TAMARIND

Tui Development Drilling Applications (EEZ100016)

Response to the Board's Request for Further Information under section 54 EEZ Act and Other Further Information - Notified Marine Consent and Marine Discharge Consent Applications

July 2018

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Contents

1 *INTRODUCTION*

This report presents Tamarind's responses to the two further information requests made by the Board of Inquiry pursuant to section 54(1) of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the "EEZ Act"), both of which were dated 10 July 2018 (the "RFIs"). This report also provides further information that has become available since Tamarind Taranaki Limited's ("Tamarind") applications for a Marine Consent and Marine Discharge Consent for development drilling activities in the Tui Permit (PMP38158) were lodged with the EPA on 8 March 2018. This information is now available as a result of more advanced project planning, including rig and chemical selection and the refinement of the drilling programme parameters.

The further information provided in this report in response to the RFIs is set out in **Part A** of this Report and is as follows:

1. Other marine consents to undertake the proposed drilling activity (*Section 2*);

2. Installation, operation and removal of the drilling rig (*Section 3*), including:

    a) Drilling rig anchoring, including the number of anchors and layout of the chain, wire and anchor spread (*Section 3.1*).
    b) Contingency rig placements (*Section 3.2*).
    c) Layout and design of the Offshore Processing Drainage System (*Section 3.3*).
    d) Temporary structures (*Section 3.4*).
    e) Protective Structures (*Section 3.5*).

3. Oil Spill Modelling (*Section 4*), including:

    a) Justification for the hindcast data timeline used in modelling;
    b) Confirmation of development well pressure statuses, including information on how long flow from the well is expected to occur under normal operation conditions, if injection is suspended.
    c) Justification for the environmental thresholds used in modelling.
    d) A summary of the mass balance at the end of simulations.

The further information provided in this report that has become available since the applications were lodged is set out in **Part B** and is as follows:

a) Management of drill cuttings (*Section 5*);

b) Harmful substances that may be discharged in offshore processing drainage (*Section 6*); and

c) Oil Spill Modelling – June to January (*Section 7*).

PART A - RESPONSES TO THE RFIs

The further information provided in this section is in response to the RFIs.

2 *OTHER MARINE CONSENTS REQUIRED FOR THE PROPOSED ACTIVITIES*

In response to the RFI, Tamarind considers that the other marine consents that will be required to undertake the proposed development drilling activities in the Tui Field are as follows –

1. A non-notified marine discharge consent under section 20B of the EEZ Act for discharges of harmful substances from a mining activity (regulation 20 of the Discharge and Dumping Regulations). A limited number and quantity of potential harmful substances will be covered in this application, which is anticipated to include residual biocides that may be present when the well caps are removed, any products with biocidal action discharged in cooling water from the drilling rig, any harmful substances that may be discharged in waste cement, hydraulic fluids that could be released in small quantities during the disconnection of the blow out preventer, and de-scalers used for cleaning wellhead connections. The list of harmful substances to be included in this application is still being confirmed in discussion with the rig contractors and Tamarind's chemical suppliers, with Tamarind working to identify and procure the least ecotoxic substance that is fit-for-purpose in each case.

2. It is currently anticipated that the lodgement of the non-notified marine discharge consent application will occur in September or October 2018 once all the relevant information is obtained and confirmed and so as to ensure the statutory timeframes under the EEZ Act are met.

In addition to the marine consents required under the EEZ Act, Tamarind will also seek approvals from a number of other agencies for its proposed activities. It is currently anticipated that these approvals will be sought in September or October 2018 once all the relevant information is confirmed and so as to meet the statutory or preferred approvals period of each agency. Approvals, other than marine consents, that will be sought include –

(a) Craft Risk Management Plan – Identifying all measures to be taken to avoid the risk of introduction of marine pests through ballast water or full fouling on vessels or the drilling rig. This document is submitted to and approved by the Ministry for Primary Industries (Biosecurity NZ).

(b) Safety Case – Describing the controls to avoid a safety incident during the activities and covering all aspects of the drilling rig operations. This document is submitted to and approved by WorkSafe NZ (High Hazards Unit).

(c) Oil Spill Contingency Plan (OSCP) – Identifying the controls to avoid or minimise a marine oil spill, response organisation and measures to a marine oil spill associated with the activities, and including a Well Control Contingency Plan. This document is submitted to and approved by Maritime NZ.

(d) Emergency Spill Response Plan (ESRP) – Identifying the controls to avoid or minimise a spill of harmful substances, response organisation and measures to a harmful substance spill associated with the activities. This document is submitted to an approved by the Environmental Protection Agency.

(Note – the OSCP and ESRP will be combined into a single operational document, with approval of the relevant matters by Maritime NZ and the Environmental Protection Agency).

A infographic of the all of the required marine consents and approvals is provided in ***Figure 2.1***.

