techniques to be applied on the proposed Browse to NWS Project. It has been prepared in the context of providing supplementary information to address submissions on the draft EIS/ERD. As project design and planning matures, and as part of the secondary approvals required under the Commonwealth and State regulations, further detail of hydrocarbon spill risk mitigation measures will be identified and assessed to ensure the risk of a significant unplanned hydrocarbon release is reduced to ALARP. This assessment utilises probabilistic (stochastic) oil spill modelling of a credible 'worst-case' spill event to establish environmental resources at risk, propose suitable response techniques and ensure response capability.

As part of secondary approval processes, Woodside will undertake further detailed assessment of which response techniques will be most appropriate and specific capability required to implement each technique. The outcomes of that assessment process will be presented in an Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) prepared to meet the requirements of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and the State Petroleum (Submerged Lands) (Environment) Regulations 2012. Details of this ALARP process is outlined in Section 7 of this document.

Operational Monitoring

Oil spill response techniques are informed by a real time operational monitoring program. Operational monitoring includes the gathering and evaluation of data to inform the oil spill response planning and operations. It also verifies and ground-truths the pre-emptive spill modelling and continued suitability of the response techniques and capability proposed in the ALARP demonstration. It includes real-time fate and trajectory modelling, spill tracking, weather updates and field observations. This response option is deployed in some capacity for every event.

Woodside maintains an Operational Monitoring Operational Plan. If shoreline contact is predicted, Response Protection Areas (RPAs) will be identified and assessed before contact. If shorelines are contacted, a shoreline assessment survey will be completed to guide effective shoreline clean-up operations. These assessments would then inform which of the suite of verified, site-specific 'Tactical Response Plans' (for locations around the WA coastline) should be activated. The Tactical Response Plans set out the appropriate response techniques, nearest equipment locations and site layout plans for safe, efficient and effective deployment of equipment. These plans also assist the Incident Management Team in mobilising resources commensurate to the nature and scale of the spill.

Scientific Monitoring

A scientific monitoring program (SMP) would be activated following a significant unplanned hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. This document outlines Woodside's ten Scientific Monitoring programs alongside their objectives, activation triggers and termination criteria.

The SMP would consider receptors at risk (ecological and socio-economic) for the entire predicted Environment that Maybe Affected (EMBA) and in particular, any identified Pre-emptive Baseline Areas (PBAs) for the credible spill scenario(s) or other identified unplanned hydrocarbon releases associated with the operational activities.

Key objectives of the Woodside oil spill SMP are:

- Assess the extent, severity and persistence of the environmental impacts from the spill event
- Monitor subsequent recovery of impacted key species, habitats and ecosystems.

The SMP comprises ten targeted environmental monitoring programs to assess the condition of a range of physico-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act listed species, environmental values associated with protected areas and socio-economic values, such as fisheries.

2 MINIMISING THE LIKELIHOOD OF HYDROCARBON RELEASE EVENTS

2.1 Woodside approach to minimising likelihood of unplanned hydrocarbon releases from well loss of containment events

Woodside's Management System (WMS) is in place to manage the Company's key risks. Well integrity is one of the major risks Woodside must manage across all assets. The role of Woodside's Drilling and Completions (D&C) function is to provide safe, cost effective, standardised and repeatable drilling, completions and well services to meet the needs of the business and to manage the lifecycle of wells and safeguard well integrity.

This is done mainly through the D&C Management System Framework (Figure 3-1) and its well lifecycle management process and supporting documents. One of the key assurance items is to deliver a Well Operations Management Plan (WOMP) which is a key permissioning document that must be approved by an independent Regulator (either NOPSEMA or DMIRS) prior to constructing, operating and permanently abandoning a well.

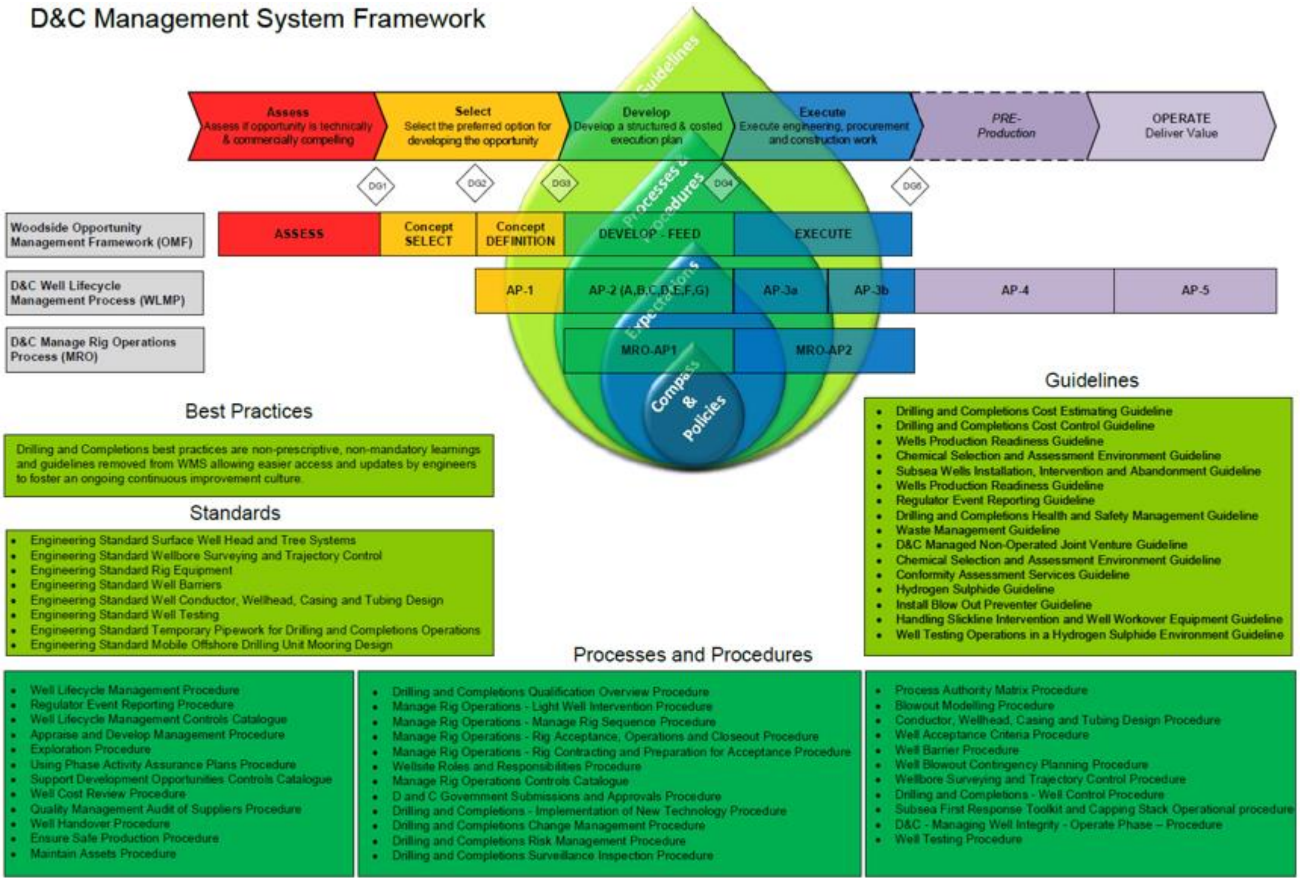

Figure 2-1: Woodside Drilling and Completions Management System Framework

The D&C Management System Framework is based on international standards, codes and best practices, informed by international agencies such as the American Petroleum Institute (API), NORSOK and the International Association of Oil and Gas Producers (IOGP). Below is a non-exhaustive list such standards published by these agencies to which Woodside's management framework complies or will be applied (as relevant) to the proposed Browse to NWS Project;

- API ST 53 - Well Control Equipment Systems for Drilling Wells

  - The purpose of this standard is to provide requirements for the installation and testing of blowout prevention equipment systems on land and marine drilling rigs.
- API ST 64 - Recommended Practice for Diverter Systems Equipment and Operations
  - This standard is intended to provide information on the design, manufacture, quality control, installation, maintenance and testing of the diverter system, and associated components. The diverter system provides a flow control system to direct controlled or uncontrolled wellbore fluids away from the immediate drilling area for the safety of personnel and equipment
- API TR 5C3 - Calculating Performance Properties of Pipe Used as Casing or Tubing
  - This technical report illustrates the equations and templates necessary to calculate the various pipe properties.
- API RP 5C5 - Procedures for Testing Casing and Tubing Connections
  - This Recommended Practice (RP) defines tests to determine the galling tendency, sealing performance, and structural integrity of threaded casing and tubing connections
- API SPEC 5CT - Specification for Casing and Tubing
  - This standard specifies the technical delivery conditions for steel pipes (casing, tubing, and pup joints), coupling stock, coupling material, and accessory material, and establishes requirements for three product specification levels.
- NORSOK D-007 – Well Testing Systems
  - This document describes the technical, functional, and operational requirements for temporary well testing, production clean-up and bleed-off equipment and systems. The equipment and systems are used for hydrocarbon flow from exploration or development wells on both mobile units and fixed platforms.
- NORSOK D002 - System requirements well intervention equipment
  - This standard describes the design, installation and commissioning principles and requirements for the well intervention equipment and their systems and equipment.
- IOGP Report 476 - Recommendations for enhancements to well control training, examination and certification
  - This report provides recommended enhancements to existing industry well control training, examination and certification processes, as well as related philosophies that should be considered for adoption throughout the industry to improve well control preparedness and performance.

Woodside's involvement in industry forums allows it to remain involved in and abreast of the latest industry best practice guidance, this involvement includes:

- active participant of APPEA's Oil Spill Preparedness and Response Working Group
- active participant of APPEA's Drilling Industry Steering Committees
- current chair of the AMOSC Subsea First Response Toolkit Steering Committee
- member of IOGP industry committees e.g. Wells Engineering Committee
- member of the IPIECA Oil Spill Working Group
- member of both the International Maritime Organization Global Initiative groups for South East Asia (GI SEA) and West and Central Africa (GI WACAF) (NB GI program is administered by IPIECA).

- member of Oil Spill Response Limited (OSRL) - the leading industry spill response organisation. In addition to the provision of equipment and personnel response resources during a spill event, OSRL provides advice and guidance to members on good practice during planning. Woodside subscribes to OSRL's quality-assurance review service for pre-submission review of Australian regulatory oil spill plans.

2.2 Measures that will be implemented to minimise the likelihood of the hydrocarbon spills from loss of well containment events.

When implementing the proposed Browse to NWS Project, the following measures (Table 2-1) will be applied at a minimum to minimise the likelihood of a hydrocarbon release occurring due to a well loss of containment event during drilling and completions activities.

These measures were identified in the context of supporting the environmental impact assessment for the proposed Browse to NWS Project at the primary approval stage. As project design and planning develops, and as part of the secondary approvals required under the Commonwealth and State regulations, further measures will be identified and assessed to ensure the risk of any unplanned hydrocarbon release is reduced to ALARP in accordance with the regulations.

Table 2-1: Prevention measures to be implemented for the proposed Browse to NWS Project to reduce the likelihood of a hydrocarbon spill

Measure	Description	Benefit
Regulator acceptance of a Well Operations Management Plan (WOMP)	At the completion of the well design and planning phase, a WOMP will be submitted to NOPSEMA/DMIRS (depending on well jurisdiction) for approval. It will summarise the well design and demonstrate that the well integrity risks have been managed to ALARP. The well design will be in accordance with D&C System and Management Framework and latest best practices at the time of undertaking this work. The sections below summarise in more detail the type of work and activities that go into developing a WOMP.	• Demonstration that the well design and construction process has successfully demonstrated that well integrity risk is ALARP.
Engineering Design	The following measures to be considered during well engineering design to reduce the likelihood of a hydrocarbon release (loss of well integrity) to ALARP: • Utilise industry and Woodside best practices. • Implement learnings from offset wells and hazards encountered. • Perform pore pressure prediction modelling using offset data. • Design fluids to maintain sufficient pressure overbalance to hydrocarbon pressure during well construction and maintain sufficient integrity in the presence of well contaminants. • Design cement barriers to limit the risk of loss of containment of well to ALARP. • Design well architecture (wellhead, conductor, casing, and tubing) to provide or support well barriers that can withstand all planned, foreseeable and survival load cases.	• Understanding the pore pressure regime of the area, utilising area-specific hazard information and using best practices during the well's engineering design allows the creation of a well design that reduces the risk of loss of well control to ALARP.

Measure	Description	Benefit
	• Design well shoe placement with sufficient kick tolerance to allow an influx to be safely circulated out of the well without breaking down the formation at the open hole weak point. • Prepare well barrier diagrams and well acceptance criteria to demonstrate a two-barrier approach to hydrocarbons is utilised during well construction operations. • Create well activity risk management bowtie diagrams to identify controls to manage a hazard. • Conduct a peer review of engineering design with Woodside and JVP subject matter experts. • All wells to be designed to ensure that well kill can occur via a single relief well • Capping stack will be capable of interfacing with wellhead and BOP connectors	
Processes and Procedures	The following processes and procedures to be considered to ensure well construction is executed as planned: • Well Programs and Guidelines, e.g. Detailed Drilling Program (DDP) and Detailed Completions Guideline (DCG), to provide step-by-step instructions to execute drilling and completions activities, and inform operations teams of key hazards and risks pertaining to well construction activities. • Standard Instructions to Drillers (SIDs): detailed step-by-step instructions for each operational activity distributed to all pertinent personnel at the operational site to facilitate a cohesive approach to execution of the activity.	• Processes and procedures allow learnings and best practices to be communicated from well design through to well construction.
Personnel Selection, Placement and Competency	Personnel competency is assessed to ensure employees, contractors, and service providers engaged in well construction activities understand their process safety responsibilities. This may be done through the following methods: • Operations supervisors to have a valid Well Control certification pertaining to their role. • Contracts with drilling service providers detailing minimum experience required from third party personnel. • Qualification to Fly (QOF) system to track third-party personnel experience and competence prior to approving their travel to the operations site.	• Process Safety is integrated into the way D&C conducts well activities on a day-to-day basis. This ensures all parties, employees, contractors and service providers engaged in D&C well activities become exposed and involved in Process Safety.

Measure	Description	Benefit
	• All emergency duty personnel and their deputies must possess the skills and awareness necessary to carry out their respective emergency management roles. Well control drills and exercises are implemented to maintain personnel competency in emergency response. This may be done through the following methods: • An Emergency Communications Exercise conducted by each rig withing 48 hours of arriving at a new location. • A scenario-based exercise involving the facility emergency response teams and activation of the Contractor's onshore emergency centres and the Corporate Incident Coordination Centre (CICC), must be conducted within one month of the commencement of a campaign, and as a minimum at six month intervals thereafter. This Level 2 exercise must include an oil spill related event once a year.	
Operational Status Monitoring	The monitoring of well integrity and adherence to well programs and procedures may be obtained through the following methods: • Daily Drilling Reports (DDRs) provide a summary of each day's operations and outline key reportable outcomes and activities used to monitor the integrity of the well • Well Acceptance Criteria (WAC) list the requirements for establishing the appropriate barriers and controls to ensure well integrity is maintained throughout the well construction phase. The achievement of WAC is witnessed by the offshore supervisor, verified by the responsible party onshore and documented in the DDR. • Well Barrier Diagrams define all barriers that must be in place through well construction activities and are verified by the operations supervisor prior to commencing the respective activity. • Management of Change process: any temporary or permanent deviations from the approved well design or approved procedures and guidelines require a risk assessment and formal approval sought from responsible parties via a Change Control Request Form. • Leading Process Safety Metrics track the status of vulnerable operational processes observed in recent industry events and are included in the DDR. Examples of	• The monitoring of well integrity and adherence to well programs and procedures allows visibility of well control status and a swifter emergency response should there be a loss of well control, thereby reducing the risk of loss of well containment.

