BEFORE THE BOARD OF INQUIRY
TAMARIND DEVELOPMENT DRILLING APPLICATIONS

EEZ100016

IN THE MATTER	of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER	of a Board of Inquiry appointed under s52 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 to decide on Tamarind Taranaki Limited's marine consent and marine discharge consent applications

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STATEMENT OF EXPERT EVIDENCE OF ALISON LANE FOR TAMARIND TARANAKI LIMITED

Dated: 20 July 2018

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THE LAWYERS

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MAY IT PLEASE THE BOARD

1. Executive Summary

1.1 The marine discharge consent application by Tamarind Taranaki Limited ("Tamarind") is for the discharge of harmful substances in offshore processing drainage from a drilling rig. Discharges of harmful substances have potential to occur where these substances are released or splashed onto the decks of the drilling rig and residues are washed into the deck drainage system with rain water.

1.2 A total of six ecotoxic or harmful substances in drilling muds and cements has have been identified by Tamarind as the substances that will be used when carrying out its proposed activities, only one of which contains components ranked a 9.1A[1]. If any of these substances are discharged through offshore processing drainage they will be subject to rapid dispersion and dilution as a result of the typical offshore wind, wave and current conditions and water depth at the site.

1.3 Based on the reported ecotoxicity of each of the products, I have calculated that ecotoxic thresholds could only be exceeded very close to the point of discharge. Additionally, these ecotoxicity thresholds are based on studies where there is an extended period of exposure (48 hours or more), which would not occur in the case of a deck drain discharge. I therefore conclude that the potential for marine ecosystems or species to be adversely impacted as a result of offshore processing drainage is negligible.

1.4 Discharge of harmful substances including chemicals or hydrocarbons may potentially occur as a result of an unplanned spill. Other than a major spill resulting from loss of bunker fuel from a vessel or a loss of well control, the potential quantities of any such discharge are relatively small and would be subject to high rates of natural dilution as described for offshore processing drainage.

1.5 A large spill of diesel from a vessel incident or crude oil from a loss of well control has potential to affect a larger area of the ocean surface and to lead

[1] Aquatic Toxicity Classifications, Hazardous Substances (Classification) Notice, 2017

to shoreline accumulations of oil that could impact on marine and coastal wildlife and environmental values. The greatest risk from such a spill would be to sensitive planktonic organisms and wildlife coming into direct contact with a slick. While I consider there is little potential for actual impacts on human health from a spill incident, the perception of risk and possible closure of fisheries or shoreline areas during a clean up could impact on fisheries interests and coastal marine users.

1.6 Tamarind has an established environmental monitoring programme, which means that the area where activities are to occur is well characterised. I consider that the existing environmental monitoring programme in the Tui field is adequate to measure any potential post-drilling impacts on the benthic sediment quality and communities.

2. Introduction

2.1 My full name is Alison Lane.

2.2 I hold the following qualifications:

2.2.1 A PhD specialising in marine hydrocarbon ecotoxicology from University of Tasmania; and

2.2.2 A Bachelor of Applied Science (Coastal Management) and Honours by research on the effects of fuel oil and dispersed oil on coral reproduction.

2.3 My post-graduate research focused on the effects of hydrocarbon contaminants and chemical dispersants on marine invertebrate species.

2.4 I am a Technical Director at ERM New Zealand Ltd and have held that position since 1 January 2015. Prior to that I was a Principal Consultant (Marine) at ERM in Australia and New Zealand since January 2013.

2.5 My previous experience includes roles as a Senior Associate (Marine) at URS in Australia, an Environmental Advisor at Maritime New Zealand, and Environmental Compliance Manager at Otago Regional Council. My work experience over the past 14 years has included aspects of marine impact assessment, oil spill planning, preparedness and response, including leading environmental planning and preparedness for marine spills at Maritime New Zealand.

2.6 I have read the following information in preparation of my evidence:

2.6.1 The Marine Consent Application and Marine Discharge Consent Application (the "Applications") and the Impact Assessment and its Annexures (the "IA"), which accompanied the Applications, and in particular those aspects relating to the discharge of harmful substances from offshore processing drainage, impacts from unplanned marine spills and monitoring studies conducted in the field.

2.6.2 The statements of evidence by:

(a) Mr Jason Peacock;
(b) Mr Iain McCallum;
(c) Dr Brian King;
(d) Dr Simon Childerhouse;
(e) Dr Sharon de Luca;
(f) Ms Nicola Gibbs;
(g) Dr David Thompson;
(h) Dr Alison MacDiarmid; and
(i) Mr Fraser Colegrave.