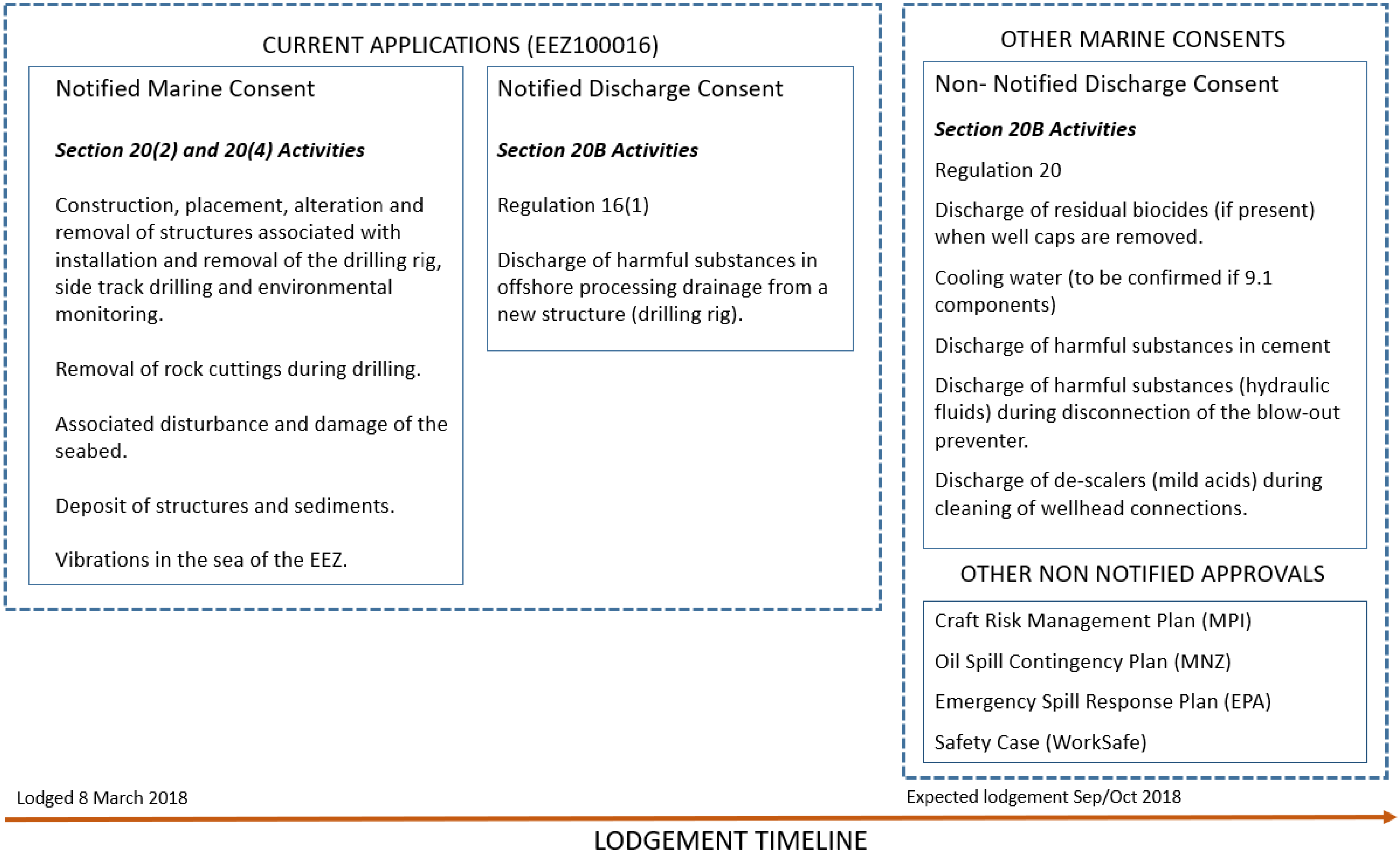

Figure 2.1 Infographic of Consents/Approvals required to undertake proposed drilling activity

3 INSTALLATION, OPERATION AND REMOVAL OF THE DRILLING RIG

The following sections provide specific responses to the RFIs and provide further detail with respect to the installation, operation and removal of the drilling rig.

3.1 DRILLING RIG ANCHORING

3.1.1 Anchor Protrusion

Board's request

1a. Section 3.2.1 of the Impact Assessment (IA) states that drilling rig anchors will be spread around the drilling rig at a diameter of 1.5km - 2.5km. This will result in the anchors protruding from the 500m exclusion zone.

1b. How will the risks associated with the anchor protrusions be limited?[1]

Tamarind's Response

The risks associated with the anchor protrusions will be limited as the drilling activity and the potential presence of the drilling rig and anchors, including anchor locations, will be notified to Maritime New Zealand and Land Information New Zealand (LINZ), which will trigger the issuing of a LINZ Notification to mariners thereby alerting mariners of the presence of the activity and anchors.

Further, Tamarind will request that a non-interference zone be established around the drilling rig and anchoring points (i.e. the vessel exclusion will extend 500m beyond the anchoring locations). Once the non-interference zone is expanded, there will be no anchor protrusion beyond the non-interreference zone. This measure will avoid risk to other vessels that may seek to anchor or trawl in the area where anchor chains and wires are located.

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[1] Appendix 1 of the RFI dated 10 July 2018

As additional mitigation, the activities will all occur within the IMO approved Precautionary Area[2], which is clearly defined on all current paper and electronic navigational charts. This Precautionary Area was established to provide additional protection to navigating vessels and oil and gas operations in the South Taranaki Bight on the basis that drilling and other operations may be occurring in the area.

The drilling rig will be illuminated at night and will be constantly transmitting a signal through the Automatic Information System, which means it will be visible on all electronic vessel navigation systems, including the specific characteristics of the drilling rig.

The drilling rig and the support vessels will be maintaining a constant visual and electronic lookout for other vessels in the area of operations. If other vessels are moving into the area and appear to be preparing to undertake activities that may put them at risk (e.g. anchoring or trawling) they will be contacted directly by the rig or support vessel to ensure they are aware of, and avoid, any potential risks associated with the placement of the mooring arrays.

3.1.2 Number of Anchors

<u>Board's request</u>

4b. If the number of anchors has the potential to vary due to metocean conditions, please provide information on:
- *i. the number of anchors that will be required by the drilling rig under different sets of metocean conditions; and*
- *ii. the details of the activities necessary for adjusting the number of anchors in response to changing metocean conditions.*

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[2] The Taranaki Offshore Precautionary Area is situated off the south west coast of the north Island and was identified as a precautionary area with effect from mid-2007. All ships are required to navigate with particular caution as a consequence of the offshore petroleum activity present in the area.

Tamarind's Response

The IA sought consent for four, but up to 12 anchors to be laid for a total of eight rig placements. Tamarind anticipates that it will use the *Hai Yang Shi You 982 Rig (***HYSY 982 Rig***),* a semi-submersible drilling rig owned by COSL Drilling Europe, for the work outlined in the marine consent applications. However, in the event the HYSY 982 Rig is not secured and/or should significant delays be incurred, an alternative but comparable semi-submersible mobile offshore drilling unit will be utilised. Having now selected the HYSY 982 Rig or a comparable alternative rig, Tamarind can now confirm the planned mooring arrangement. For each rig placement a total of eight (8) of anchors will be attached to the drilling rig and four (4) anchors will be attached to the blow out preventer (BOP). Accordingly, only the eight anchors used to hold the drilling rig will require extended lengths of chain and wire to be laid on the seabed (up to 1,000 m with possible lateral disturbance of up to 1 m as described in the impact assessment).

The anchors used on the BOP will be located close to the wellhead (i.e. within approximately 25 m of the existing wellhead structure), with the supporting wires angled directly up to the BOP and under tension and therefore the wires will not lay on the seabed. This arrangement will significantly reduce the previously anticipated area of seabed disturbance relative to the use of 12 anchors for the rig.

The final design of the BOP anchors is still under consideration, but it is noted that one option may extend deeper into the seabed than the 3 m penetration of the rig anchors (i.e. up to 6 m). This option is being considered on the basis that these anchors have a far smaller "footprint" on the seabed, thus offsetting those potential disturbance effects. Given that the benthic organisms that may be impacted by deposition or disturbance of the seabed occur in the upper sediment layers surface (typically <20cm) it is not considered this additional penetration would generate greater impacts on benthic organisms.

Tamarind can also confirm that initial and subsequent mooring spreads comprising of anchors, chain and wire for the rig anchoring and possibly the BOP anchors will be placed on the seabed prior to the drilling rig's arrival at a particular location. This is known as "pre-lay". It is anticipated that anchors would not be in place more than three (3) months prior to the rigs arrival at a given location, however it could be more if delays, including weather induced delays, occur.

It is also noted that the IA indicated that up to twenty four (24) anchors could be placed on the seabed at any one time (if a second set of anchors was pre-laid at the next planned drilling location before the drilling rig is relocated (see Section 3.2.1 of the IA). Tamarind is now able to confirm that no more than 12 rig anchors and eight (8) BOP anchors in total will be placed on the seabed at any point in time.