Measure	Description	Benefit
	metrics include well control equipment checks, any deviations to D&C Standards and fluid column status.	
Primary Well Control	The implementation and on-going verification of primary well control may be obtained through the following measures: • A minimum of two well barrier enveloped to isolate reservoirs and/or zones with flow potential to subsea/surface. • Well barriers are selected and installed to limit the risk of loss of containment to ALARP. • If the primary well barrier is a fluid column, the following must be met to qualify and verify the barrier: – The hydrostatic head margin exerted by the fluid exceeds the predicted most likely formation pressure at the point of overbalance. – Critical fluid properties and specifications are described prior to any operation – The hydrostatic pressure does not exceed the formation fracture pressure (SHmin) in the open hole including a safety margin which considers circulation events. – The fluid level can be measured, maintained and monitored. – Fluid density changes due to temperature and compressibility in the wellbore are factored into overbalance estimates. – Fluid volumes and flow rates are monitored and flow checks are performed.	• Establishing, qualifying and verifying primary barriers allows reduction of the risk of loss of well containment to ALARP.
Secondary Well Control	Secondary well control is established to mitigate the risk of loss of primary well control. This may be done through the following measures: • The assessment of well control equipment requirements must be conducted for all new campaigns. • Surface well control and associated equipment requirements for well intervention must follow the requirements of NORSOK D002 Well Intervention Equipment Rev 2013. • A third-party Woodside Control equipment Inspector must inspect the well control equipment for workover and subsea intervention prior to each campaign.	• Establishing, qualifying and verifying secondary barriers allows well control to be maintained should primary well control barriers be lost, reducing the risk of loss of well containment to ALARP.

Measure	Description	Benefit
	• Two independent systems for monitoring critical well bore data should be provided (typically by the drilling contractor and mudloggers). • A diverter system must be installed. • Surface BOP stacks must have a minimum 5000 psi configuration. • Subsea BOP stack must be consistent with the requirements of API Standard 53. • Consideration must be given to the appropriate BOP ram configuration and control systems to ensure BOP will reduce risks to ALARP. • A full BOP pressure test must be carried out once the BOP is initially landed Subsequent pressure test frequency is not to exceed 21 days. • BOP rams must be function tested from surface, and remotely (via ROV) every 7 days.	
Well Control Preparedness / Managing Loss of Primary Well Control	Well control preparedness may be accomplished through the following measures: • Formation Integrity Tests (FIT) or Leak-off Tests (LOT) must be carried out after a string of casing has been cemented and before a new section of hole is drilled. • A well "termination rate" sheet must be updated at least daily when a new hole is being drilled. • Best practices and procedures must be followed to prevent kicks while tripping and drilling • Well control drills. • Flow checks must be made as per best practices. • Pit volumes must be independently monitored and any anomalies investigated.	• Well control preparedness allows for a swifter response to the loss of primary well control, reducing the likelihood of a hydrocarbon spill.

3 MINIMISING THE CONSEQUENCE OF WELL LOSS OF CONTAINMENT EVENTS

3.1 Source control techniques to be applied on the proposed Browse to NWS Project

In the unlikely event of a loss of containment event originating from a subsea well, source control will be required to bring the well back under control and to stop hydrocarbons from being released to the environment. Source control is a generic term for all activities related to the direct intervention of a well that has experienced loss of containment, with the intent to halt or control the release of hydrocarbons to the environment.

Table 3-1 outlines the source control response techniques that will, at a minimum, be implemented for the proposed Browse to NWS Project to reduce the consequence of a hydrocarbon spill from a loss of well control.

The techniques to be applied, including provision of maximum response timeframes for each key source control activity, is considered to be in alignment with industry best practice.

For source control planning Woodside's approach is aligned to Regulator and Industry best practices, codes and standards. A non-exhaustive list of these are outlined below:

- UK Oil & Gas Guidelines on Relief Well Planning, Issue 2, March 2013
- ISCWSA Well Intercept Sub committee Ebook v7
- SPE Technical Report on Calculation of WCD SPE-174705-TR
- IOGP Report 594 (Source Control and Emergency Response Planning Guide)
- IOGP Report 591 (Guidance for source control competence and skills)
- Australian Offshore Titleholders Source Control Guidelines
- NOPSEMA Source Control Planning and Procedures Information Paper
- American Petroleum Institute Recommended Practice (API RP) 17W which provides guidelines for the design, manufacture, use, preservation, transportation, and maintenance procedures of subsea capping stacks

Table 3-1: Source control response measures that will be implemented for the proposed Browse to NWS Project to reduce consequence of a hydrocarbon spill

Response technique to be available	Overview of technique	Expected benefits	Response timeframe
Source control via blowout preventer (BOP) intervention	The BOP rams are operated from surface, or via a Remotely Operated Vehicle (ROV), to close the well. The status of the well and any pipe, wire or tooling across the BOP's are considered when selecting the appropriate rams to close the well. In the event of the worst-case scenario with a loss of well containment during drilling operations occurring and the BOP not automatically being shut in, ROV operations to manually operate the BOP would be attempted.	Controlling a loss of well containment at source via BOP intervention would be the most effective way to limit the quantity of hydrocarbon entering the marine environment.	For the proposed Browse to NWS Project, source control via BOP intervention will be available for immediate response. An ROV will be available on the MODU ready for immediate deployment to attempt initial BOP well intervention. A separate ROV will be available (on a separate vessel) to attempt BOP well intervention within 48 hours.
Debris clearance using subsea first response toolkit	Should a blow-out occur that can't be remediated by actuation of BOP closure rams, it is possible there may be debris or damage to equipment that would restrict access to the well to allow further response. A subsea first response toolkit (SFRT) would be deployed to survey the location and remove debris to facilitate deployment of a capping stack. Woodside has contracts in place for year round assistance for the mobilisation, deployment, and operation of the SFRT equipment together with trained and qualified personnel.	Facilitates use and deployment of capping stack onto the well.	In the event of a loss of well containment, the SFRT will be mobilised to site and available for deployment within 11 days.
Source control via debris clearance and capping stack	A suitable and compatible capping stack would be installed on a blowing out well to stop hydrocarbons from escaping to the environment.	Controlling a loss of well containment at source via capping stack would be an effective way to limit the quantity of	A suitable capping stack (on a suitable vessel) will be mobilised to site and the capping stack will be available for deployment within 11[1] - 16[2] days, targeting

		hydrocarbon entering the marine environment.	deployment within 13 days. Once equipment arrives in the field, deployment would commence immediately as metocean and hydrocarbon plume conditions allow for safe deployment. Note 1 - 11 days is the mobilisation timeframe for the Singapore-based Wild Well Control Inc. capping stack to Port Hedland as calculated in the Australian oil and gas industry response time model (OSRL-APPEA, June 2021). This timeframe assumes the availability of a suitable vessel in Singapore within 24 hours. Note 2 - 16 days is the estimated mobilisation timeframe based on the OSRL-APPEA response time model (11 days) plus transit time to the spill location and contingency if a suitable vessel is not available within 24 hours.
Source control via relief well drilling	A Blowout Contingency and Relief Well Plan is created for the worst-case discharges of a campaign and may detail the following: • Worst case discharge rates • Design of a relief well and point of intersection at the blowing out well • Pump rates and pressures capable of killing the blowing out well and establishing primary well control • A list of suitable MODUs in the region with suitable pump capacity that may be mobilised to perform relief well drilling	A relief well aids in the intersection and kill of a blowing out well, establishing primary well control. This is the only guaranteed, 100% reliable technique for stopping a well loss of containment event permanently.	A Blowout Contingency and Relief Well Plan will be created for the worst case release scenarios. A drill rig capable of commencing relief well drilling will be mobilised and in field, available to commence drilling the relief well, within 16 days. Predicted relief well drilling timeframe breakdown is as follows: Source, contract and mobilise MODU — Up to 16 days

				Drilling, casing and look ahead	Up to 47 days
				Intersection & well kill	Up to 14 days
				TOTAL:	77 days

3.2 New, emerging and innovative hydrocarbon spill response techniques to be considered for implementation on the proposed Browse to NWS Project

As part of detailed source control planning activities, all available techniques and strategies will be reviewed, as part of the secondary approval and ALARP demonstration process (See Section 5.2)

At a minimum, based on today's known technology, each of the new and emerging source control techniques outlined in Table 3-2 will be reviewed for their applicability to the proposed Browse to NWS Project and implemented if identified as being required to demonstrate hydrocarbon spill risks have been reduced to ALARP. Each of the techniques below will specifically be considered for implementation on the proposed Browse to NWS Project.

Woodside is committed to ongoing monitoring and evaluation of source control technologies and methodologies to ensure it is continually aligned to best practice. Therefore, prior to the submission of environment plan for any drilling activities, which have a maximum duration of five years. Woodside will review best practice spill response techniques including a review of latest standards published by API, IPIECA, IOGP or and relevant regulatory guidelines.

Table 3-2: New, emerging and non-standard response measures that will reduce the consequence of a hydrocarbon spill that will be assessed prior to implementation of the proposed Browse to NWS Project

Response technique	Overview of technique	Expected benefits	Feasibility considerations
Kinetic blow out stopper (KBOS) emergency shut in device	The Kinetic Blowout Stopper (K-BOS) emergency shut-in device has the potential to increase reliability and effectiveness of blow-out prevention measures	• As a last resort it would allow shut in of a well quickly stopping flow of hydrocarbons.	This emerging technology has not previously been used by Woodside. Drilling contractors have conducted field trials of integrating the emergency shut-in device to the BOP stack. The device may become more widely available in future.

Response technique	Overview of technique	Expected benefits	Feasibility considerations
	above those provided by a subsea BOP stack.	• The K-BOS offers increased ability to shear tubulars that may not be successfully severed by a hydraulic BOP shear ram, while also being controlled independently of the BOP control system.	
Mudline closure device	The system is designed to augment the existing rigs BOP safety system and provides two additional sets of rams with an independent control system. However the gain in system reliability is less than by using K-BOS as the shear ram design is the same as for the BOP.	• Additional control system redundancy	This technology has not previously been used by Woodside.
Offset capping alternative to conventional capping stack deployment	This technique offers a solution in shallow water when worst case discharge rates are too high to install a capping stack conventionally (vertical access). For the proposed Browse to NWS Project, the water depth is in the 'mid water' range so this technique may not be required.	• Solution for capping at high rates when combined with shallow water.	Technical feasibility: • The base case considerations for offset intervention installation equipment (OIE) requires a coordinated response by 4 to 7 vessels working simultaneously outside of the 500m exclusion zone. In the event of a worst-case shallow water gas discharge, the 10% LEL modelled radius extends beyond the area of activity required for the OIE deployment thereby introducing health and safety risk to any vessels required for the initial deployment of the carrier and subsequent operations with ROV during capping operations. Though manageable for single vessels, it is prohibitive for operations requiring SIMOPs with numerous vessels working at 180 degrees from one another.

Response technique	Overview of technique	Expected benefits	Feasibility considerations
			Other factors: • Due to the OIE's size and scale, fabrication of equipment, e.g. mooring anchors, outside of the contractor's scope of supply is likely to require engagement of international suppliers, further increasing complexity and uncertainty in associated time frames. • Screening indicates that mobilising some components of the OIE, based in Italy, can only be mobilised by sea and is likely to erode any time savings realised through stopping flow of the well via a relief well. The March 2019 OSRL exercise in Europe tested deployment of the OIE and highlighted that it will require a 600+MT crane vessel for deployment to ensure there is useable hook height for the crane to conduct the lift of the carrier. Vessels with such capability and a current Australian vessel safety case are not locally or readily available.
Dual vessel capping stack deployment	The capping stack would be handed off from a crane vessel to the anchor handler vessel (AHV) work wire outside of the exclusion zone. The AHV would then manoeuvre the barge into the plume to position the capping stack over the well. In this method, the barge would be in the plume, but the AHV and all personnel would be able to maintain a safe position outside of the gas zone. The capping stack would be lowered on the AHV	While the use of dual vessel to deploy the capping system could reduce the quantity of hydrocarbon entering the marine environment, this is an unproven technology. Additionally, the feasibility issues surrounding a dual vessel capping deployment together with mobilisation lead times for both a cap and required vessels and support equipment, would minimise any environmental benefit.	A dual vessel deployment is somewhat feasible provided a large enough deck barge can be located. Deck barges of 120 m are not, however, very common and will present a logistical challenge to identify and relocate to the region. Furthermore, the longer length barges may need mooring assist to remain centred over the well.

Response technique	Overview of technique	Expected benefits	Feasibility considerations
	work wire so a crane would not be required on the barge.		
Subsea containment system alternative to capping stack deployment	The technique involves the installation of a large containment system on top of the well that directs hydrocarbons to a surface containment system, such as a vessel or tanker.	While the use of a subsea containment system could reduce the quantity of hydrocarbon entering the marine environment, this is an unproven technology. Additionally, the system is unlikely to be feasibly deployed and activated for at least 90 days following a blowout due to equipment requirements and logistics. No environmental benefit is therefore predicted given the release duration is predicted to be 77 days before drilling of a relief well under the adopted control measure.	The timing for mobilisation, deployment and activation of the subsea containment system is likely to be >90 days which is longer than the expected 77 days relief well drilling operations based on the location, size and scale of the equipment required, including seabed piles that can only be transported by vessel.
Subsea well kill spools	For use in shallow or deep water, subsea kill spools facilitate the delivery of high-rate kill fluid to a relief well via subsea hoses. The technique requires the use of a second MODU in deep water, or another vessel with fluid storage and pumping capabilities in shallow water.	Delivery of very high kill rates achievable for well kill: • Avoids requirement for two relief wells (undesirable) • Reduces kill fluid density • Lower kill system pressures • Reduces requirement for additional, high-pressure pump skids Uses conventional pumping line-ups on MODU.	This technology is under consideration by Woodside and initial feasibility studies are complete. The subsea kill spool equipment is available on an ‘access’ basis, similar to the capping stack. The equipment can be air-freighted to Australia within the required response timeframe. For deep water applications, a second MODU is required to provide additional kill fluid storage and pumping capacity, otherwise the deployment of this technology is uncomplicated. Various installation options are available, e.g. MODU, IMR vessel, construction vessel.

4 HYDROCARBON SPILL RESPONSE TECHNIQUES TO BE IMPLEMENTED ON THE PROPOSED BROWSE TO NWS PROJECT

4.1 Hydrocarbon spill response techniques that will be implemented for the proposed Browse to NWS Project, to reduce consequence of a hydrocarbon spill from a well loss of containment event

The following outlines the spill response techniques that will be applied, at a minimum, to minimise the consequence of loss of containment events. Further details of the nature of this event are outlined in the draft EIS/ERD, to which this document is an Appendix.

As part of the secondary approval process, Woodside will undertake further detailed assessment of the applicable response techniques. The outcomes of that assessment process will be presented in an Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) prepared to meet the requirements of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and the State Petroleum (Submerged Lands) (Environment) Regulations 2012.