There will be no requirement to modify these locations or the anchor configuration during each of the rig's placement, irrespective of changing metocean conditions.

3.1.3 Layout of chain, wire and anchor spread

<u>Board's request</u>

4a. Provide confirmation on the layout of chain, wire and anchor spread to be used for anchoring the drilling rig, once it has been chosen.

<u>Tamarind's Response</u>

Based on the configuration of anchors described above, the expected anchoring configuration, layout of chain and calculations for assessing anchoring disturbance are shown in *Figure 3.2.* The anticipated area of seabed disturbance from anchoring will be approximately 13,000 m^2 per placement for drilling. The total area of seabed disturbance for all four placements is estimated to be 52,000 m2. This area of disturbance equates to approximately 0.01% of the area of the Tui Permit (PMP38158).

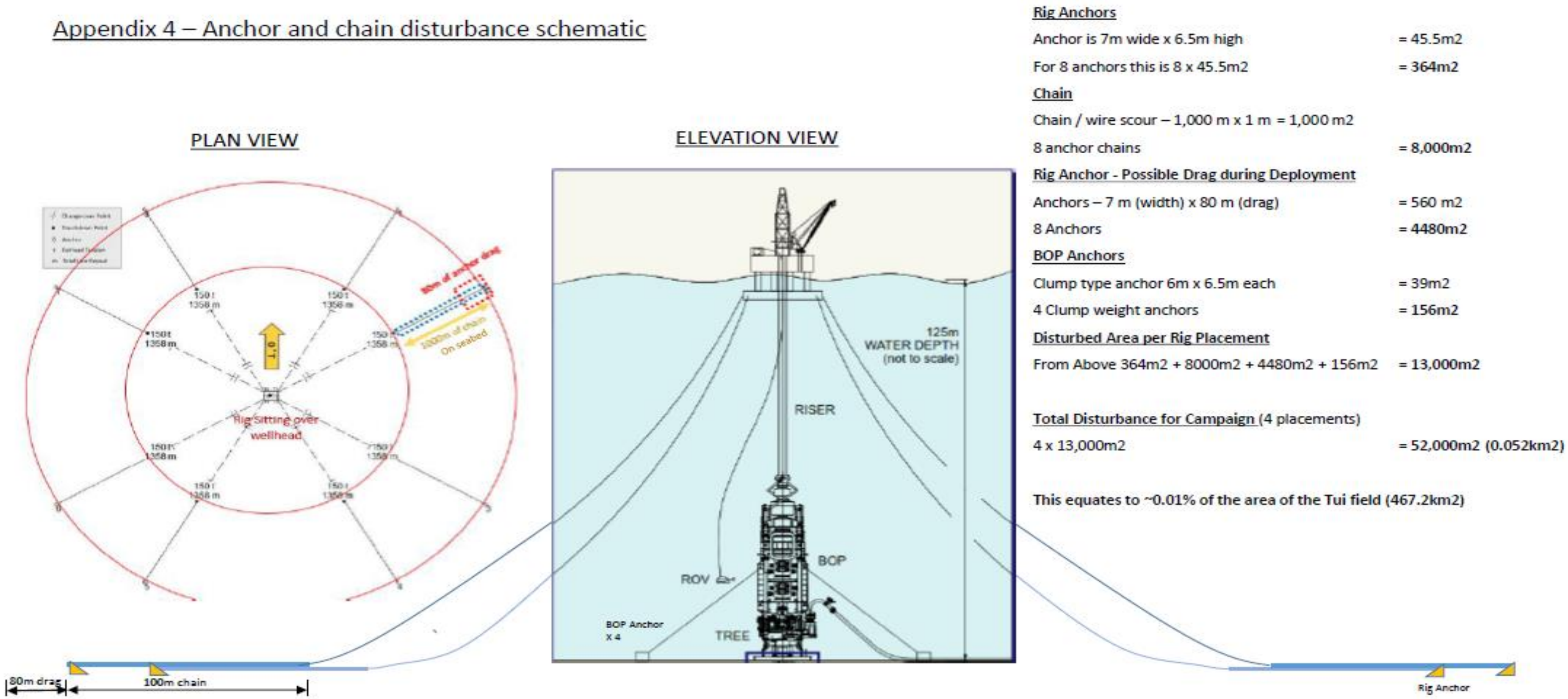

Figure 3.2 Proposed Anchoring Design and Disturbance Calculations

3.2 *CONTINGENCY RIG PLACEMENTS*

Board's Request

2a. *Provide information on the locations intended for contingency rig placements in response to equipment and weather downtime.*
2b. *Provide confirmation of the baseline conditions of the benthic environment at these locations*

Tamarind's Response

After detailed planning Tamarind can confirm that the drilling rig will only be moored at up to four (4) locations in the Tui field to provide access to any of the selected donor wells.

Accordingly there will be no contingency rig placements, even where work has stopped due to equipment or weather downtime.

The baseline environmental conditions surrounding all the proposed rig placement sites (i.e. the existing Tui Field well sites) is characterised in the environmental monitoring survey data described in Section 4.2 and 4.3 and Annex D of the Impact Assessment submitted with Tamarind's marine consent applications.

3.3 *OFFSHORE PROCESSING DRAINAGE SYSTEM*

Board's Request

3. *Provide the expected layout and design of the Offshore Processing Drainage system once the drilling rig is selected.*

Tamarind's Response

The IA stated that Tamarind was unable to provide full details of the deck drain system on board the drilling rig at that time, as the specific rig to be utilised had not yet been confirmed (Section 3.6). However a general description of a drilling rig deck drainage system was provided.

As above, Tamarind anticipates that it will use the HYSY 982 Rig for the work outlined in the marine consent applications. However, in the event the HYSY 982 Rig is not secured and/or should significant delays be incurred an alternative but comparable semi-submersible mobile offshore drilling unit will be utilised.

Accordingly, further information on the expected configuration of the areas where harmful substances are stored and used, and the potential for these products to enter deck drains, is now able to be provided. A summary description of the deck drainage and hazardous substances storage and handling procedures are provided below and a detailed illustration is attached to this report as ***Annexure A***.

- All storage of bulk drilling muds, cementing products and other harmful substances will be in fully enclosed areas in which any spills do not have potential to enter the offshore processing drainage;
- Drill pipe will be stored in an enclosed area where any run-off of residual drilling muds is collected and recirculated into the closed loop mud system (i.e. this runoff will not enter offshore processing drainage);
- Only equipment that is being changed out for technical reasons would be stored on deck areas where runoff has potential to enter the deck drainage. All runoff from this deck area will be directed to the hazardous drain systems for settlement of solids and processing through the oil filtering equipment;
- As drill cuttings are now being returned to shore for disposal, these will be stored in sealed and covered skips where they can be offloaded to supply vessels for transport. These skips will be contained in a fully bunded area, allowing for containment of any spillage so that it can be cleaned up before any runoff is directed to the hazardous drain system.
- Because the SBM is used in a closed loop where fluid is continually recycled during drilling operations, this minimises both the need to transport it to site and store excessive quantities either on vessels or the drilling rig. Once drilling finishes it is stored on board the drilling rig and re-used on subsequent wells, again minimizing the risk of losses to the environment.

3.4 *Temporary Structures*

Board's Request

5. *Will a temporary structure be placed on the seafloor to allow Remotely Operated Vehicles to hold position for extended periods during operations*

Tamarind's Response

No temporary structures will be placed on the seafloor with respect to the ROV operations.

3.5 *Protective Structures*

Board's Request

6a. *Are there protective structures already in place which act to mitigate against potential damage to flowlines and the umbilical during activities associated with the current applications*

6b. *If not already present, will such structures be installed?*

6c. *If such structures are going to be installed, please provide information on the potential effects of their placement and removal that are relevant to the restricted activities listed in section 20 of the EEZ Act.*

Tamarind's Response

The location of all anchors will be carefully planned such that no protective structures are required for the existing flowlines or umbilicals in the Tui Field. In all cases, any existing structures will be avoided during anchoring.

4 *OIL SPILL MODELLING*

This section provides specific responses to the RFI and provides further details with respect to oil spill modelling.

4.1 JUSTIFICATION FOR THE HINDCAST DATA TIMELINE USED IN MODELLING

Board Request

7. Provide justification for the hind cast data timelines used in modelling

Tamarind's Response

Tamarind engaged RPS Australia West PTY Limited to carry out the oil spill modelling which is included in the IA. The response to this question has been prepared by RPS and is further discussed in the Evidence of Dr Brian King[3].

"It is accepted it is best practice to ensure the hindcast datasets are synchronised/coupled and we agree with the Coffey Report on that matter. We note due to a typographical error in our Oil Spill Modelling Reports (refer to Annexure F of the IA) (the "RPS Reports"), the hind cast data timelines are unclear[4]. We can confirm that we have used the entire HYCOM dataset and CFSR dataset and tidal current dataset (reconstruction from HYDROMAP) for the entire 10 year period 2003 to 2012. Further, we can confirm that the assessments conducted use these entire datatsets in a synchronised/coupled manner so that the start dates and end dates always correspond amongst the datasets within the model. Thus there is no artificial behaviour in the spill trajectories in the RPS Reports and the modelling has been conducted using best practice including full synchronisation/coupling throughout the assessment, including all months and days of each year."

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[3] Refer to the Evidence of Dr Brian King, paragraph 11.2

[4] Refer to section 3.3 in the RPS Reports, which reads: "For this study, the HYCOM hindcast currents were obtained for the year 2012". The text should have read: "For this study, the HYCOM hindcast currents were obtained for the years 2003-2012"

4.2 *WELL PRESSURE*

Board Request

8a. Provide confirmation of development well pressure statuses.

8b. Provide information on how long flow from the well would be expected to occur under normal operating conditions, if injection is suspended.

Tamarind Response

Development well pressures are confirmed in two specific ways:

1) Actual pressure data from the reservoir is gathered when any new well is drilled in the field. This data point is then compared with the pressure data that the field reservoir simulator generates, and the simulation model is adjusted accordingly. This process is known as history matching. The last pressure point collected from the field was in 2014 when Pateke-4H was drilled. This data point has been used to assist with history matching the current model.

2) Further, as part of the process of determining whether there are development opportunities in the field, the field simulation model is updated with the latest set of data and history matched. This process provides a reliable and accurate calculation of the current reservoir pressure and the pressure that will be encountered when the wells are drilled.

With respect to the time the well would be expected to flow under normal operating conditions, for the current wells, if gas lift (injection) is halted, the wells will stop flowing immediately as the lower reservoir pressure and higher water cut prevent the wells from flowing without gas lift (injection). For the sidetrack wells, the lower initial water cut will result in the wells being able to flow unassisted for a period. The history matched reservoir simulation model predicts that in the worst case, the sidetrack well would be able to flow until the water cut reached approximately 91%, or around 360 days from the point at which well control was lost.

Spill modelling has therefore been undertaken to allow for the flow continuing for an extended period, being the longest time it would take for an alternate drilling rig to undertake intervention drilling or a relief well.

The modelling has also been developed to reflect the worst possible well control scenario while using the most productive well in the field. The scenario modelled in this case was:

- No drill pipe is present in the wellbore;
- No sand collapse, sand production, wellbore collapse or bridging over of the wellbore;
- No broaching at the casing shoe or casing collapse;
- No restrictions at the wellhead and no BOP in place;
- No upper flow threshold applied to the model;
- The model assumes that a relief well would require 110 days to complete, in the worst case.

4.3 JUSTIFICATION FOR THE ENVIRONMENTAL THRESHOLDS USED IN MODELLING

Board Request

9. *Provide justification for the chosen environmental thresholds used in modelling. The chosen thresholds appear high relative to other oil spill modelling studies carried out by RPS.*

Tamarind's Response

As above, the response to this question has been prepared by Dr. Brian King of RPS, and is also set out in paragraphs 11.3 – 11.7 of his statement of evidence.

"It is important to note that the thresholds used by RPS are typical for best practice assessments in recent years. It should be noted that the studies compared to this study are older, while the reports for this consent application are different as we consider these current thresholds as best practice in 2018.

Specifically, the Australian Maritime Safety Authority provided more recent guidance for best practice in planning for an offshore oil spill following experiences with the Montara and Deepwater Horizon/Macondo spills (AMSA 2015a and 2015b). Specifically, AMSA concluded that a minimum of 0.5 g/m2 (which closely equates to 0.5 µm) was the limit of detectable oil in the coastal and offshore environment and the 100 g/m2 was the limit of actionable oil on the shorelines and hence these thresholds were used in the RPS (2018) reports and are used in all our assessments since 2015 and are considered best practice.

The 100 g/m2 threshold (~100 µm) is recommended in the Australian Maritime Safety Authority's (AMSA) foreshore assessment guide (AMSA 2015b) as the acceptable minimum shoreline thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone. The 100 g/m2 threshold has been selected in the RPS reports to define the zone of potential moderate contact on the shorelines and is also referred to as the limit for actionable shoreline oil. The RPS reports also use a lower shoreline threshold of 10 g/m2 (approximately 10 µm) which is an order of magnitude below any ecologically important shoreline threshold being 100 g/m2. This lower level is often reported as it is more indicative of the shorelines perceived to be affected due to stranded oil visibility and hence the potential to trigger temporary closures of shorelines as a precautionary measure only. At these levels and the Tui Crude oil type that will form waxy flakes when it comes ashore, 10 g/m2 is equivalent to 10 x 1 ml droplets or 10 very small flakes per square meter of shorelines which is very low coverage at this level. The ability to detect oil on shore lower than these levels is unlikely hence we use 10 g/m2 extensively as the current best practice lower threshold for shoreline reporting following AMSA 2015b.