Woodside's processes for spill response planning and preparedness are aligned with industry and international good practice including, but not limited to, the following:

- Australian Maritime Safety Authority
  - The National Plan Oil Spill Control Agents List
- Department of Parks and Wildlife and Australian Marine Oil Spill Centre
  - Inter-Company Oil Spill Wildlife Response Plan
  - Western Australian Oiled Wildlife Response Plan
- European Maritime Safety Agency
  - Manual on the applicability of oil spill dispersants
- International Petroleum Industry Environment Conservation Association (IPIECA) and International Association of Oil and Gas Producers (IOGP)
  - Dispersants: surface application
- International Tanker Owners Pollution Federation (ITOPF)
  - Fate of Marine Oil Spills, Technical Information Paper
  - Use of Dispersants to Treat Oil Spills, Technical Information Paper
  - Aerial Observation of marine oil spills, Technical Information Paper
  - Use of skimmers in oil pollution response, Technical Information Paper
- National Oceanic and Atmospheric Administration (NOAA)
  - Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments.

Table 4-1 presents the hydrocarbon spill response techniques that will be implemented for the proposed Browse to NWS Project to reduce consequence of a hydrocarbon spill.

Table 4-1: Hydrocarbon spill response techniques that will be available to be implemented for the proposed Browse to NWS Project to reduce the consequence of a hydrocarbon spill from well loss of containment

Response technique	Overview of technique	Outcome	Feasibility
Monitor and evaluate	Monitor and evaluate includes the gathering and evaluation of data to inform oil spill response planning and operations. It includes fate and trajectory modelling, spill tracking, weather updates and field observations. This response option is deployed in some capacity for every event. Operational monitoring is typically undertaken from the outset of a spill. This is needed to assess the nature of the spill and track its location. The data collected from the operational monitoring will inform the need for any additional operational monitoring, deployment of response techniques and may assist post-spill scientific monitoring. It also informs when the spill has entered WA State Waters and control of the incident passes to Western Australia Department of Transport (WA DoT).	Will be effective in tracking the location of the spill, informing when it has entered State Waters, predicting potential impacts and triggering further monitoring and response techniques as required. Monitoring techniques include: • OM01 Predictive modelling of hydrocarbons – used throughout spill. ‘Ground-truthed’ using the outputs of all other monitoring techniques. • OM02 Surveillance and reconnaissance to detect hydrocarbons and resources at risk – from outset of spill. • OM03 Monitoring of hydrocarbon presence, properties, behaviour and weathering in water – from outset of spill. • OM04 Pre-emptive assessment of sensitive receptors at risk – triggered once OM01, OM02 and OM03 inform likely RPAs at risk. • OM05 Shoreline assessment – once OM02, OM03 and OM04 inform which RPAs have been impacted.	Monitoring of a spill is a feasible response technique and an essential element of all spill response incidents. Outputs will be used to guide decision making on the use of other monitoring/response techniques and providing required information to regulatory agencies including AMSA and WA DoT.
Subsea Dispersant Injection (SSDI) [1]	Application of subsea dispersant may reduce the scale and extent of hydrocarbons reaching the surface and thus reduce spill volumes contacting predicted RPAs. Subsea dispersant injection involves the deployment of a subsea dispersant manifold with associated equipment to inject chemical dispersant directly into the hydrocarbon	Application of subsea dispersant may reduce the scale and extent of hydrocarbons reaching the surface and thus reduce spill volumes contacting predicted RPAs. SSDI can increase dispersed/entrained hydrocarbons which can potentially have higher toxicity to biota in shallow water than naturally dispersed hydrocarbons.	Predicted to be feasible for the subsea release due to the hydrocarbon properties of the proposed Browse to NWS Project condensate. Furthermore, SSDI could potentially be applied from outside the exclusion zone thus could be deployed even when there are high VOC levels at the spill source.

Response technique	Overview of technique	Outcome	Feasibility
	plume in the event of a loss of well containment. As it may take some time to mobilise subsea dispersant equipment, surface dispersants are generally used in the interim to treat oil that makes it to the surface provided appropriate surface concentrations thresholds (>50 g/m^2) are present. The use of subsea dispersants has similar benefits to surface dispersant application including a potential reduction in the volume of hydrocarbons that reach the shoreline thereby reducing impacts to sensitive receptors. In addition to these benefits, subsea dispersant application may reduce volatile organic compound (VOC) levels during surface response operations, reducing risks and hazards to responders.	Entrained oil could potentially impact on sensitive shallow-water receptors e.g. corals, which may be otherwise unaffected. Entrained oil plume likely to be increased resulting in greater spatial extent of entrained oil. The proximity to Scott Reef and the potential for dispersant use to result in impacts to Scott Reef would also influence the decision on the use of subsea dispersants. Where a hydrocarbon spill may potential enter WA State waters, the use of subsea dispersants would be subject to approval from the WA DoT.	This response technique may not be feasible in the event of a worst-case blow-out due to potential high gas flow rates. The proximity to Scott Reef and the potential for dispersant use to result in impacts to Scott Reef would also influence the decision on the use of subsea dispersants. Where a hydrocarbon spill may potential enter WA State waters, the use of subsea dispersants would be subject to approval from the WA DoT.
Surface dispersant application[1]	Surface dispersant application may reduce surface hydrocarbons and therefore prevent, or reduce the scale of, shoreline contact. Surface dispersant may be applied via vessel or aerial means. Priority would be placed on treating high volume surface hydrocarbons closest to the release location as this is where high surface concentrations are predicted, and dispersant application is expected to achieve the greatest environmental benefit. Surface dispersant application is weather and sea-state dependent. Periods of downtime can be expected.	Application of surface dispersant would likely reduce the volumes of hydrocarbons contacting sensitive surface and shoreline receptors. Dispersant can also enhance biodegradation and may reduce VOCs in some circumstances therefore reducing potential health and safety risk to responders. Dispersant can increase dispersed/entrained hydrocarbons which can potentially have higher toxicity to biota in shallow water than naturally dispersed hydrocarbons. Subsurface oil plume likely to increase in size resulting in greater spatial extent of entrained oil.	Dispersants are not generally considered a feasible response technique when applied on thin surface films such as condensate as the dispersant droplets tend to pass through the surface films without binding to the hydrocarbon. This technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles. The proximity to Scott Reef and the potential for dispersant use to result in impacts to Scott Reef would also influence the decision on the use of subsea dispersants. Where a hydrocarbon spill may potential enter WA State waters, the

Response technique	Overview of technique	Outcome	Feasibility
		Entrained oil could potentially impact on sensitive shallow-water receptors e.g. corals, which otherwise may have been unaffected.	use of subsea dispersants would be subject to approval from the WA DoT.
Mechanical dispersion	Mechanical dispersion involves the use of a vessel's propeller wash and/or fire hose to target surface hydrocarbons to achieve dispersion into the water column.	This technique is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages. Additionally, the volatile nature of the oil likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon.	Although the technique is feasible, highly volatile hydrocarbons are likely to weather, spread and evaporate quickly. The volatile nature of the oil likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon. Additionally, any vessel used for mechanical dispersion activities would be contaminated by the hydrocarbon and could potentially cause secondary contamination of unimpacted areas when exiting the spill area. The decontamination of a vessel used for mechanical dispersion activities would result in additional quantities of oily waste requiring appropriate handling and treatment.
In-situ burning[1]	This technique requires calm sea state conditions as is required for containment and recovery operations, which limits its feasibility. Optimum weather conditions are <20 knot wind speed and waves <1 to 1.5 m with oil collected to a minimum 3 mm thick layer.	In-situ burning is only effective where minimum slick thickness can be achieved and where calm metocean conditions can be ensured. There are health and safety risks for response personnel associated with the containment and subsequent burning of hydrocarbons. It is also suggested that the residue from attempts to burn would sink, thereby posing a risk to the environment and/or increase the release of atmospheric pollutants. The longer-term effects of burn residues on the marine environment are not	There is a limited window of opportunity in which this technique can be applied (prior to evaporation of the volatiles) which would be difficult to achieve. Furthermore, this technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles.

Response technique	Overview of technique	Outcome	Feasibility
		fully understood and therefore, no assessment of the potential environmental impact can be determined.	
Containment and recovery	Containment and recovery is used to reduce damage to sensitive resources by the physical containment and mechanical removal of hydrocarbons from the marine environment. It has a lower capacity for removing surface oil than the application of dispersant but avoids potential additional impacts created by the resulting increase in entrained hydrocarbons in the water column.	Containment and recovery has an effective recovery rate of 5-10% when a hydrocarbon encounter rate of 25-50% is achieved at BAOAC 4 and 5. It has the potential to reduce the magnitude, probability, extent, contact and accumulation of hydrocarbon on shorelines receptors when suitable encounter rates can be achieved. It also has the potential to reduce the magnitude and extent of contact with submerged receptors by removing oil before further natural entraining/dissolving of hydrocarbons occurs.	Predicted low effectiveness – typical expectation is less than 10% of hydrocarbon released can be contained and recovered. Deepwater Horizon/Macondo was approx. 3–5% with the largest containment and recovery operation ever conducted. Meteorological conditions and sea-state must allow the deployment of booms and skimmers. Surface hydrocarbon would need to be corralled to a sufficient thickness to permit efficient recovery by skimmers. The volatile nature of the hydrocarbon may lead to unsafe conditions near release location.
Shoreline protection and deflection	The placement of protection or deflection booms on and near a shoreline is a response technique to reduce the potential volume of hydrocarbons contacting or spreading along shorelines, which may reduce the scale of shoreline clean-up. Hydrocarbons contained by the booms would be collected where practicable.	Shoreline protection and deflection can be effective at preventing contamination of sensitive resources and can be used to corral oil into slicks thick enough to skim effectively.	If real-time Operational Monitoring activities (OM01, OM02 and OM03) indicate surface hydrocarbons are moving toward shorelines, pre-emptive assessments of sensitive receptors at risk (OM04) and existing TRPs will be utilised to guide shoreline protection and deflection operations, in agreement with WA DoT (for Level 2/3 spills). Protection strategies can be used for targeted protection of sensitive resources.

Response technique	Overview of technique	Outcome	Feasibility
			Access to sensitive areas may cause more negative impact than benefit.
Shoreline clean-up	Shoreline clean-up may be undertaken using a broad range of techniques when floating hydrocarbons contact shorelines. The timing, location and extent of shoreline clean-up activities can vary from one scenario to another, depending on the hydrocarbon type, sensitivities and values contacted, shoreline type and access, degree of oiling, and area oiled. Shoreline clean-up is typically undertaken as a three-phase process: • Phase one (gross contamination removal) involving the collection of bulk oil, either floating against the shoreline or stranded on it. • Phase two (moderate to heavy contamination removal) involving removal or in-situ treatment of shoreline substrates such as sand or pebble beaches. • Phase three (final treatment or polishing) involving removal of the remaining residues of oil.	Shoreline clean-up is an effective means of hydrocarbon removal from contaminated shorelines where coverage is at an optimum level of 250 g/m^2.	If real-time Operational Monitoring activities (OM01, OM02 and OM03) indicate hydrocarbons will contact shorelines, pre-emptive assessments of sensitive receptors at risk (OM04), shoreline assessments (OM05) and existing TRPs will be utilised to guide shoreline protection and deflection operations, in agreement with WA DoT (for Level 2/3 spills). Can reduce or prevent impact on sensitive receptors in most cases. Must ensure, through shoreline assessment, that sensitive sites will benefit from clean-up activities as the response itself may cause more negative impact than benefit through disturbance of habitats and species.
Oiled wildlife response	This technique involves implementing a response in accordance with the Oiled Wildlife Operational Plan. This plan includes the process for the IMT to mobilise resources depending on the nature and scale of the spill. Oiled wildlife operations would be implemented with advice and assistance from the Oiled Wildlife Advisor	Oiled wildlife response is an effective response technique for reducing the overall impact of a spill on wildlife. This is mostly achieved through hazing to prevent additional wildlife from being contaminated and through rehabilitation of those already subject to contamination.	In the event that wildlife are at risk of contamination, oiled wildlife response will be undertaken in accordance with the Wildlife Response Operational Plan as and where required. In addition, any rehabilitation could only be undertaken by trained specialists.

Response technique	Overview of technique	Outcome	Feasibility
	from the Department of Biodiversity, Conservation and Attractions (DBCA). Oiled wildlife response is undertaken in accordance with the Western Australian Oiled Wildlife Response Plan to ensure it is conducted in accordance with legislative requirements under the *Animal Welfare Act* 2002 (WA).		In the event of highly volatile atmospheric conditions surrounding the spill, response options may be limited to hazing to ensure the safety of response personnel.

1 – These techniques may cause environmental impacts greater than that which they seek to reduce, and (as with any measure) would only be implemented after consideration of net environmental benefits, and in the case of dispersant application, with regulatory approval of the specific action.

4.1.1 Hydrocarbon spill response planning document and approvals overview

The documents outlined in Table 4-2 will be used to manage the mitigation, preparedness and response for a hydrocarbon release on the proposed Browse to NWS Project. Each will be prepared to meet relevant regulatory requirements to the satisfaction of regulators.

Relevant regulations are outlined in Table 4-2. Woodside's approach to hydrocarbon spill preparedness and mitigation adheres to Australian regulatory requirements as detailed in Table 5-3 and Table 4-4.

Table 4-2: Hydrocarbon spill preparedness and response documentation

Document	Document overview
Activity specific Environment Plan required under the Commonwealth and State regulations	• Demonstrates that potential adverse impacts on the environment associated with the specific activities associated with the proposed Browse to NWS Project (during both routine and non-routine operations) are mitigated and managed to ALARP and will be of an acceptable level.
Oil Pollution Emergency Plan (OPEP) – Woodside's OPEP is comprised of the following elements:	
OPEA Australia	• Describes the arrangements and processes adopted by Woodside when responding to a hydrocarbon spill from a petroleum activity.
Activity specific Oil Spill Preparedness and Response Mitigation Assessment	• Evaluates response options to address the potential environmental impacts resulting from an unplanned loss of hydrocarbon containment associated proposed Browse to NWS Project activities.
Oil Pollution First Strike Plan (FSP)	• Facility specific document providing details and tasks required to mobilise a first strike response. • Primarily applied to the first 24 hours of a response until a full IAP specific to the event is developed. • Oil Pollution FSPs are intended to be the first document used to provide immediate guidance to the responding IMT.
Operational Plans (including the activity-specific Source Control Emergency Response Plan)*	• Lists the actions required to activate, mobilise and deploy personnel and resources to commence response operations. • Includes details on access to equipment and personnel (available immediately) and steps to mobilise additional resources depending on the nature and scale of a release. • Relevant operational plans will be initially selected based on the Oil Pollution FSP; additional operational plans would be activated depending on the nature and scale of the release.
Tactical Response Plans (TRP)	• Provides options for response techniques in selected Response Protection Areas (RPAs). Provides site, access and deployment information to support a response at the location.
Support Plans	• Support Plans detail Woodside's approach to resourcing and the provision of services during a hydrocarbon spill response.
*Source Control Emergency Response Plan (SCERP)	Activity/campaign plan detailing the feasible source control response techniques and the associated project-specific details required for execution.

Document	Document overview
	SCERP covers: • Blowout prevention (BOP) intervention – attempt an intervention on existing BOP stack on source well head (if conditions allow). • Debris Removal – preparation of the subsea well head/ BOP for running of the capping stack, to ensure a safe working environment, and to provide access to the wellsite for intervention. • Capping Stack – a pressure containment device installed on top of a BOP or Well head/ Xmas tree to either shut in or contain the flow of hydrocarbons to the marine environment. Relief Well Plan covers: • Relief well drilling and dynamic kill – drilling a well to intersect the source and kill (stop) the release of hydrocarbons by dynamic killing and re-establishing well barriers.

Table 4-3: Hydrocarbon spill preparedness and response approach to meet Commonwealth Legislation

Content	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Document/Section Reference
Details of (oil pollution response) control measures that will be used to reduce the impacts and risks of the activity to ALARP and an acceptable level	Regulation 13(5), (6), 14(3)	• Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA)
Describes the oil pollution emergency plan (OPEP)	Regulation 14(8)	Woodside's OPEP has the following components: • Woodside Oil Pollution Emergency Arrangements (Australia) (OPEA) • Oil Pollution First Strike Plan (FSP) • OSPRMA
Details the arrangements for responding to and monitoring oil pollution (to inform response activities), including control measures	Regulation 14(8AA)	• OSPRMA • FSP • Activity source control emergency response plan (SCERP)
Details the arrangements for updating and testing the oil pollution response arrangements	Regulation 14(8), (8A), (8B), (8C)	• EP • OSPRMA
Details of provisions for monitoring impacts to the environment from oil pollution and response activities	Regulation 14(8D)	• OSPRMA

Content	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Document/Section Reference
Demonstrates that the oil pollution response arrangements are consistent with the national system for oil pollution preparedness and control	Regulation 14(8E)	• OPEA

Table 4-4: Hydrocarbon spill preparedness and response approach to meet Western Australia State regulations

Content	State regulations	Document/Section Reference
Approval of oil spill contingency plan submitted in accordance with condition imposed by Minister	Regulation 15(10) – Petroleum (Submerged Lands) (Environment) Regulations 2012	• OPEA • FSP
	Regulation 15(10) – Petroleum and Geothermal Energy Resources (Environment) Regulations 2012	

5 MANAGEMENT RISK OF HYDROCARBON SPILLS TO AS LOW AS REASONABLY PRACTICABLE – PROCESS FOR EVALUATION AND DEMONSTRATION

5.1 Introduction

The hydrocarbon spill risk management framework outlined in this document provides only a high level summary of the response techniques to be applied on the proposed Browse the NWS Project. It was prepared in the context of providing supplementary information for the assessment of the proposed Browse to NWS Project as part of the environmental impact assessment. As project design and planning matures, and as part of the secondary approvals required under the Commonwealth and State regulations, further detail of hydrocarbon spill risk mitigation measures will be identified and assessed to ensure the risk of a significant unplanned hydrocarbon release is reduced to ALARP.

Woodside follows a well-established process in the development of its oil spill prevention, preparedness, and response position for its projects and activities with the objective of mitigating and managing the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, so that they are controlled to ALARP and acceptable levels.

The outcomes of the process are typically presented in an Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) in accordance with requirements of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and the State Petroleum (Submerged Lands) (Environment) Regulations 2012 relating to hydrocarbon spill response arrangements.

The following outlines Woodside's ALARP demonstration and evaluation process.

5.2 ALARP demonstration process summary

Woodside's hydrocarbon spill ALARP process is aligned with guidance provided by NOPSEMA in *Oil Spill Risk Management Guidance Note N-04750-GN1488* (2021) and is set out in the 'Woodside Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) Guidelines'. The ALARP process is summarised as follows:

1. Consider the response planning need in terms of surface area (km^2) and available surface hydrocarbon volumes (m^3) against existing Woodside capability;
2. Consider alternative, additional, and improved options for each response technique/control measure by providing an initial and, if required, detailed evaluation of:
    - predicted cost associated with adopting the control measure
    - predicted change/environmental benefit
    - predicted effectiveness/feasibility of the control measure.
3. Evaluate the risks and impacts of implementing the proposed response techniques, and any further control measures with associated environmental performance to manage these additional risks and impacts.

Woodside considers the risks and impacts from a hydrocarbon spill to have been reduced to ALARP when:

1. A structured process for identifying and considering alternative, additional, and improved options has been completed for each selected response technique

2. The analysis of alternate, additional, and improved control measures meets one of the following criteria:
    - all identified, reasonably practicable control measures have been adopted
    - no identified reasonably practicable additional, alternative and/or improved control measures would provide further overall increased proportionate environmental benefit; or
    - no reasonably practical additional, alternative, and/or improved control measures have been identified.
3. Where an alternative, additional and/or improved control measure is adopted, a measurable level of environmental performance has been assigned
4. Higher order impacts/ risks have received more comprehensive alternative, additional, and improved control measure evaluations and do not just compare the cost of the adopted control measures to the costs of an extreme or clearly unreasonable control measure
5. Cumulative effects have been analysed when considered in combination across the whole activity.

The response technique selection is based on the risk assessment conducted in the EP. The risk assessment identifies the type of oil, volume of release, duration of release, predicted fate, weathering and the EMBA (along with other requirements such as time to impact and predicted volumes ashore). Modelling is then used to inform the SIMA and the prioritisation of suitable response options. The scale of the response techniques selected in the pre-operational SIMA is informed through the assessment of results from deterministic modelling.

6 OPERATIONAL AND SCIENTIFIC MONITORING

6.1 Operational monitoring

Operational monitoring includes the gathering and evaluation of data to inform the oil spill response planning and operations. It includes fate and trajectory modelling, spill tracking, weather updates and field observations. This response option is deployed in some capacity for every event.

Woodside maintains an *Operational Monitoring Operational Plan*. If shoreline contact is predicted, Response Protection Areas (RPAs) will be identified and assessed before contact. If shorelines are contacted, a shoreline assessment survey will be completed to guide effective shoreline clean-up operations. This plan includes the process for the Incident Management Team to mobilise resources depending on the nature and scale of the spill.

Table 6-1 provides details of Woodside's operational monitoring plans that support the successful execution of this response technique.

Table 6-1: Operational monitoring objectives, triggers and termination criteria

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 1 (OM01) Predictive Modelling of Hydrocarbons to Assess Resources at Risk	OM01 focuses on the conditions that have prevailed since a spill commenced, as well as those that are forecasted in the short term (1–3 days ahead) and longer term. OM01 utilises computer-based forecasting methods to predict hydrocarbon spill movement and guide the management and execution of spill response operations to maximise the protection of environmental resources at risk. The objectives of OM01 are to: • Provide forecasting of the movement and weathering of spilled hydrocarbons. • Identify resources that are potentially at risk of contamination. • Provide simulations showing the outcome of alternative response options (booming patterns etc.) to inform on-going Spill Impact Mitigation Assessment (SIMA) and continually assess the efficacy of available response options in order to reduce risks to ALARP.	OM01 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM01 are: • The hydrocarbon discharge has ceased and no further surface oil is visible. • Response activities have ceased. • Hydrocarbon spill modelling (as verified by OM02 surveillance observations) predicts no additional natural resources will be impacted.
Operational Monitoring Operational Plan 2 (OM02) Surveillance and reconnaissance to detect hydrocarbons and resources at risk	OM02 aims to provide regular, on-going hydrocarbon spill surveillance throughout a broad region, in the event of a spill. The objectives of OM02 are: • Verify spill modelling results and recalibrate spill trajectory models (OM01). • Understand the behaviour, weathering and fate of surface hydrocarbons. • Identify environmental receptors and locations at risk or contaminated by hydrocarbons. • Inform ongoing SIMA and continually assess the efficacy of available response options in order to reduce risks to ALARP.	OM02 will be triggered immediately following a level 2/3 hydrocarbon spill.	The termination triggers for the OM02 are: • 72 hours has elapsed since the last confirmed observation of surface hydrocarbons. • Latest hydrocarbon spill modelling results (OM01) do not predict surface exposures at visible levels.

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
	• To aid in the subsequent assessment of the short- to long-term impacts and/or recovery of natural resources (assessed in SMPs) by ensuring that the visible cause and effect relationships between the hydrocarbon spill and its impacts to natural resources have been observed and recorded during the operational phase.		
Operational Monitoring Operational Plan 3 (OM03) Monitoring of hydrocarbon presence, properties, behaviour and weathering in water	OM03 will measure surface, entrained and dissolved hydrocarbons in the water column to inform decision-making for spill response activities. The specific objectives of OM03 are as follows: • Detect and monitor for the presence, quantity, properties, behaviour and weathering of surface, entrained and dissolved hydrocarbons. • Verify predictions made by OM01 and observations made by OM02 about the presence and extent of hydrocarbon contamination. Data collected in OM03 will also be used for the purpose of longer-term water quality monitoring during SM01.	OM03 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM03 are as follows: • The hydrocarbon release has ceased. • Response activities have ceased. • Concentrations of hydrocarbons in the water are below available ANZECC/ ARMCANZ (2018) trigger values for 99% species protection.
Operational Monitoring Operational Plan 4 (OM04) Pre-emptive assessment of sensitive receptors at risk	OM04 aims to undertake a rapid assessment of the presence, extent and current status of shoreline sensitive receptors prior to contact from the hydrocarbon spill, by providing categorical or semi-quantitative information on the characteristics of resources at risk. The primary objective of OM04 is to confirm understanding of the status and characteristics of environmental resources predicted by OM01 and OM02 to be at risk, to further assist in making decisions on the selection of appropriate response actions and prioritisation of resources. Indirectly, qualitative/semi-quantitative pre-contact information collected by OM04 on the status of environmental resources may also aid in the verification of environmental baseline data and	Triggers for commencing OM04 include: • Contact of a sensitive habitat or shoreline is predicted by OM01, OM02 and/or OM03. • The pre-emptive assessment methods can be implemented before contact from hydrocarbons (once a receptor has been contacted by	The criteria for the termination of OM04 at any given location are: • Locations predicted to be contacted by hydrocarbons have been contacted. • The location has not been contacted by hydrocarbons and is no longer predicted to be contacted by hydrocarbons (resources should be reallocated as appropriate).

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
	provide context for the assessment of environmental impacts, as determined through subsequent SMPs. OM04 would be undertaken in liaison with WA DoT as the control agency once the oil is in State Waters (if a Level 2/3 incident).	hydrocarbons it will be assessed under OM05).	
Operational monitoring operational plan 5 (OM05) Monitoring of contaminated resources	OM05 aims to implement surveys to assess the condition of wildlife and habitats contacted by hydrocarbons at sensitive habitat and shoreline locations. The primary objectives of OM05 are: • Record evidence of oiled wildlife (mortalities, sub-lethal impacts, number, extent, location) and habitats (mortalities, sub-lethal impacts, type, extent of cover, area, hydrocarbon character, thickness, mass and content) throughout the response and clean-up at locations contacted by hydrocarbons to inform and prioritise clean-up efforts and resources, while minimising the potential impacts of these activities. Indirectly, the information collected by OM05 may also support the assessment of environmental impacts, as determined through subsequent SMPs. OM05 would be undertaken in liaison with WA DoT as the control agency once the oil is in State Waters (if a Level 2/3 incident).	OM05 will be triggered when a sensitive habitat or shoreline is predicted to be contacted by hydrocarbons by OM01, OM02 and/or OM03.	The criteria for the termination of OM05 at any given location are: • No additional response or clean-up of wildlife or habitats is predicted. • Spill response and clean-up activities have ceased. OM05 survey sites established at sensitive habitat and shoreline locations will continue to be monitored during SM02. The formal transition from OM05 to SM02 will begin on cessation of spill response and clean-up activities.

6.2 Oil spill scientific monitoring program

A Scientific Monitoring Program (SMP) would be activated following a significant unplanned hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. This would consider receptors at risk (ecological and socio-economic) for the entire predicted Environment that Maybe Affected (EMBA) and in particular, any identified Pre-emptive Baseline Areas (PBAs) for the credible spill scenario(s) or other identified unplanned hydrocarbon releases associated with the operational activities.

Mobilisation of field teams for the activated SMPs could generally be achieved within 7-10 days of notification of a spill occurring.

Key primary aim of the SMP is to determine the magnitude of environmental impacts arising from a hydrocarbon spill, where magnitude has extent, severity and persistence (including recovery) dimensions.

The SMP comprises ten targeted environmental monitoring programs to assess the condition of a range of physico-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act listed species, environmental values associated with protected areas and socio-economic values, such as fisheries. Woodside's ten Scientific Monitoring programs are detailed in Table 6-2 alongside their objectives, activation triggers and termination criteria.

These SMPs have been designed to cover all key tropical and temperate habitats and species within Australian waters and broader, if required.

These SMPs are subject to change from time to time and will be finalized as part of the proposed Browse to NWS Project secondary approval documentation.

Table 6-2: Oil Spill Scientific Monitoring Program – Objectives, Activation Triggers and Termination Criteria

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
Scientific monitoring program 1 (SM01) Assessment of Hydrocarbons in Marine Waters	SM01 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine waters following the spill and the response. The specific objectives of SM01 are as follows: • Assess and document the extent, severity and persistence of hydrocarbon contamination with reference to observations made during surveillance activities and / or in-water measurements made during operational monitoring. • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM01 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors	SM01 will be terminated when: • Operational monitoring data relating to observations and / or measurements of hydrocarbons on and in water have been compiled, analysed and reported. • The report provides details of the extent, severity and persistence of hydrocarbons which can be used for analysis of impacts recorded for sensitive receptors monitored under other SMPs. SMP monitoring of sensitive receptor sites: • Concentrations of hydrocarbons in water samples are below NOPSEMA guidance note (2019[3]) concentrations of 1 g/m2 for floating, 10 ppb for entrained and dissolved. • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in water have been documented at sensitive receptor sites monitored under other SMPs.
Scientific monitoring program 2 (SM02) Assessment of the Presence, Quantity and Character of Hydrocarbons in Marine Sediments	SM02 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine sediments following the spill and the response. The specific objectives of SM02 are as follows: • Determine the extent, severity and persistence of hydrocarbons in marine sediments across selected sites where hydrocarbons were observed or recorded during operational monitoring. • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM02 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • Response activities have ceased. • Operational monitoring results made during the response phase indicate that shoreline, intertidal or sub-tidal sediments have been exposed to surface, entrained or dissolved hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation).	SM02 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Concentrations of hydrocarbons in sediment samples are below ANZECC/ ARMCANZ (2013[4]) sediment quality guideline values (SQGVs) for biological disturbance. • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in sediments have been documented.
Scientific monitoring program 3 (SM03) Assessment of Impacts and Recovery of Subtidal and Intertidal Benthos	The objectives of SM03 are: • Characterize the status of intertidal and subtidal benthic habitats and quantify any impacts to functional groups, abundance and density that may be a result of the spill. • Determine the impact of the hydrocarbon spill and subsequent recovery (including impacts associated with the implementation of response options). Categories of intertidal and subtidal habitats that may be monitored include: • Coral reefs • Seagrass • Macro-algae • Filter-feeders SM03 will be supported by sediment contamination records (SM02) and characteristics of the spill derived from OMPs.	SM03 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of PBAs of receptor locations identified by time to hydrocarbon contact >10 days, to target receptors and sites where it is possible to acquire pre-hydrocarbon contact baseline; and • Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) for subtidal and intertidal benthic habitat.	SM03 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Overall impacts to benthic habitats from hydrocarbon exposure have been quantified. • Recovery of impacted benthic habitats has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