To better assess the potential for sea surface exposure, each of the 100 spill trajectories was tracked to a minimum of 0.5 g/m2, which equates approximately to an average thickness of ~0.5 µm. Oil of this thickness is described as a silvery to rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement 2009) and is also considered the practical limit of observing oil in the marine environment (AMSA, 2015a). This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. We define this lowest threshold as the potential extent for socio economic impact. Hence, the 0.5 g/m2 threshold has been selected to define the zone of potential low exposure on the sea surface in the RPS reports. Please also note that the Bonn Agreement Oil Appearance Code (Bonn Agreement 2009) for the very low level of 0.04 μm is defined as a thickness that can only been seen under ideal viewer conditions which are possible for harbour spill but unlikely in the coastal environment and is no longer used in best practice assessments for oil spill contingency planning.

Studies indicate that the dissolved aromatic compounds (typically the mono-aromatic hydrocarbons and the two and three ring poly-aromatic hydrocarbons) are commonly the largest contributor to the toxicity of solutions generated by mixing oil into water (Di Toro et al., 2007). The exposure level (threshold concentration over a given duration) was used to assess the potential for exposure to sub-sea habitats and species by entrained and dissolved aromatic hydrocarbons. The threshold value for species toxicity in the water column is based on global data from French et al. (1999) and French-McCay (2002, 2003), which showed that species sensitivity (fish and invertebrates) to dissolved aromatics exposure > 4 days (96-hour LC50) under different environmental conditions varied from 6 to 400 μg/l (ppb) with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Further, a minimum threshold of 6 parts per billion (ppb) over 96-hours or equivalent was used to assess in-water low exposure zones (Engelhardt, 1983; Clark, 1984; Geraci and St. Aubin, 1988; Jenssen, 1994; Tsvetnenko, 1998). Again, we consider 6 ppb to be a conservative threshold and we use it extensively in recent years for these types of assessment following AMSA 2015a".

4.4 SUMMARY OF MASS BALANCE

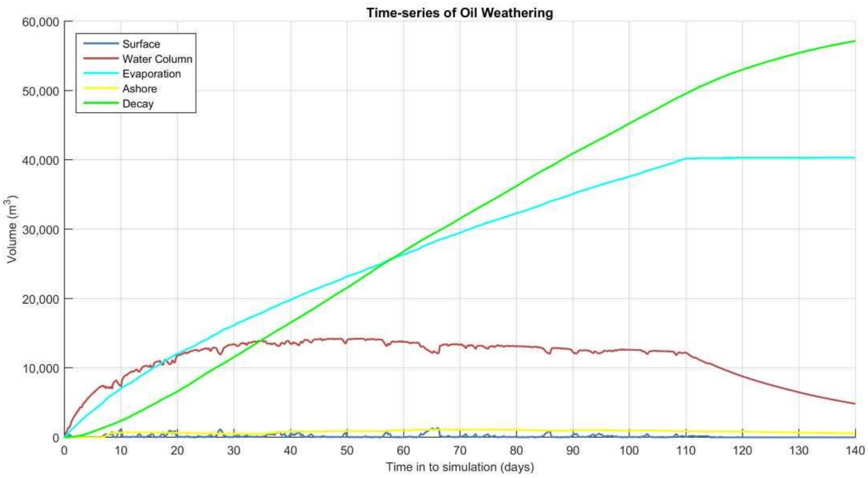
Board Request

10. Provide a summary of the mass balance at the end of simulations, specifically explaining the fate of the persistent fraction.

Tamarind's Response

As above, the following response to this question has been prepared by Dr. Brian King of RPS, and is also set out in paragraphs 11.8 – 11.9 of his statement of evidence.

"In order to respond to this, it is helpful to look at examples of the fates graphs for one of the spill simulations conducted as shown below. The example below shows the scenario that produced the maximum volume of oil ashore during any of the simulations conducted. The time series below shows that the residual oil components are significantly dispersed at sea due to the dispersive nature of the Tui Crude Oil (waxy residual above its pour point) which is then available for decay over time. Due to the varying currents, the crude dispersed into the water column occurs most often in deep water, allowing for dilution. Being a light crude, there is also significant and rapid evaporation of the volatile components. Sea surface exposure only occurs during light wind conditions and hence minimizing the volumes coming ashore.



Specifically the mass balance (above) of this example demonstrates that the spill initially occurred during rough weather and mixes into near surface waters of the water column due to the high energy mixing. In this example, some oil comes ashore after 8 days as this rough weather abates and surface slicks start to form around day 7. Over time, the high energy moderate to rough weather events come (no surface slicks and subsurface oil is mixed deeper and moved around) and go (near surface water column oil floats to makes surface slicks). Ultimately, the degree of mixing in this offshore region ensures that crude oil and diesel is dispersed while allowing for some evaporation and decay. Further, the flow rate of the spill reduces with time, and hence prevents any accumulation within the water column after day 30 as shown in the above example time series. Other mass balances show similar patterns, just the timing of the moderate to rough weather events changes for each simulation."

To summarise, the mass balance at the end of simulations is difficult to specify because the spill rate and weather events change with time, and as such each of the mass balances will be slightly different.

PART B – OTHER FURTHER INFORMATION

The further information provided in this section is information that has become available since the applications were lodged. This information is also discussed in the evidence-in-chief prepared by Tamarind's witnesses.

5 MANAGEMENT OF DRILL CUTTINGS

At the time the Impact Assessment was lodged it was not known whether drill cuttings would be treated and disposed of at sea or returned to shore for disposal. The disposal of cuttings was therefore allowed for in the application, with the activity and potential impacts discussed in Sections 3.2.5, 6.3 and 6.4 of the Impact Assessment. Modelling of the depth of deposition and turbidity in the water column was also provided in Annex E of the Impact Assessment.

After further detailed design work Tamarind is now able to confirm it will use only a single synthetic based drilling fluid, known as synthetic based "mud" (SBM) for drilling the side-tracks in the campaign.

Tamarind is also able to confirm that the drill cuttings returned to surface during drilling operations will be sieved onboard the drill rig to remove the majority of the Synthetic Based Mud (SBM) drilling fluid. The fluid will then be recycled directly by return to the drilling fluid system on the rig. Once separated the drill cuttings will be sealed in specifically designed and built skips, and then transported back to shore for storage and processing.

Tamarind therefore do not now intend to discharge any drill cuttings to the ocean at any of the well locations. As a consequence, the predicted deposition of up to 460 m^3 of drill cuttings and muds on the seabed that was described in the Impact Assessment <u>will not occur.</u>

The predicted the potential impacts on benthic communities from deposition were previously assessed as being ***minor***. It is considered that the impacts from deposition of equipment and other material but not including drill cuttings will be reduced and that the overall impact magnitude will be ***small*** (defined as affecting a specific group of localised individuals within a population over a short time period (one generation or less), but not affecting other trophic levels or the population itself). The residual impact significance on benthic communities of deposition associated with the side-track drilling would therefore be ***negligible***.

Category	Residual Impact
Magnitude of Deposition Impacts on Benthic Communities	Small
Sensitivity of Benthic Communities to Deposition	Low
Significance Deposition Impacts on Benthic Communities	Negligible

The potential impact significance from turbidity was previously assessed as ***negligible***, but will be further reduced given that drill cuttings and muds will no longer be discharged offshore.

6 HARMFUL SUBSTANCES IN OFFSHORE PROCESSING DRAINAGE

6.1 HARMFUL SUBSTANCES

The IA stated that the exact chemicals that would be used on board the rig could not be confirmed as the information was not available, but that it would be provided when it became available (Section 3.6 of the IA). It further stated that it is possible a number of the substances expected to be required during the drilling activities will be found to not contain any harmful components, however as a precautionary step it listed any substances that may potentially contain harmful substances (Table 3.3 of the IA) and it assumed that those substances had a category of 9.1A under the *Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001.*

Tamarind has now confirmed the specific harmful substances that may be used on the drilling rig, where there is potential for discharge of these through the offshore processing drainage.

In New Zealand, hazardous substances are classified based on a range of characteristics including toxicity, as described the *Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001.* Specific classification descriptions based on the nature and degree of hazard are detailed in the *Hazardous Substances (Classification) Notice 2017.* With respect to aquatic toxicity (the criteria for a "harmful substance" for the purposes of the EEZ Act) four categories have been defined as shown in *Box 1* below. The classifications (9.1A to 9.1D) have been used throughout this discussion as relevant to describe the specific harmful substances that Tamarind may discharge through deck drainage.

Box 1: Classification for Harmful Substances

9.1A – Substances that are very ecotoxic in the aquatic environment.

A substance for which data indicate an acute aquatic ecotoxicity value less than or equal to 1 milligram of the substance per litre of water.

9.1B - Substances that are ecotoxic in the aquatic environment.

Unless the chronic aquatic ecotoxicity value is greater than 1 milligram of the substance per litre of water, a substance—

(a) for which data indicate an acute aquatic ecotoxicity value greater than 1 milligram, but less than or equal to 10 milligrams, of the substance per litre of water; and

(b) that is not rapidly degradable or is bioaccumulative, or is not rapidly degradable and is bioaccumulative.

9.1C – Substances that are harmful in the aquatic environment.

Unless the chronic aquatic ecotoxicity value is greater than 1 milligram of the substance per litre of water, a substance -

(a) for which data indicate an acute aquatic ecotoxicity value greater than 10 milligrams, but less than or equal to 100 milligrams, of the substance per litre of water; and

(b) that is not rapidly degradable or is bioaccumulative, or is not rapidly degradable and is bioaccumulative.

9.1D - Substances that are slightly harmful to the aquatic environment or are otherwise designed for biocidal action.

(a) a substance for which data indicate that—

(i) the acute aquatic ecotoxicity value is greater than 1 milligram per litre of water but less than or equal to 100 milligrams of the substance per litre of water, but does not meet the criteria for hazard classification 9.1B or 9.1C; or

(ii) the chronic aquatic ecotoxicity value is less than or equal to 1 milligram of the substance per litre of water, but does not meet the criteria for hazard classification 9.1A, 9.1B, or 9.1C; or

(b) a substance that is designed for biocidal action, other than a substance that is designed for biocidal action against a virus, protozoan, bacterium, or an internal organism in humans or in other vertebrates, but does not meet the criteria for any hazard classification in class 9 other than 9.1D; or

(c) a substance that is not rapidly degradable and that is bioaccumulative unless the chronic aquatic ecotoxicity value is greater than 1 milligram of the substance per litre of water, but does not meet the criteria for hazard classifications 9.1A, 9.1B, or 9.1C.

The substances with the highest risk of entering the deck drains are those used in the drilling fluids or cements as these are held and used in the greatest quantities and will be present as residues on drill pipe, casings and other equipment that may be stored on deck areas. Other harmful substances that are considered include hydraulic fluids and lubricants (although all equipment using these fluids is within contained areas) and products used in very small quantities such as protective grease where there is not considered to be a feasible risk of spillage into deck drains.

Tamarind have taken considerable care selecting the SBM components to be used to minimise the use of harmful substances as far as practicable.

A total of six (6) harmful substances are now anticipated to be used in drilling fluids (synthetic based muds, inhibited seawater and wellbore clean up products) or cements. Key information on each product is summarised in *Table 3.2*.

Table 6.1 Harmful Substances used in the Drilling Project

Product	Use	Constituents / Core Content	HSNO Aquatic Toxicity Classifications
DRILLING MUDS			
Saraline 185V	Synthetic Based Mud (Planned)	Distillates, C8-C26. Branched and Linear (99-100%)	9.1B (All), 9.1B (F)
Lime	Synthetic Based Mud (Planned)	Calcium hydroxide (100%)	9.1D
Aldacide G	Inhibited Seawater (Planned)	Glutaraldehyde (10-30%)	9.1A (algal, crustacean), 9.1D (fish)
		Methanol (0.1-1%)	Not a harmful substance

Baraklean Dual	Wellbore Clean-up (Contingency)	Ethylene glycol monobutyl ether (30-60%)	Not a harmful substance
		Alcohols, C9-11, ethoxylated (10-30%)	9.1D
CEMENTING PRODUCTS			
NF-6	Cement (Planned)	Vegetable oil (60-100%)	9.1 D
		Aluminum stearate (1-5%)	Not a harmful substance
Cleanbore B	Cement (Contingency)	Mixture of C9-C11 alcohol ethoxylate (60-100%)	9.1D

Of the drilling fluids and cementing chemicals that are anticipated to be used, only one (Aldacide G) contains a component (comprising 10-30% of the total product) that is classified as 9.1A and one product (Saraline 185V) contains a component that is classified as 9.1B. The remaining four (4) products contain only ingredients that are ranked 9.1D or are not ecotoxic to aquatic organisms.

The primary hydrocarbon constituent of the drilling fluid is Shell GTL Saraline 185V. Saraline is readily biodegradable in both marine water (OECD 306) and freshwater (OECD 301F). It does not bioaccumulate and does not contain known carcinogens (e.g. poly-aromatic hydrocarbons) nor BTEX (benzene, toluene, ethylbenzene and xylenes).