[3] NOPSEMA (2019) Bulletin #1 – Oil spill modelling – April 2019, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf
[4] Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO and Water Science Report 08/07. Land and Water, pp. 132.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
Scientific monitoring program 4 (SM04) Assessment of Impacts and Recovery of Mangroves / Saltmarsh	The objectives of SM04 are: • Characterize the status of mangroves (and associated salt marsh habitat) at shorelines exposed/contacted by spilled hydrocarbons. • Quantify any impacts to species (abundance and density) and mangrove/saltmarsh community structure. • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options). SM03 will be supported by sediment sampling undertaken in SM02 and characteristics of the spill derived from OMPs.	SM04 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days. • Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) for mangrove/saltmarsh habitat.	SM04 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Impacts to mangrove and saltmarsh habitat from hydrocarbon exposure have been quantified. • Recovery of impacted mangrove/saltmarsh habitat has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 5 (SM05) Assessment of Impacts and Recovery of Seabird and Shorebird Populations	The Objectives of SM05 are to: • Collate and quantify impacts to avian wildlife from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population level. • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to seabirds and shorebird populations at targeted breeding colonies / staging sites / important coastal wetlands where hydrocarbon contact was recorded.	SM05 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days • Operational monitoring predicts shoreline contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at important bird colonies / staging sites / important coastal wetland locations. • Records of dead, oiled or injured bird species made during the hydrocarbon spill or response.	SM05 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to seabird and shorebird populations from hydrocarbon exposure have been quantified. • Recovery of impacted seabird and shorebird populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 6 (SM06) Assessment of Impacts and Recovery of Nesting Marine Turtle Populations	The objectives of SM06 are to: • To quantify impacts of hydrocarbon exposure or contact on marine turtle nesting populations (including impacts associated with the implementation of response options). • Collate and quantify impacts to adult and hatchling marine turtles from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels (including impacts associated with the implementation of response options). • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to nesting marine turtle populations at known rookeries (including impacts associated with the implementation of response options).	SM06 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days. • Predicted shoreline contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at known marine turtle rookery locations. or • Records of dead, oiled or injured marine turtle species made during the hydrocarbon spill or response.	SM06 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to nesting marine turtle populations from hydrocarbon exposure have been quantified. • Recovery of impacted nesting marine turtle populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 7 (SM07) Assessment of Impacts to Pinniped Colonies including Haul-out Site Populations	The objectives of SM07 are to: • Quantify impacts on pinniped colonies and haul-out sites as a result of hydrocarbon exposure/contact. • Collate and quantify impacts to pinniped populations from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels.	SM07 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days • Identified shoreline contact of hydrocarbons ((at or above 0.5 g/m^2 surface, ≥5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at known pinniped colony or haul-out site(s) (i.e. most northern site is the Houtman Abrolhos Islands). or • Records of dead, oiled or injured pinniped species made during the hydrocarbon spill or response.	SM07 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to pinniped populations from hydrocarbon exposure have been quantified. • Recovery of pinniped populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
Scientific monitoring program 8 (SM08) Desk-Based Assessment of Impacts to Other Non-Avian Marine Megafauna	The objective of SM08 is to provide a desk-based assessment which collates the results of OM02 and OM05 where observations relate to the mortality, stranding or oiling of mobile marine megafauna species not addressed in SM06 or SM07, including: • Cetacean; • Dugongs • Whale sharks and other shark and ray populations • Sea snakes • Crocodiles. The desk-based assessment will include population analysis to infer potential impacts to marine megafauna species populations.	SM08 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring reports records of dead, oiled or injured non-avian marine megafauna during the spill/ response phase.	SM08 will be terminated when the results of the post-spill monitoring have quantified impacts to non-avian megafauna. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 9 (SM09) Assessment of Impacts and Recovery of Marine Fish associated with SM03 habitats	The objectives of SM09 are: • Characterise the status of resident fish populations associated with habitats monitored in SM03 exposed/contacted by spilled hydrocarbons • Quantify any impacts to species (abundance, richness and density) and resident fish population structure (representative functional trophic groups). • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options).	SM09 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented with SMO3.	SM09 will be undertaken and terminated concurrent with monitoring undertaken for SM03, as per the SMP termination criteria process • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 10 (SM10) Assessment of physiological impacts important fish and shellfish species (fish health and seafood quality/safety) and recovery	SM10 aims to assess any physiological impacts to important commercial fish and shellfish species (assessment of fish health) and if applicable, seafood quality/safety. Monitoring will be designed to sample key commercial fish and shellfish species and analyse tissues to identify fish health indicators and biomarkers, for example: • Liver Detoxification Enzymes (ethoxyresorufin-O-deethylase (EROD) activity) • PAH Biliary Metabolites • Oxidative DNA Damage • Serum SDH • Other physiological parameters, such as condition factor (CF), liver somatic index (LSI), gonado-somatic index (GSI) and gonad histology, total weight, length, condition, parasites, egg development, testes development, abnormalities. Seafood tainting may be included (where appropriate) using applicable sensory tests to objectively assess targeted finfish and shellfish species for hydrocarbon contamination. Results will be used to make inferences on the health of commercial fisheries and the potential magnitude of impacts to fishing industries.	SM10 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring (OM01, OM02 and OM05) indicates the following: • The hydrocarbon spill will or has intersected with active commercial fisheries or aquaculture activities. • Commercially targeted finfish and/or shellfish mortality has been observed/recorded. • Commercial fishing or aquaculture areas have been exposed to hydrocarbons (≥0.5 g/m^2 surface and ≥5 ppb for entrained/dissolved hydrocarbons); and • Taste, odour or appearance of seafood presenting a potential human health risk is observed.	SM10 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Physiological impacts to important commercial fish and shellfish species from hydrocarbon exposure have been quantified. • Recovery of important commercial fish and shellfish species from hydrocarbon exposure has been evaluated. • Impacts to seafood quality/safety (if applicable) have been assessed and information provided to the relevant stakeholders and regulators for the management of any impacted fisheries. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

6.2.1 Receptors at risk and baseline knowledge

In order to assess the baseline studies available and suitability for oil spill scientific monitoring, Woodside maintains knowledge of environmental baseline studies through the upkeep and use of its Environmental Knowledge Management System.

Woodside's Environmental Knowledge Management System is a centralised platform for scientific information on the existing environment, marine biodiversity, Woodside environmental studies, key environmental impact topics, key literature and web-based resources. The system comprises a number of data directories and an environmental baseline database. The environmental baseline database was set up to support Woodside's SMP preparedness and as a SMP resource in the event of an unplanned hydrocarbon spill. The environmental baseline database is subject to updates including annual reviews completed as part of the SMP standby contract. This database is accessed pre-PAP to identify Pre-emptive Baseline Areas (PBAs) where hydrocarbon contact is predicted to occur <10 days.

In addition to Woodside's Environmental Knowledge Management System, it is acknowledged that many relevant baseline datasets are held by other organisations (e.g. other oil and gas operators, government agencies, state and federal research institutions and non-governmental organisations). In order to understand the present status of environmental baseline studies a spatial environmental metadata database for Western Australia known as the Industry-Government Environmental Metadata (IGEM) was established. IGEM is a collaboration comprising oil and gas operators (including Woodside), government and research agencies and other organisations. IGEM-held data was integrated into the Department of Water and Environmental Regulation (WA) Index of Marine Surveys for Assessment (IMSA)[5] in 2020. The Index of Marine Surveys for Assessments (IMSA) is an online portal to information about marine-based environmental surveys in Western Australia. IMSA is a project of the Department of Water and Environmental Regulation for the systematic capture and sharing of marine data created as part of an environmental impact assessment (EIA). In the event of an unplanned hydrocarbon release, Woodside intends to interrogate the information on baseline studies status as held by the various databases (e.g. Woodside Environmental Knowledge Management System, IMSA and other sources of existing baseline data) to identify Pre-emptive Baseline Areas (PBAs), i.e., receptors at risk where hydrocarbon contact is predicted to be >10 days, and baseline data can be collected before hydrocarbon contact.

[5] https://biocollect.ala.org.au/imsa#max%3D20%26sort%3DdateCreatedSort

7 ADDITIONAL SUPPORTING INFORMATION

7.1 Interpretation of Scott Reef recovery potential following a 13-day loss of well control event

In preparing the Browse to NWS draft EIS/ERD, modelling was conducted to predict consequences and hydrocarbon fate and dispersion following a range of spill events, including a well loss of containment. As per Regulatory guidance, this modelling estimated the consequence of the spill occurring unconstrained for a duration of 77-days. The 77-day period was estimated based on early information regarding rig mobilisation time and relief well drill time.

Within this HSRMPA, commitments are made that a capping stack would be mobilised to any well experiencing a loss of containment event within 13 days of the event occurring. Successful deployment of a capping stack would stop the flow of hydrocarbons to the environment. To understand the environmental outcomes of this event, oil spill modeling of this scenario was performed for a 13-day spill to the equivalent well loss of containment event contained in the draft EIS/ERD. The results of this modelling are shown in **Appendix A.**

As is logical, the modelling predictions showed a marked reduction in the volume of hydrocarbons released to the Scott Reef environment after a 13-day as compared to 77-day event, reducing the potential for chronic hydrocarbon exposure impacts to the environment and Scott Reef system.

Based on these modelling results, an interpretation is provided to support, that following a 13-day spill event as described, it is predicted that the ecological integrity of Scott Reef would be expected to recover back to levels representing a maximum level of ecological protection (LEP) (refer to **Section 7.1.5.2** for the definition of maximum LEP.

This interpretation is support by results of the AIMS long term monitoring program at Scott Reef which have tracked the condition of shallow coral communities and fish assemblages over 28 years. The long-term reef condition pre-disturbance and post disturbance of this remote reef system's transition from degraded to healthy to degraded states is well documented (refer to Gilmour et al., 2013 and 2022). Based on coral recovery documented for extreme heat stress and wave damage events at Scott Reef, it is predicted that the coral communities (measured as estimates of live coral cover) are expected to recover in a timeframe of over a decade to several decades. This outcome assumes local water quality and fish stocks are largely unaffected in the longer term, as is credible. Such recovery predictions include a return to ecological integrity and a maximum level of ecological protection. However, as has been documented (see Gilmour *et al*. 2022), shifts in community structure (sliding baselines) are likely to continue and be compounded by future disturbance regimes.

Detailed evaluation supporting these predictions are outlined below.

7.1.1 The hydrocarbon spill scenario evaluated

A short-term (13 day) uncontrolled release of 24,000 m^3 unstabilised, Torosa condensate from TRC (previously named TRA-C) well, with a five-day surface release phase followed by an eight-day subsea release phase, representing loss of containment after a loss of well control was modelled (**Appendix A**). The hydrocarbon budget breakdown (condensate fate) calculated for the total released hydrocarbon volume for each release phase based on the characteristics of the Torosa condensate was as follows:

Surface:

- Evaporate within first 24 hrs of exposure = 3,960 m^3 (16.5%)

- Longer evaporation component over several days (low-volatility fraction) = 7,872 m^3 (32.8%)
- Residual fraction = 12,168 m^3 (50.7%).

Subsea:

- Evaporate within first 24 hrs of exposure = 13,056 m^3 (54.4%)
- Longer evaporation component over several days (low-volatility fraction) = 4,968 m^3 (20.7%)
- Residual fraction = 5,976 m^3 (24.9%).

To predict hydrocarbon impacts to Scott Reef ecological thresholds for hydrocarbon exposure were applied as shown in **Table 7-1**.

Table 7-1: Ecological impact thresholds applied to the deterministic hydrocarbon spill modelling to predict potential environmental impacts

Hydrocarbon type	Surface hydrocarbons (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Accumulated hydrocarbons (g/m^2)
Torosa condensate	10	50	100	100

7.1.2 Hydrocarbon spill modelling results

The 13-day spill scenario represents a marked reduction in the volume of Torosa condensate released (24,000 m^3) and a predicted reduction of 59,904 m^3 (surface) and 29,420 m^3 (subsea) residual fraction in the waters over Scott Reef as compared to the loss of well containment (well blowout) presented in the proposed Browse to NWS Project draft EIS/ERD (Woodside, 2019)[6]. Controlling a loss of well containment at source via a capping stack would be an effective way to limit the quantity of hydrocarbon entering the marine environment and as outlined in this document, source control measures to reduce the consequence of a hydrocarbon spill include targeting deployment of a capping stack within 13 days will be applied.

The results presented by the deterministic modelling (RPS, 2022) are summarised in Table 7-2 and show minimum times to contact to sensitive receptors including north and South Scott Reef.

Table 7-2: A summary of the deterministic modelling results for the short-term (13 day) uncontrolled release of 24, 000 m3 of unstabilised Torosa condensate from TRA-C well (data source: RPS, 2022)

Scenario	Model parameter	Summary
A short-term (13 day) uncontrolled release of 24,000 m^3 unstabilised, Torosa Condensate from TRA-C well, with a 5-day surface release	Floating	Exposure above the threshold of ≥ 10 g/m^2 are predicted to occur within 5 hours for North Scott Reef and 18 hours for South Scott Reef.

[6] Scenario 1 (worst-case credible hydrocarbon spill) was for a long-term 77-day uncontrolled release of 142,154 m3 of unstabilised Torosa condensate

phase followed by an 8-day subsea release phase, representing loss of containment after a loss of well control.		Sandy Islet, Scott Reef predicted to be contacted at levels ≥10 g/m^2 within 52 hours
	Entrained	Exposures above the threshold of ≥100 ppb are predicted to occur within 7 hours for North Scott Reef and 15 hours for South Scott Reef. Maximum entrained hydrocarbon concentrations at any depth were: 4,359 ppb at North Scott Reef and 2,589 ppb for Scott Reef South - Lagoon
	Dissolved	Maximum dissolved aromatic hydrocarbon concentrations at any depth were: 3,403 ppb at North Scott Reef and 2, 539 ppb for Scott Reef South - Lagoon
	Shoreline	Maximum shoreline accumulation for Scott Reef Sandy Islet was 10,051 g/m^2
Note: Exposure/Contact equals hydrocarbon concentrations that exceed threshold. For dissolved aromatic hydrocarbons these are assumed to extend from the sea surface and to depths of approximately 20 m (subsea plume).		

Scott Reef spans approximately 100 km, consisting of three atoll reefs approximately 20 km in length. Hydrocarbon contact for the three reefs over the modelled five-week period is show in **Figure 7-1**.

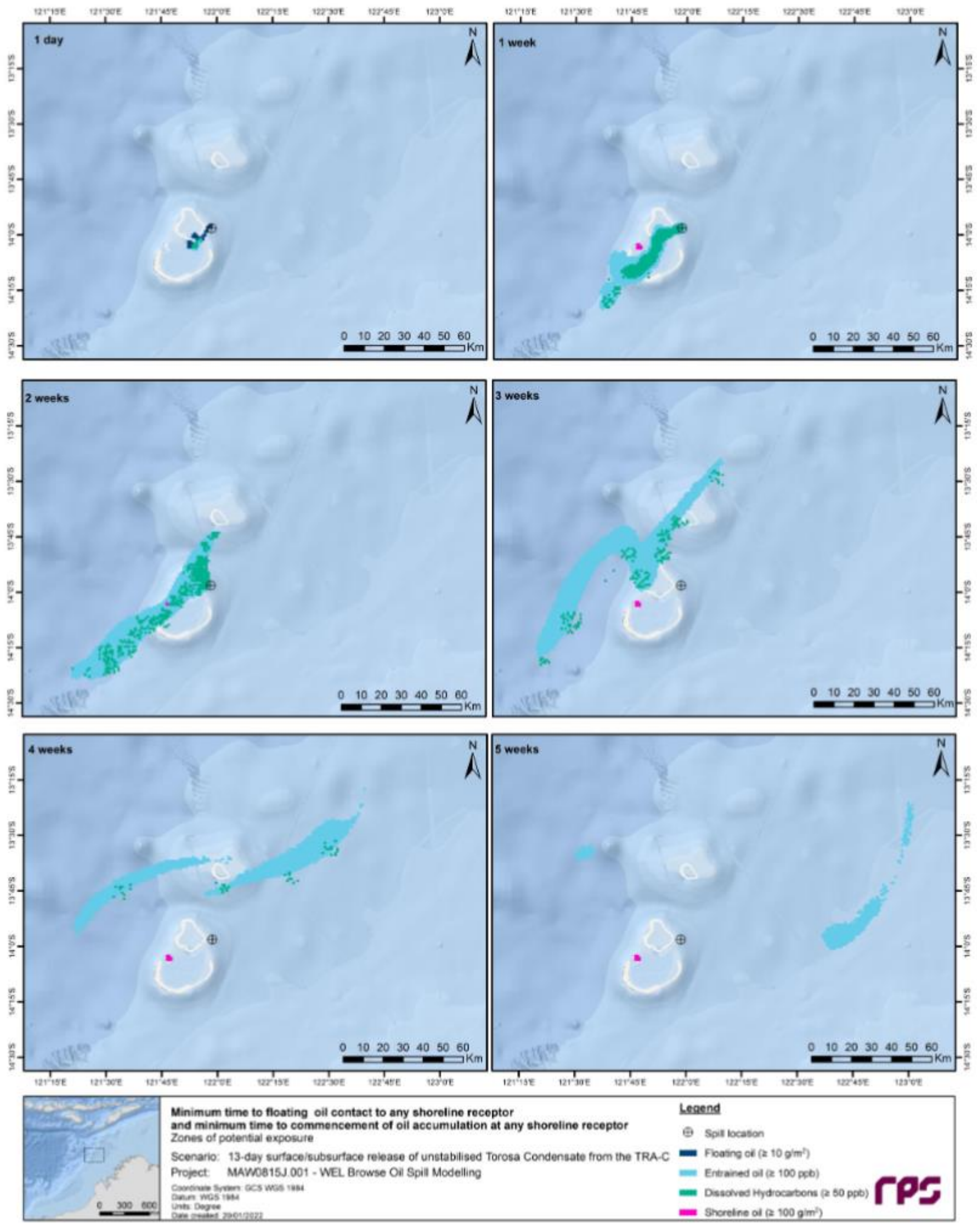

Figure 2.1 Time-varying areal extent of potential exposure at defined floating oil, entrained oil, dissolved aromatic hydrocarbon and shoreline oil threshold concentrations, resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the minimum time to floating oil contact with the offshore edge of any shoreline receptor polygon (at a threshold of 10 g/m^2) and the minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2).