A search of the specific gravity for the ecotoxic ingredients shows all to be very close to 1mg/mL (i.e. the product is very similar in density to freshwater), meaning the products will not sink and accumulate on the seabed

7 *UNPLANNED EVENT – SPILL MODELLING FOR JUNE – JANUARY*

The IA states that the drilling campaign is currently anticipated to commence in the summer and autumn season of 2018/2019 (section 3.2.4) and that the campaign duration is expected to take between seven and nine months at the outside. The spill modelling presented in Annexure F of the Impact Assessment took account of a release at any time during the anticipated project window (February to May) and then tracked it forward for up to 110 days (i.e. the modelling allowed for spill movement and weathering extending into winter and spring, depending on the tine of the release). To ensure the best information is available, including for spill planning and preparedness purposes, Tamarind has commissioned additional spill modelling from RPS Australia West Pty Ltd (RPS) to assess the behaviour of a spill where the release occurred in the period of June to January[5] as the prevailing weather conditions in this period may differ to summer and autumn. The spill scenarios considered included a worst case loss of well control that continued for 110 days (release volume totalling 654,516 bbls) and a 200m^3 diesel spill. The modelling methods used for the June to January period were the same as those used for a spill occurring in the February to May period[6] as described in the reports attached as Annexure F to the Impact Assessment. The full modelling report for the June to January period is included in ***Annexure B*** of this report (the "**RPS Winter Report**"). A summary of the RPS Winter Report's findings is provided below and in particular, how the findings differ from those in the previous reports.

7.1 Vessel Spill Incident

The higher wind speeds in the winter conditions resulted in a greater potential movement of a visible surface slick, which was predicted to extend a maximum of up to 64 km (34 km for the 99th percentile). The extent of moderate and high surface exposures were very similar to the previously modelled conditions, being a maximum of 18 km and 6 km, respectively.

The stronger winds also resulted in a 1% probability for shoreline contact (South Taranaki) from a vessel spill, although the minimum time for oil to accumulate on the shoreline was 86 hours. The maximum volume of oil to reach land was found to be 2 m^3 and affected not more than 1 km of shoreline (shoreline contact occurred in one of the 100 model runs.

7.2 Loss of Well Control

Sea Surface Exposure

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[5] RPS (2018) Tamarind Resources – Tui Field Oil Spill Modelling – Vessel Spill and 110-Day Loss of Well Control (June to January). Report No. MAQ0710J, Dated 13 July 2018

[6] RPS (2018) Tamarind Resources – Tui Field –Oil Spill Modelling (Vessel Spill and 45 Day Loss of Well Control). Report No. MAQ0648J, Dated 21 March 2018; and RPS (2018) Tamarind Resources – Tui Field – 110 Day Oil Spill Modelling. Report No. MAQ0648J, Dated 21 March 2018

Table 7.1 shows a summary of the potential extent of sea surface exposure (slicks) for the low, medium and high thresholds.

Table 7.1 Summary of potential zones of sea surface exposure (110-day loss of well control, June – January)

Period	Distance and direction	Zones of potential sea surface exposure		
		Low (0.5–10 g/m^2)	Moderate (10–25 g/m^2)	High (>25 g/m^2)
June - January	Max. distance from release site (km)	346	67	58
	Max. distance from release site (km) (99th percentile)	285	44	25
	Direction	North-Northeast	North-Northeast	East

The modelling shows that for a release between June and January the low sea surface exposure zone is potentially extended by 62 km (maximum distance from release) and 47 km (99th percentile) relative to a release between February and May. Both moderate and high sea surface exposure distances were also slightly extended (5 – 18 km).

Table 7.2 identifies potential for surface slick exposure and the time for oil to reach different regions and districts. There was less of a southerly component to the movement of a slick in winter conditions, resulting in increased probability of surface slicks reaching New Plymouth and further north. However, it is noted that surface slicks above the moderate (6% probability) or high (1% probability) threshold are still shown to reach only south Taranaki.

Table 7.2 Summary of potential zones of sea surface exposure to specific receptors (110-day loss of well control, June – January)

Receptors		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
		Low (0.5–10 g/m²)	Moderate (10–25 g/m²)	High (>25 g/m²)	Low (0.5–10 g/m²)	Moderate (10–25 g/m²)	High (>25 g/m²)
Regional Shorelines	Mana Island	11	0	0	419	0	0
	Kapiti Island	19	0	0	206	0	0
	Wanganui	91	0	0	136	0	0
	Franklin	11	0	0	341	0	0
	Marlborough	2	0	0	300	0	0
	South Taranaki	100	6	1	53	98	357
	New Plymouth	100	0	0	84	0	0
	Waitomo	74	0	0	172	0	0
	Otorohanga	13	0	0	354	0	0
	Waikato	35	0	0	248	0	0
	South Wairarapa	1	0	0	856	0	0
	Wellington	12	0	0	500	0	0
	Hutt City	1	0	0	764	0	0
	Kapiti Coast	33	0	0	215	0	0
	Horowhenua	72	0	0	207	0	0
	Manawatu	49	0	0	196	0	0
	Rangitikei	79	0	0	161	0	0
	Porirua	10	0	0	604	0	0
	Tasman	1	0	0	711	0	0
	Waitakere	1	0	0	895	0	0
Marine Reserves	Parininihi Marine Reserve	70	0	0	176	0	0
	Kapiti Marine Reserve	17	0	0	210	0	0
	Tapuae Marine Reserve	93	0	0	122	0	0
Marine Mammal Sanctuaries	West Coast North Island Marine Mammal Sanctuary - Taranaki	100	0	0	59	0	0
	West Coast North Island Marine Mammal Sanctuary - Northland	2	0	0	468	0	0
	West Coast North Island Marine Mammal Sanctuary - Waikato	93	0	0	121	0	0
	West Coast North Island Marine Mammal Sanctuary - Auckland	13	0	0	329	0	0

Dissolved Hydrocarbons and Aromatics

Greater mixing energy resulted in dissolved aromatics leeching away from the entrained oil while in the water column, resulted in zones of potential low and moderate exposure in the top 40 m of the water column, compared to the top 30m under summer condition.

The highest exposure to dissolved aromatics in the 0 – 10 m depth layer was a moderate exposure (potentially impacting average sensitive species) and occurred adjacent to the South Taranaki shoreline.

Zones of potential entrained hydrocarbon exposure were much smaller than for the dissolved aromatics. The low exposure zone was limited to the upper 10 m of the water column and no moderate or high exposures occurred at any depth.

Shoreline Exposure

Shoreline exposure patterns were similar to the modelling for a release between February and May, although again there was an increased probability of shoreline contact in South Taranaki and New Plymouth as a result of the stronger easterly flows. In other cases the differences in exposure probability were only a few percent, and no additional regions were predicted to be affected by moderate or high shoreline loadings although the time to oil stranding was lessened relative to summer conditions (3 – 37 days compared to 7 – 42 days in the February to May period). Modelled peak loadings on shorelines were also increased, particularly in parts of the Whanganui/Manawatu region. *Table 7.3* shows the summary results for the potential shoreline exposure from a loss of well control for the winter conditions. *Table 7.4* provides a summary of the potential shoreline exposure at specific receptor locations.

Table 7.3 Summary of shoreline contact at or above 10g/m2 (110-day loss of well control, June – January)

Shoreline statistics	June– January Period
Probability of contact to any shoreline (%)	100
Absolute minimum time for visible oil to shore (hours)	61
Maximum volume of hydrocarbons ashore (m^3)	1,067
Average volume of hydrocarbons ashore (m^3)	535
Maximum length of the shoreline at 10 g/m^2 (km)	414
Average shoreline length (km) at 10 g/m^2 (km)	266
Maximum length of the shoreline at 100 g/m^2 (km)	273
Average shoreline length (km) at 100 g/m^2	161
Maximum length of the shoreline at 1,000 g/m^2	33
Average shoreline length (km) at 1,000 g/m^2 (km)	9

Table 7.4 Summary of shoreline contact to individual shoreline receptors (110-day loss of well control, June – January)

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (day)
	>10 g/m2	>100 g/m2	>1,000 g/m2	>10 g/m2	>100 g/m2	>1,000 g/m2	Mean	Peak	Mean	Peak	>10 g/m2	>100 g/m2	>1,000 g/m2	>10 g/m2	>100 g/m2	>1,000 g/m2	
Mana Island	10	7	0	420	814	-	175	413	5	9	2	2	0	3	3	0	17
Kapiti Island	18	14	0	209	214	-	204	904	18	50	8	5	0	18	10	0	9
Wanganui	90	80	9	141	164	307	146	1841	31	120	17	10	2	41	24	3	6
Marlborough	1	0	0	303	-	-	40	41	1	1	2	0	0	2	-	0	13
South Taranaki	100	100	70	61	72	106	275	4199	319	739	119	73	7	164	109	27	2
New Plymouth	100	99	26	99	110	273	183	3156	126	419	66	39	3	120	82	9	4
Waitomo	74	69	9	170	190	286	157	2541	62	292	31	20	2	81	67	6	7
Otorohanga	13	9	0	261	405	-	108	300	9	21	6	5	0	11	9	0	15
Waikato	32	23	0	252	325	-	95	490	11	34	7	4	0	31	12	0	10
South Wairarapa	1	0	0	836	-	-	58	79	2	2	3	0	0	3	0	0	36
Wellington	12	4	0	503	635	-	73	344	2	10	3	2	0	9	4	0	21
Hutt City	1	1	0	753	821	-	71	124	2	2	3	1	0	3	1	0	32
Kapiti Coast	32	30	0	218	252	-	168	758	28	69	15	8	0	41	19	0	9
Horowhenua	72	69	26	210	220	377	261	5651	58	265	17	10	3	42	40	9	9
Manawatu	47	40	0	197	209	-	182	989	25	81	10	9	0	14	14	0	8
Rangitikei	79	73	16	162	189	208	257	1775	56	164	17	14	2	34	28	5	7
Porirua	10	10	0	592	639	-	161	569	15	21	9	5	0	18	6	0	25
Tasman	1	0	0	714	-	-	22	29	1	1	3	0	0	3	0	0	30
Waitakere	1	0	0	897	-	-	48	61	4	4	3	0	0	3	0	0	37
Franklin	11	8	0	343	376	-	86	215	9	14	5	3	0	19	6	0	14

Annexure A

Deck Drainage System - HYSY 982 Drilling Rig

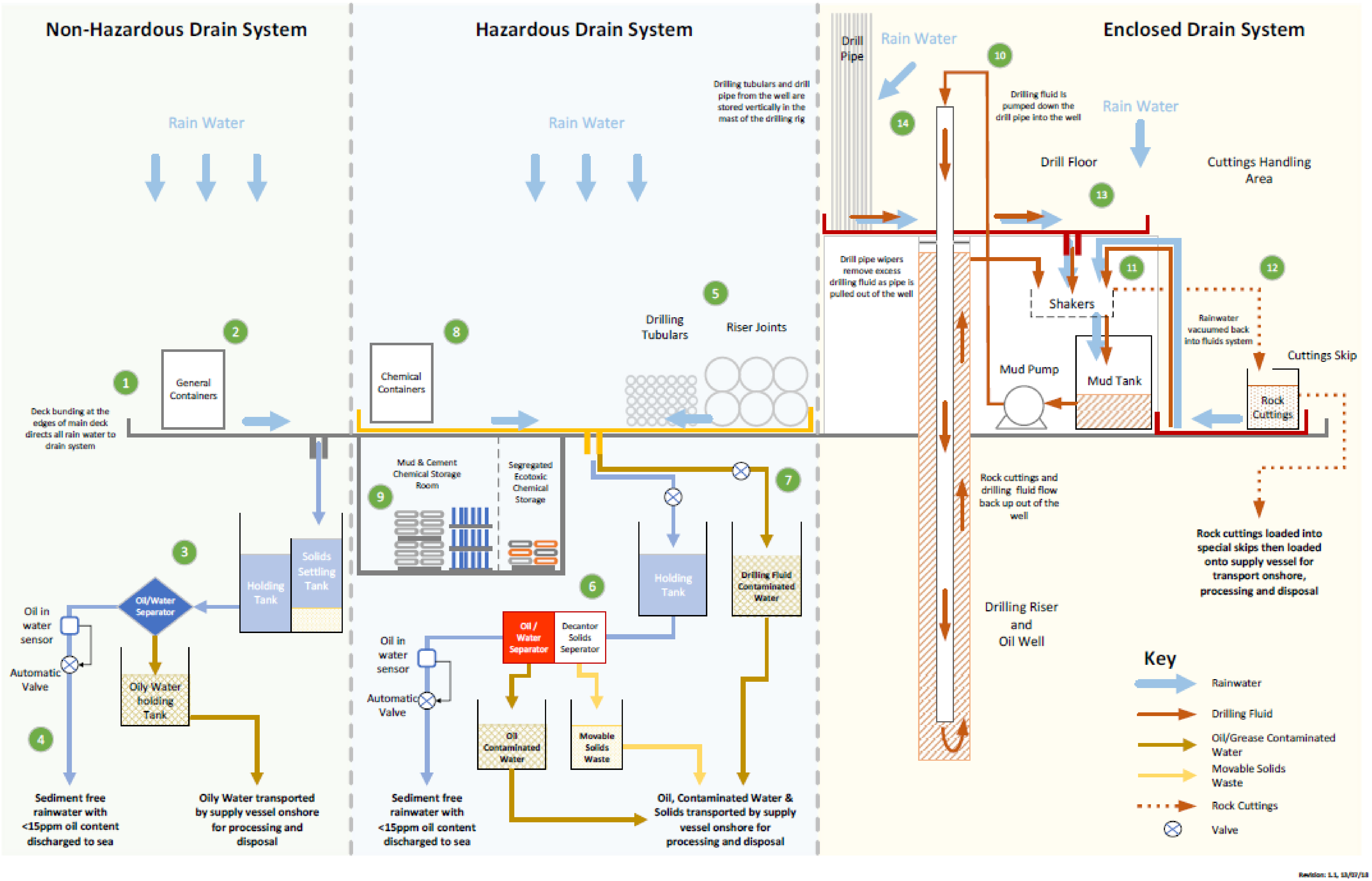

Figure A.1 Management of Drainage and Hazardous Substances on Board the HYSY 982 Drilling Rig

Annex B

RPS Winter Report

Oil Spill Modelling – June to January