Figure 7-1: Deterministic hydrocarbon spill trajectories for Scott Reef for the short-term scenario – 13 days surface/subsurface blowout of unstabilised Torosa condensate at the TRA-C well. Data source: RPS (2022)

7.1.3 Predicted impacts to corals and coral communities from hydrocarbon exposure

Potential impacts to coral communities in the highly unlikely event of a hydrocarbon release are related to the types and volumes of the hydrocarbon fates that are predicted to contact Scott Reef. The primary impacts are from exposure to floating hydrocarbons through smothering and coating, and exposure to dissolved and entrained hydrocarbons that may result in lethal and sublethal toxicity impacts to corals, other sensitive sessile benthos and mobile invertebrates and vertebrates (fishes) within the upper water column (<20 m depth), including upper reef slopes (subtidal corals) and reef flats (inter-tidal corals), as documented in Section 6.3.21.4 of the Browse to NWS Project draft EIS/ERD (Woodside, 2019).

Further research on toxicity thresholds applicable to tropical marine systems has been published and further support the 50 ppb threshold concentration for dissolved hydrocarbons which is based on poly-aromatic hydrocarbons (PAHs) in the absence of ultraviolet radiation (UVR). The applied dissolved hydrocarbon threshold is lower than that identified by Negri *et al*. (2021) based on a chronic protection threshold for 95% of species and the recommended Target Lipid Model (TLM) threshold for tropical marine ecosystems. It is also applicable to sub-surface blowouts where mono-aromatic hydrocarbons (MAHs) comprise a high proportion of the dissolved hydrocarbons (Negri *et al*. 2021). The thresholds do not account for high levels of UVR which shallow tropical reefs are routinely exposed to and can lead to substantial increases in the toxicity of some oil components through phototoxicity (French-McCay *et al*. 2018; Nordborg *et al*. 2020). Deepwater horizon oil spill comparative risk assessment modelling to evaluate different spill response options applied a surface hydrocarbon threshold of 10 g/m^2 as this is viewed as a conservative, lower threshold for all wildlife and LC50s in the range of 10 ppb for sensitive early life stages to several 100 ppb for less sensitive species and older life stages (French-McCay *et al*. 2018). These hydrocarbon concentration values were similar to results published for coral larvae (Negri *et al.* 2016 and 2021) and adult corals (Turner *et al*. 2021).

7.1.4 Predictions of Scott Reef recovery following a 13-day well loss of containment scenario (13-day release from TRC Well)

The long-term monitoring at Scott Reef by AIMS, funded by the BJV, has afforded remarkable insights into the recovery of remote coral reef systems from acute disturbance (i.e., heat stress and mass bleaching; damaging waves generated by storms and cyclones), Gilmour *et al.,* 2013 and 2022. For the purposes of this assessment, it is assumed that similar patterns of shallow coral community recovery from mass bleaching events (with reference to scale and severity), can be applied to predict the recovery of Scott Reef following an unplanned, highly unlikely release of hydrocarbons. No account of chronic ongoing residual toxicity effects from hydrocarbons is made in this assessment.

Based on the expert opinion report on recovery trajectories of coral communities at Scott Reef (AIMS, 2014) impacts to coral communities at Scott Reef were grouped into shallow-water (≤20 m depth) and deep-water (≥20 m depth). Deep-water communities are located only in the South Reef lagoon and based on the deterministic modelling predictions for dissolved hydrocarbon subsea plumes do not extend below 20 m depth (RPS, 2022), it is therefore assumed that South Reef lagoon is not impacted. Shallow-water coral communities include reef slope habitats at North and South Reef and the lagoon at North Reef (**Figure 7-2**). The reef flat habitat while considered most vulnerable to direct exposure from surface (floating) hydrocarbons supports extremely low coral cover and species diversity and is not included further in the recovery assessment. Hydrocarbon spill exposure will impact the upper slope coral communities. Impact predictions are summarised in Table 7-3, based on the definition of ecological integrity for Scott Reef. Exposure of corals to hydrocarbons in these shallow reef environments of Scott Reef is likely to be patchy and variable depending on the hydrocarbon concentrations and durations of exposure for different areas of the three reefs in the highly unlikely event of a hydrocarbon spill.

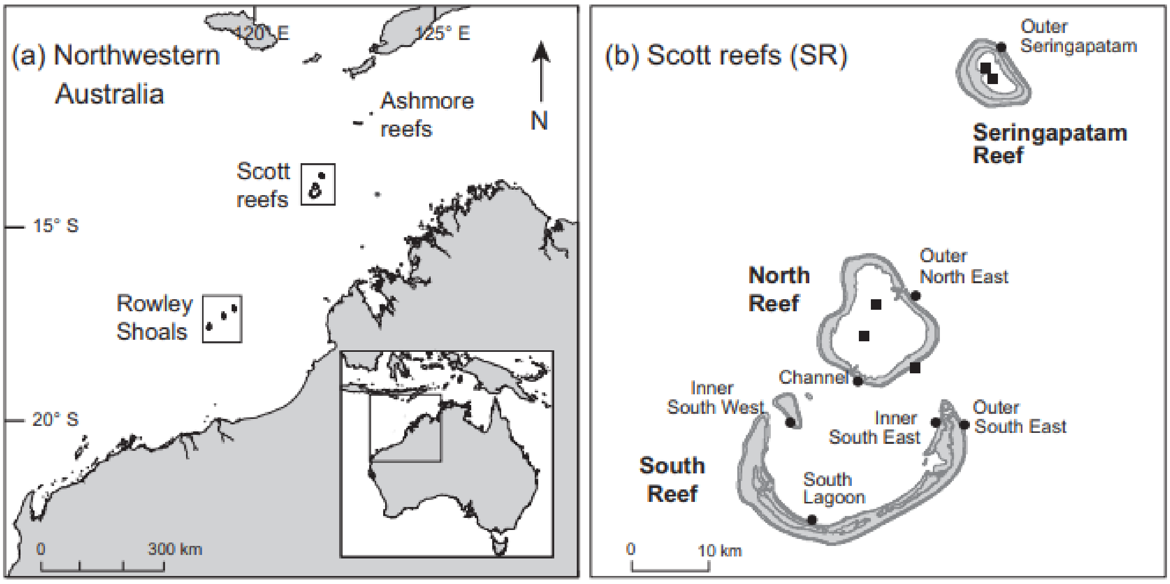

Figure 7-2: Location of Scott Reef and the AIMS' long-term monitoring sites (source: Gilmour et al. 2022)

Table 7-3: Predicted impacts to the coral communities of Scott Reef based on the definition of ecological integrity

Criterion	Attributes	Predicted impact from hydrocarbon spill (13 days)
Abiotic	Oceanographic processes	No impact
	Geomorphology	No impact
	Water quality	Impact – temporary reduction in water quality for multiple weeks at ecological impact hydrocarbon threshold concentrations for floating, dissolved and entrained hydrocarbon fates.
Biotic	Live coral cover	Significant impact though patchy and variable across the affected shallow coral communities. Hydrocarbon exposure above ecological thresholds for the 13-day release are predicted to mainly impact the upper slope, shallow coral communities of South and North Scott Reef and the shallow water North Scott Reef lagoon.
	Coral composition	Significant impact to the mixed coral, branching *Acropora*, *Isopora*, massive *Porites* and soft corals is predicted for all North Scott Reef coral communities, and west and south coral communities of South Scott Reef. The eastern side of South Scott Reef is predicted to experience sublethal/low mortality impacts. Common *Acropora* branching corals have been reported as more susceptible to hydrocarbon exposure than *Porites* massive corals (Yender and Michel, 2010). Assuming parallels in recovery as documented for Scott Reef from mass bleaching and storm events as documented by

Criterion	Attributes	Predicted impact from hydrocarbon spill (13 days)
		Gilmour et al. (2022), life history variation will influence both susceptibility to disturbance and subsequent recovery. Gilmour *et al.* (2022) documented regrowth of injured corals at the least affected communities (composed of corals species such as massive *Porites*) within three years and within five years recorded rapid increases in the cover of the most susceptible corals (including *Acropora*) had occurred. It is noted, however, similar to mass bleaching events at Scott Reef rarer, more susceptible coral taxa may not recover. Furthermore, there will be variation in impacts and recovery among communities across the reef system. Recovery of impacted coral communities is predicted to be in the order of >decade to several decades.
	Algal cover and composition (turf vs macroalgae)	Significant impacts are possible and mixed responses across the different macroalgal groupings (green, brown and reds) and corallines (critical to coral larvae settlement) ranging from no impact to declines in abundance, sublethal impacts (impaired photosynthetic ability) and inhibited growth (Keesing *et al*. 2018).
	Fish assemblages and trophic functional groups (herbivores and piscivores)	Significant impacts possible due to potential exposure to dissolved and entrained hydrocarbons. Fish mortalities are rarely observed as a result of hydrocarbon spills (ITOPF, 2011), however this is generally associated with pelagic fish that reportedly can detect and avoid surface waters underneath hydrocarbon spills by moving into deeper water or away from affected areas. Coral reef site-attached fish will experience a high likelihood of impact either directly or indirectly, with the loss of refuge due to impacts to coral structure in reef areas with highest impacts, i.e., coral mortality.
	Coral recruitment	Adult coral reproduction impairment due to hydrocarbon exposure or a spill coinciding with a primary mass coral spawning period may result in the loss of coral recruitment for that year. Coral recruitment is dependent on the survival and regrowth of adult coral colonies within the Scott Reef system. Given the reproductively closed system, it is imperative that coral larval sources survive and/or recover and the deterministic spill modelling indicates areas of the reef system will not be significantly impacted and will remain a source of coral recruitment.

Recovery

Gilmour *et al*. (2013) documented the recovery of Scott Reef from the mass bleaching event of 1998 was within 12 years based on coral cover, recruitment, generic diversity, and community structure to levels similar to the pre-bleaching years. The recovery from the 1998 mass bleaching may have been even faster if not for a series of more moderate disturbances, including two cyclones, an outbreak of coral disease and a second bleaching event. The published research demonstrated that even coral reefs with a negligible supply of larvae from outside sources can recover relatively quickly from disturbances in the absence of chronic human pressures. An extended long-term data series for Scott Reef and analysis of a second extreme heat stress and mass bleaching event in 2016, showed a disproportionate loss of susceptible coral groups resulting in homogenized communities across Scott Reef, with post-bleaching structure in 1998 and 2016 being more similar than any other time in more than two decades (Gilmour *et al.*, 2022). AIMS are currently documenting the status of the shallow coral communities surveyed in 2021.

Additional considerations:
The importance of maintaining reef fish trophic functional groups for coral recovery
Gilmour et al (2013) reported no phase shift to macroalgae dominated communities associated with the 80% decline in coral cover resulting from the 1998 mass bleaching event. The recorded high densities of herbivorous fishes also increased after the loss of coral, probably in response to the increased cover of turf algae. This finding suggests a surplus grazing capacity within the system that assisted subsequent coral recruitment and survival. Consequently, a high proportion of the coral larvae that were produced locally and settled actually survived. High survival and growth of corals resulted in rapid rates of transition through increasing colony size classes, with corresponding increases in brood stock and reproductive output. Reproductive output and recruitment were similar to pre-disturbance levels within a decade of the bleaching (Gilmour et al 2013). Findings relating to reef fish recovery for Floridian reefs impacted by Deepwater Horizon have shown changes in fish community structure, persistently low densities among certain fish groups (including herbivores) and lasting, community-wide impacts (Lewis *et al*., 2020). The available evidence suggests initial reef fish declines in 2010, likely reflected both mortality and emigration resulting from hydrocarbon exposure and resource limitations on impacted reefs. The dynamics of available substrate with coralline algae (needed for coral larvae settlement) and herbivorous fish inhibiting a phase shift to macroalgal dominated communities is critical to the recovery of Scott Reef in the highly unlikely event of a loss of well containment hydrocarbon spill.

Shifting baselines
Gilmour *et al*. (2022) discussed the future shifts in coral community structure and highlighted the need to consider long-term dynamics, and the mechanism driving local variation when assessing management strategies to slow the rate of degradation. In developing management strategies for the recovery of Scott Reef in the highly unlikely event but catastrophic consequences of an unplanned, large-scale hydrocarbon release the same suite of factors would need to be considered.

7.1.5 Definitions supporting this interpretation

7.1.5.1 Definition of ecological integrity for Scott Reef

Karr et al. (2022) defined ecological integrity as an ecological system able to support and maintain an adaptive biological system comprising the full range of parts and processes expected for that region, a system whose evolutionary legacy remains intact.

EPA (2016a) defines ecological integrity for benthic communities and habitats as ‘the composition, structure, function and processes of ecosystems, and the natural variation of these elements’.Obura et al. (2022) stated ‘coral reef ecological integrity is complex and includes functional, compositional, structural and spatial components and presents challenges when defining one of the most diverse, complex and variable ecosystems in the world’.
With consideration of the above definitions, ecological integrity of Scott Reef is presented as a suite of abiotic and biotic criterion and attributes and these are used to assess hydrocarbon spill impacts and recovery for a short-term (13 day) uncontrolled release of 24,000 m^3 unstabilised, Torosa Condensate from a well loss of containment event at a TRC well (previously named TRA-C) Table 7-4.

Table 7-4: Criterion and Attributes to define Scott Reef Ecological Integrity

Criterion	Attributes
Abiotic	Oceanographic processes
	Geomorphology
	Water quality
Biotic	Live coral cover
	Coral composition
	Algal cover and composition (turf vs macroalgae)
	Fish assemblages and trophic functional groups (herbivores and piscivores)
	Coral recruitment

7.1.5.2 Definition of Maximum level of ecological protection

The definition of Maximum level of ecological protection (LEP) as defined by EPA (2016b) is 'Activities to be managed so that there were no changes beyond natural variation in ecosystem processes, biodiversity, abundance, and biomass of marine life or in the quality of water, sediment and biota'.

7.2 Financial assurance for stakeholder compensation and environmental remediation

Under section 571(2) of the OPGGS Act titleholders are required to have and maintain sufficient financial assurance to meet the costs, expenses and liabilities that may arise in connection with carrying out petroleum activities, including those associated with responding to a major oil spill, as a prior condition of acceptance of an EP. This process requires titleholders to estimate the sum of the greatest reasonably credible costs, expenses and liabilities that may arise from a worst-case petroleum incident as described in the EP for the activity, which includes the cost of carrying out environmental monitoring of the impact of the petroleum incident and operational response measures required for containment, clean up and **remediation** of the environment. NOPSEMA will review evidence to demonstrate titleholders are compliant with this requirement prior to acceptance of each relevant EP.

While there is no equivalent legislative requirement in WA State Waters, Woodside will include an assurance/commitment that is equivalent to that required under S571(2) of the OPGGS Act within EPs prepared for activities within State Waters to avoid any doubt that the BJV will maintain sufficient financial assurance to meet the costs, expenses and liabilities that may arise in connection with carrying out petroleum activities, whether they are occurring in Commonwealth or State waters.

The BJV are committed to maintaining financial resources and capability and implementing all necessary action to fund remediation of natural resources impacted by any unplanned environmental impacts arising from unplanned loss of hydrocarbons from the project.

Compensation

Throughout our 65-year history, Woodside has not experienced any significant uncontrolled release of oil or gas to the environment as a result of loss of well control. This is testament to Woodside's focus on the safety of our people and protection of the environment in which we operate. The ability to effectively respond and recover in the highly unlikely event of a major incident is a key priority for Woodside. In the highly unlikely event of a major spill event from a Woodside well during the proposed Browse to NWS Project activities, Woodside will engage with stakeholders affected by the event. Potentially directly affected stakeholders are identified during the development of the EP. Woodside also has existing channels for stakeholders to contact Woodside including phone and email as outlined on our website and factsheets.

In the highly unlikely event of a major spill, there will be a process in place regarding compensation claims from anyone who believes they have suffered a financial loss as a result. the key principles in Woodside responding to compensation claims include but are not limited to simplicity, fairness and timeliness. Data required to support any claims include but are not limited to a description of the impact, records to demonstrate Woodside's legal liability, economic loss and, for commercial fishing licence holders, data such as spatial distribution and temporal trends in historic catch and effort data. Where there is a meaningful prospect that Woodside would be found to have legal liability, we may assess the claim and pay compensation. The process will be further outlined to stakeholders during the development of EPs for each activity.

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9 GLOSSARY & ABBREVIATIONS

9.1 Glossary

Term	Description / Definition
ALARP	Demonstration through reasoned and supported arguments that there are no other practicable options that could reasonably be adopted to reduce risks further.
Control	The means by which risk from events is eliminated or minimised.
Control measure (risk control measure)	The features that eliminate, prevent, reduce or mitigate the risk to environment associated with PAP.
Credible spill scenario	A spill considered by Woodside as representative of maximum volume and characteristics of a spill that could occur as part of the PAP.
Environment that may be affected	The summary of quantitative modelling where the marine environment could be exposed to hydrocarbons levels exceeding hydrocarbon threshold concentrations.
Incident	An event where a release of energy resulted in or had (with) the potential to cause injury, ill health, damage to the environment, damage to equipment or assets or company reputation.
Loss of Well Control	Uncontrolled flow of formation or other fluids. The flow may be to an exposed formation (an underground blowout) or at the surface (a surface blowout). Flow through a diverter Uncontrolled flow resulting from a failure of surface equipment or procedure
Preparedness	Measures taken before an incident in order to improve the effectiveness of a response
Reasonably practicable	... a computation ... made by the owner, in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) [showing whether or not] that there is a gross disproportion between them ... made by the owner at a point of time anterior to the accident. (Judgement: Edwards v National Coal Board [1949])
Receptors at risk	Physical, biological and social resources identified as at risk from hydrocarbon contact using oil spill modelling predictions.
Regulator	NOPSEMA are the Environment Regulator under the Environment Regulations.
Response technique	The key priorities and objectives to be achieved by the response plan Measures taken in response to an event to reduce or prevent adverse consequences.
Threshold	Hydrocarbon concentrations applied to the risk assessment to evaluate hydrocarbon spills.

9.2 Abbreviations

Abbreviation	Meaning
AHV	Anchor Handling Vessel
ALARP	As low as reasonably practicable
APPEA	Australian Petroleum Production and Exploration Association
BOP	Blowout Preventer
CF	Condition Factor
CICC	Corporate Incident Coordination Centre
DBCA	Western Australia Department of Biodiversity, Conservation and Attractions (former Western Australian Department of Parks and Wildlife)
DGP	Detailed Completions Guideline
DDP	Detailed Drilling Program
DDR	Daily Drilling Reports
EMBA	Environment that May Be Affected
FIT	Formation Integrity Tests
FSP	First Strike Plan
GSI	Gonado-somatic index
IOGP	International Association of Oil and Gas Producers
IPIECA	International Petroleum Industry Environment Conservation Association
ITOPF	International Tanker Owners Pollution Federation
KBOS	Kinetic blow out stopper
LSI	liver somatic index
LOT	Leak-off Tests
NEBA	Net Environmental Benefit Analysis
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OM	Operational Monitoring
OPEA	Oil Pollution Emergency Arrangements
OPEP	Oil Pollution Emergency Plan
OSPRMA	Oil Spill Preparedness and Response Mitigation Assessment
PBA	Pre-emptive Baseline Areas
QOF	Qualification to Fly
ROV	Remotely Operated Vehicle(s)
RPA	Response Protection Area
SCERP	Source Control Emergency Response Plan
SFRT	Subsea First Response Toolkit
SIDS	Standard Instructions to Drillers
SMP	Scientific Monitoring Program

Abbreviation	Meaning
SSDI	Subsea Dispersant Injection
SFRT	Subsea First Response Toolkit
TRP	Tactical Response Plan
VOC	Volatile Organic Compound
WA DoT	Western Australia Department of Transport
WAC	Well Acceptance Criteria
WOMP	Well Operations Management Plan
WMS	Woodside Management System

Appendix A – Browse TRA-C Well Quantitative Spill Risk Assessment – Deterministic Analysis

BROWSE TRA-C WELL QUANTITATIVE SPILL RISK ASSESSMENT - DETERMINISTIC ANALYSIS

Memo

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David Wright	[Signature]	20 January 2022

Prepared by:

RPS

David Wright
Manager - Perth

Level 2, 27-31 Troode Street
West Perth WA 6005

T +61 8 9211 1111
E david.wright@rpsgroup.com

Prepared for:

Woodside Energy Ltd

Dan Stone
Environmental Engineer – Developments Environment

Mia Yellagonga, Karlak, 11 Mount Street
Perth WA 6000

T +61 8 9348 4672
E daniel.stone@woodside.com.au

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1 INTRODUCTION

1.1 Background

In 2019, RPS was commissioned by Woodside Energy Ltd (Woodside) to undertake a quantitative spill risk assessment of hypothetical hydrocarbon spill scenarios related to the proposed Browse Joint Venture (BJV) Browse to North West Shelf Project (RPS, 2019). Woodside are now preparing to articulate to the regulator a series of contingency measures for the TRA-C loss of well control scenario (referred to as Scenario 1 in RPS, (2019)) which may be able to halt the release after 13 days instead of 77 days. RPS has been commissioned to support the preparation of environmental approvals documentation for the specified hydrocarbon release scenario. The Browse hydrocarbon resource is located in the Brecknock, Calliance and Torosa reservoirs located approximately 425 km north of Broome and approximately 290 km off the Kimberley coastline.

Woodside identified one hydrocarbon spill scenario for investigation. The scenario was modelled in a stochastic manner and assessed over an annual period, with equivalent weighting of all four calendar quarters achieved through equal replication of simulations in each quarter.

The preliminary outcomes of the stochastic assessment for have been provided to Woodside in a technical memorandum (RPS, 2021). This additional memorandum presents the results of deterministic analysis for Scenario 1 to aid oil spill response planning. Details of the scenario are:

- Scenario: A Short-Term (13-Day) uncontrolled release of 24,000 m^3 of unstabilised Torosa Condensate from the TRA-C well (13° 58' 12.5" S, 121° 58' 37.7" E), with a 5-day surface release phase followed by an 8-day subsea release phase, representing loss of containment after a loss of well control.

1.2 Deterministic Analysis of Spill Scenarios (Phase 2)

After assessing the stochastic modelling (Phase 1) outcomes for Scenario 1, Woodside determined there was a requirement for additional model outputs to be provided for selected replicate simulations in order to inform the oil spill response and contingency planning process.

Deterministic model runs of interest were selected from the stochastic set of replicate simulations according to the following criteria:

- Minimum time to floating oil contact with the offshore edge(s) of any shoreline receptor polygon (at a threshold of 10 g/m^2).
- Minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2).
- Minimum time to entrained oil (at a threshold of 100 ppb) or dissolved hydrocarbons (at a threshold of 50 ppb) contact with the offshore edge(s) of any shoreline receptor polygon.
- Maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2).
- Maximum cumulative oil volume accumulated at any individual shoreline receptor (at concentrations in excess of 100 g/m^2).

The identified runs corresponding to each of the above cases are summarised in Table 1.1 and **Error! Reference source not found.** for Scenarios 1B and 1C, respectively.

Tabulated results showing minimum times for contact to sensitive receptors nominated by Woodside, and maximum concentrations and volumes, have been produced for defined floating oil (10 g/m^2 and 50 g/m^2), shoreline oil (100 g/m^2 and 250 g/m^2), entrained oil (100 ppb) and maximum entrained and dissolved hydrocarbon concentrations. These results are presented in Section 2.

In addition, the following outputs have been produced and delivered separately in shapefile and spreadsheet data formats:

- Mapped floating oil contours at thresholds of 10 g/m^2 and 50 g/m^2.
- Mapped shoreline impacts at thresholds of 100 g/m^2 and 250 g/m^2.

- Time series data of floating oil impacts at receptors.
- Time series data of shoreline impacts at receptors.
- Mapped time series concentration and viscosity data at thresholds of 50 g/m^2/100 g/m^2 and 2,500 cP/5,000 cP, respectively.

Table 1.1 Identified replicate simulation meeting the deterministic analysis selection criteria for Scenario 1.

Replicate	Selection Criteria	Quarter	Run No.	Time/Volume /Area	First/Worst Receptor Contacted
1	Minimum time to floating oil contact with the offshore edge(s) of any shoreline receptor polygon (at a threshold of 10 g/m^2)	4	15	0.8 days	Scott Reef South
2	Minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2)	4	15	1.8 days	Scott Reef South
3	Minimum time to entrained oil (at a threshold of 100 ppb) or dissolved hydrocarbons (at a threshold of 50 ppb) contact with the offshore edge(s) of any shoreline receptor polygon	3	7	0.5 days	Scott Reef South
4	Maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2)	3	10	507 m^3	Scott Reef South
5	Maximum cumulative oil volume accumulated at any individual shoreline receptor (at concentrations in excess of 100 g/m^2)	3	10	507 m^3	Scott Reef South

2 RESULTS OF DETERMINISTIC ANALYSIS

2.1 Overview

This section summarises the risk estimates calculated for the replicate simulations identified as yielding the worst-case outcomes for Scenario 1, according to the criteria described in Section 1.2. The worst-case replicates identified for this scenario are summarised in Table 1.1.

Tabulated results showing minimum times for contact to sensitive receptors nominated by Woodside, and maximum concentrations and volumes, are presented for defined floating oil (10 g/m^2 and 50 g/m^2), shoreline oil (100 g/m^2 and 250 g/m^2), entrained oil (100 ppb) and maximum entrained and dissolved hydrocarbon concentrations.

The minimum time estimates shown in the tables present the shortest time for any oil to drift from the source to both the offshore boundary of a sensitive receptor and to the receptor shoreline, relative to the commencement of the spill.

2.2 Results

2.2.1 Scenario: Short-Term (13-Day) Surface/Subsea Blowout of Unstabilised Torosa Condensate at the TRA-C Well

Table 2.1 **Summary of exposure predictions at sensitive receptors resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the minimum time to floating oil contact with the offshore edge of any shoreline receptor polygon (at a threshold of 10 g/m²) and the minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m²).**

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Argo-Rowley Terrace MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Ashmore Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Browse Island*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Buccaneer & Bonaparte Archipelagos	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Cartier Island MP	NC	NC	NC	NC	NC	NC	NC	NC	<1	<1
Hibernia Reef*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Indonesia	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesian Boundary	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberley MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Kimberley Coast	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Oceanic Shoals MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Rowley Shoals - Clerke Reef State MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North*	5	6	NA	NA	NA	NA	NA	7	4,359	3,403
Scott Reef South	18	118	42	43	10,051	251	251	15	2,489	2,539
Seringapatam Reef*	NC	NC	NA	NA	NA	NA	NA	427	363	830
Sumba	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Ashmore Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Cartier Island	NC	NC	NC	NC	NC	NC	NC	NC	NC	<1
Rowley Shoals - Clerke Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Sahul Banks*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Scott Reef Central	42	NC	42	43	10,051	251	251	181	931	608
Scott Reef Central - Sandy Island	52	NC	42	43	10,051	251	251	193	644	272
Scott Reef North - Flats*	8	18	NA	NA	NA	NA	NA	9	3,971	3,220
Scott Reef North - Lagoon*	15	43	NA	NA	NA	NA	NA	29	2,415	3,403
Scott Reef South - Flats*	66	NC	NA	NA	NA	NA	NA	66	2,179	1,191
Scott Reef South - Lagoon*	15	19	NA	NA	NA	NA	NA	15	2,598	2,539
Adele Island	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Echuca Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Eugene McDermott Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Fantome Bank*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Heywood Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Vulcan & Goeree Shoals*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
WA Coastline	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

NC: No contact to receptor predicted for specified threshold. NA: Not applicable.

* Floating oil will not accumulate on submerged features and at open ocean locations.

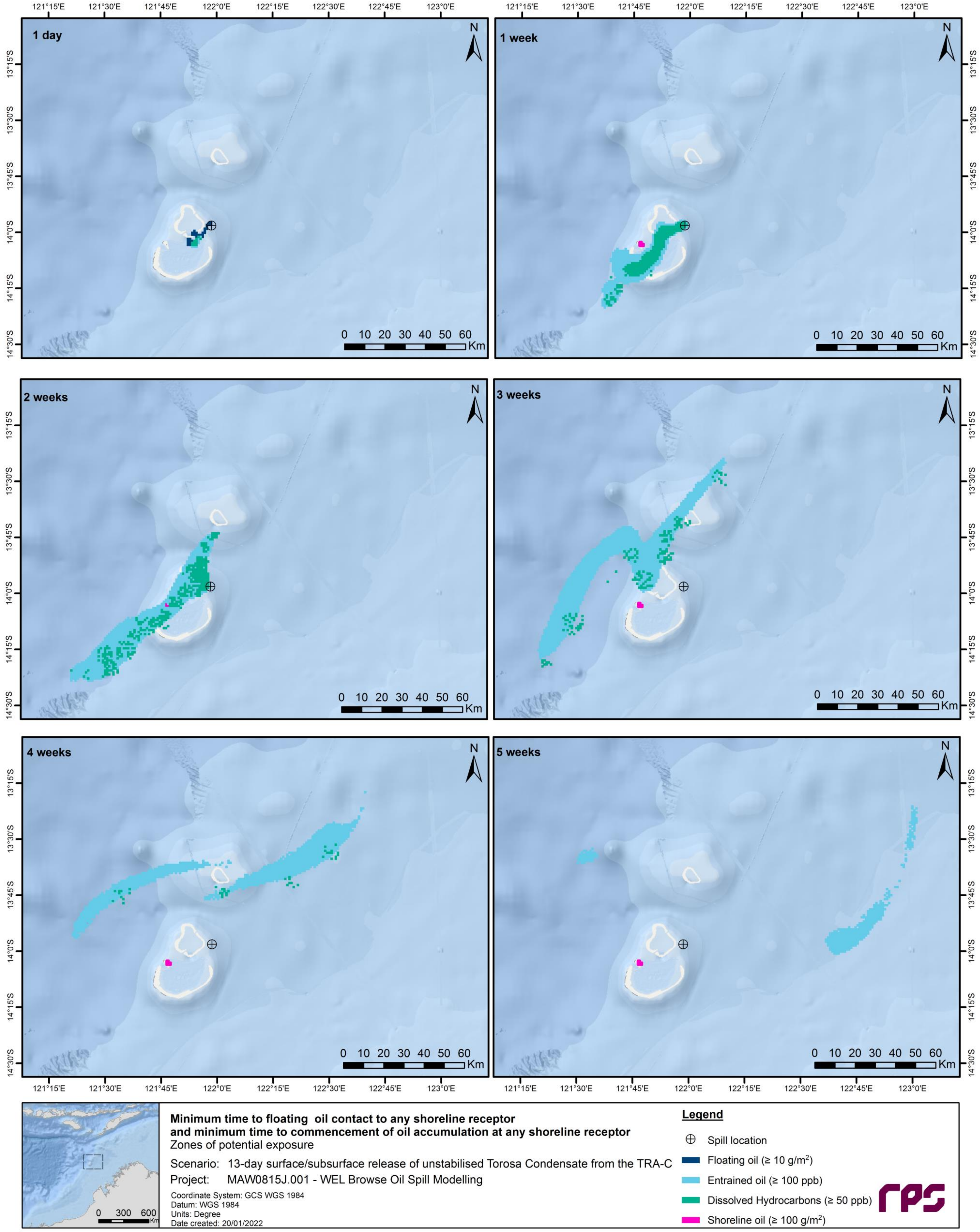

Figure 2.1 **Time-varying areal extent of potential exposure at defined floating oil, entrained oil, dissolved aromatic hydrocarbon and shoreline oil threshold concentrations, resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the <u>minimum time to floating oil contact with the offshore edge of any shoreline receptor polygon (at a threshold of 10 g/m²)</u> and the <u>minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m²)</u>.**

Table 2.2 Summary of exposure predictions at sensitive receptors resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the minimum time to entrained oil (at a threshold of 100 ppb) contact with the offshore edge(s) of any shoreline receptor polygon.

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Argo-Rowley Terrace MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Ashmore Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	<1	<1
Browse Island*	NC	NC	NA	NA	NA	NA	NA	700	209	28
Buccaneer & Bonaparte Archipelagos	NC	NC	NC	NC	NC	NC	NC	NC	10	NC
Cartier Island MP	NC	NC	NC	NC	NC	NC	NC	NC	2	<1
Hibernia Reef*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Indonesia	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesian Boundary	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberley MP*	NC	NC	NA	NA	NA	NA	NA	335	322	269
Kimberley Coast	NC	NC	NC	NC	NC	NC	NC	NC	10	<1
Oceanic Shoals MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Rowley Shoals - Clerke Reef State MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North*	65	NC	NA	NA	NA	NA	NA	28	773	66
Scott Reef South	NC	NC	NC	NC	NC	NC	NC	13	8,036	3,997
Seringapatam Reef*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Sumba	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Ashmore Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	<1
Cartier Island	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC
Rowley Shoals - Clerke Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Sahul Banks*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Scott Reef Central	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef Central - Sandy Island	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North - Flats*	NC	NC	NA	NA	NA	NA	NA	NC	87	4
Scott Reef North - Lagoon*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Scott Reef South - Flats*	NC	NC	NA	NA	NA	NA	NA	20	6,326	3,172
Scott Reef South - Lagoon*	NC	NC	NA	NA	NA	NA	NA	16	7,138	3,172
Adele Island	NC	NC	NC	NC	NC	NC	NC	NC	72	<1
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Echuca Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	<1
Eugene McDermott Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Fantome Bank*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Heywood Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	<1	NC
Vulcan & Goeree Shoals*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
WA Coastline	NC	NC	NC	NC	NC	NC	NC	NC	93	<1

NC: No contact to receptor predicted for specified threshold. NA: Not applicable.

* Floating oil will not accumulate on submerged features and at open ocean locations.

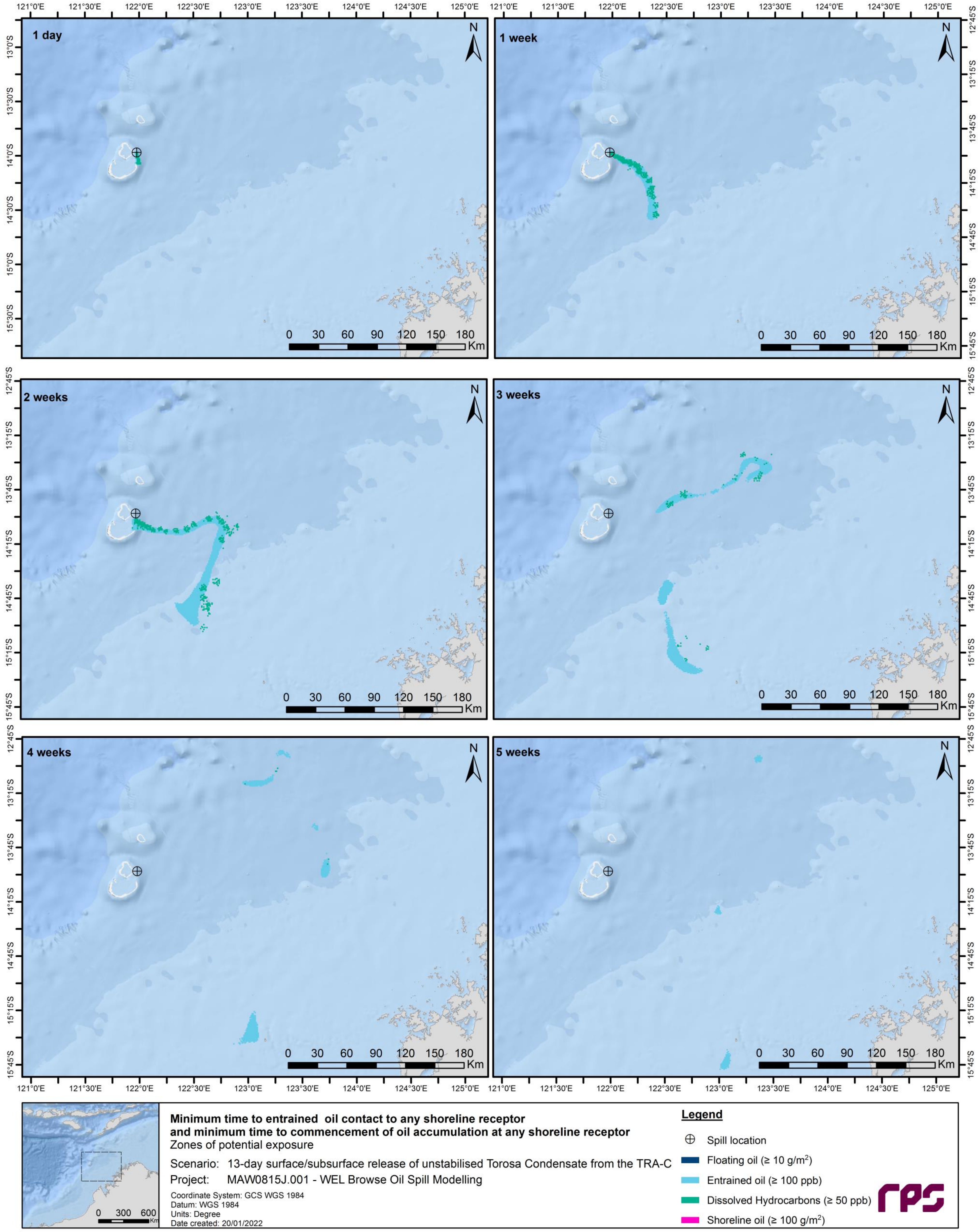

Figure 2.2 **Time-varying areal extent of potential exposure at defined floating oil, entrained oil, dissolved aromatic hydrocarbon and shoreline oil threshold concentrations, resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the the minimum time to entrained oil (at a threshold of 100 ppb) contact with the offshore edge(s) of any shoreline receptor polygon.**

Table 2.3 Summary of exposure predictions at sensitive receptors resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the minimum time to entrained oil (at a threshold of 100 ppb) contact with the offshore edge(s) of any shoreline receptor polygon.

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Argo-Rowley Terrace MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Ashmore Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	10	<1
Browse Island*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Buccaneer & Bonaparte Archipelagos	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Cartier Island MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Hibernia Reef*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Indonesia	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesian Boundary	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberley MP*	NC	NC	NA	NA	NA	NA	NA	NC	16	6
Kimberley Coast	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Oceanic Shoals MP*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Rowley Shoals - Clerke Reef State MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef MP	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North*	7	15	NA	NA	NA	NA	NA	60	4,146	2,528
Scott Reef South	106	126	112	112	18,450	507	507	126	1,197	1,623
Seringapatam Reef*	NC	NC	NA	NA	NA	NA	NA	NC	70	240
Sumba	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Ashmore Reef	NC	NC	NC	NC	NC	NC	NC	NC	6	<1
Cartier Island	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Clerke Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals - Mermaid Reef	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Sahul Banks*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Scott Reef Central	108	126	112	112	18,450	507	507	126	1,197	987
Scott Reef Central - Sandy Island	113	126	112	112	18,450	507	507	126	1,124	737
Scott Reef North - Flats*	10	15	NA	NA	NA	NA	NA	126	2,849	2,356
Scott Reef North - Lagoon*	15	36	NA	NA	NA	NA	NA	127	1,988	2,528
Scott Reef South - Flats*	163	NC	NA	NA	NA	NA	NA	155	652	1,375
Scott Reef South - Lagoon*	100	NC	NA	NA	NA	NA	NA	126	1,197	1,623
Adele Island	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Barracouta Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC

Receptor	Minimum time to receptor (hours) for floating oil at		Minimum time to accumulation (hours) of shoreline oil at		Maximum local accumulated concentration (g/m²)	Maximum accumulated volume (m³) along this shoreline, exceeding concentrations of		Minimum time to receptor (hours) for entrained oil at ≥100 ppb	Maximum entrained oil concentration (ppb), at any depth	Maximum dissolved aromatic hydrocarbon concentration (ppb), at any depth
	≥10 g/m²	≥50 g/m²	≥100 g/m²	≥250 g/m²		100 g/m²	250 g/m²			
Echuca Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Eugene McDermott Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Fantome Bank*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Heywood Shoal*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
Vulcan & Goeree Shoals*	NC	NC	NA	NA	NA	NA	NA	NC	NC	NC
WA Coastline	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

NC: No contact to receptor predicted for specified threshold. NA: Not applicable.

* Floating oil will not accumulate on submerged features and at open ocean locations.

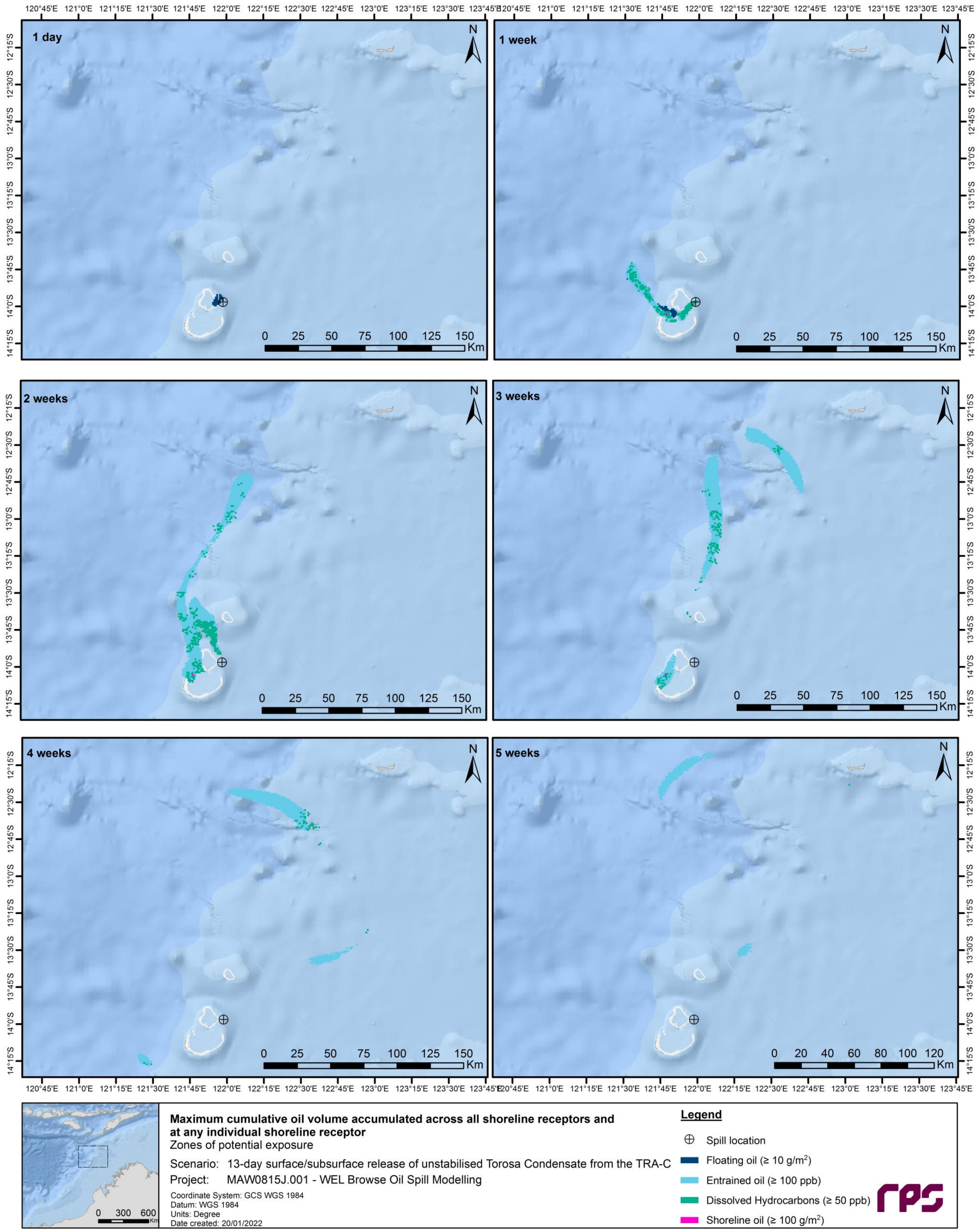

Figure 2.3 **Time-varying areal extent of potential exposure at defined floating oil, entrained oil, dissolved aromatic hydrocarbon and shoreline oil threshold concentrations, resulting from a 13-day surface/subsea release of unstabilised Torosa Condensate at the TRA-C well, for the replicate case with the <u>the minimum time to entrained oil (at a threshold of 100 ppb) contact with the offshore edge(s) of any shoreline receptor polygon.</u>**

3 REFERENCES

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RPS 2021, Woodside Browse TRA-C Oil - Quantitative Spill Risk Assessment – Rev 0, provided to Woodside Energy Ltd by RPS, West Perth, WA, Australia, 10/12/2021.