2.6.3 Submissions.

2.6.4 Proposed consent conditions.

2.6.5 EPA Key Issues Report, dated July 2018

2.6.6 The following independent reviews commissioned by the EPA (the "Technical Reviews"):

(a) *Technical Review of Oil Spill Modelling*, prepared by Coffey Services (NZ) Limited, dated June 2018;

(b) *Technical Review and Analysis of Operational* Activities *associated with Sidetrack Development Drilling and Marine Discharge Consent - Assessment Report*, prepared by Oil and Gas Solutions Pty Limited, dated 22 May 2018; and

(c) *Review of Marine Environmental Impact* Assessment, prepared by SEAPEN Marine Environmental Services, dated 26 May 2018.

2.6.7 Tamarind's '*Response to the s54 Request for Further Information'*, dated July 2018 ("RFI Response").

2.7 My role in relation to Tamarind's Applications has been to assist Tamarind to prepare the Applications and IA and to provide technical leadership and oversight with respect to the assessments within these documents. I have also considered and assessed the potential impacts of the deck drain discharges and the unplanned activities on marine ecosystems and I have been engaged to provide expert evidence on this topic and to respond to any issues relevant to my expertise raised by the Board of Inquiry, the EPA and/or submitters.

Code of conduct

2.8 I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2014 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is entirely within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

2.9 My qualifications as an expert witness are set out above. The issues addressed in this brief relate to the application for a marine consent and marine discharge consent and are matters within my area of expertise

Scope of evidence

2.10 In this evidence, I will discuss the following:

2.10.1 Harmful substances in offshore processing drainage;

2.10.2 Potential impacts on the environment and existing interests of planned discharges of harmful substances from offshore processing drainage;

2.10.3 Potential impacts on the environment and existing interests of unplanned spills of fuel, oil or chemicals associated with the use of a drilling rig;

2.10.4 Spill response planning;

2.10.5 Environmental monitoring undertaken to inform the assessment of impacts from activities in the field;

2.10.6 Response to issues raised by the EPA Key Issues Report and technical reviews, where these are relevant to my evidence; and

2.10.7 Response to issues raised by submitters, where these are relevant to my evidence.

3. Harmful substances in offshore processing drainage

Description of planned deck-drain discharges

3.1 The marine discharge consent application by Tamarind is for discharges of harmful substances in offshore processing drainage from the drilling rig. In simple terms, the proposed deck drain discharges can be described as 'run-off' from the decks of a drilling rig which may contain some harmful substances used in drilling and general maintenance activities on the decks of the drilling rig. The term harmful substance is defined in the Environmental Effects - Discharge and Dumping) Regulations 2015 (the "Discharge and Dumping Regulations"), and includes substances that are ecotoxic to aquatic species (classified as 9.1 under the *Hazardous Substances (Classification) Notice, 2017*) and oil.

3.2 Based on the design of the offshore processing drainage system on the drilling rig as described in Mr McCallum's evidence[2] and Tamarind's RFI Response, deck drainage is separated into hazardous and non-hazardous drainage systems for treatment and disposal. The non-hazardous drains receive water only from areas where there is no handling, use or storage of harmful substances. In areas where harmful substances are used or stored the areas are contained in such a way as to prevent the release of any spilled products (e.g. in storage holds or mud recycling tanks) or drainage is directed to a system that provides for containment, treatment and monitoring of large volumes of water before any discharge. The drainage system also has provision for stored water to be pumped off the drilling rig to a vessel or shore-based reception facility.

3.3 As described in the evidence of Mr McCallum[3], only limited areas of the drilling rig may be used for storage of drill pipe and other drilling equipment that is being changed out (i.e. exceptional cases) where there is potential for runoff to be directed into the hazardous drains.

3.4 Detailed descriptions of the treatment systems and control measures to avoid and manage any spills of harmful substances on the drilling rigs are included in the IA, the RFI Response and the evidence of Mr McCallum. Tamarind has identified that in a worst feasible case a volume of 20 litres of any spilled harmful substance has potential to enter the hazardous deck drain system and be discharged as offshore processing drainage.

4. Potential impacts of planned deck-drain discharges

4.1 The potential impact of Tamarind's potential deck-drain discharges on the environment will be a function of:

4.1.1 The mechanisms of ecotoxicity and exposure of environmental receptors;

[2] Refer to the Evidence of Iain McCallum, page 23

[3] Refer to the Evidence of Iain McCallum, page 24, paragraph 3.12

4.1.2 The characteristics of the discharges; and

4.1.3 The possible exposure levels of receptors to the discharges, influenced by discharge volumes and dilution.

Mechanisms of ecotoxicity and exposure of environmental receptors

4.2 In general, effects of contamination may occur at any level of ecological organisation, from individual organisms to inter-species relationships and energy flow[4]. These effects are a function of the physical, chemical and biological properties of the contaminant, and of the interactions occurring within the ecosystem[5]. It is recognised that sub-lethal effects, such as impaired reproduction, may be at least as significant as lethality in their impacts on ecosystems [5, 6].

4.3 Different species have different sensitivities to harmful substances and these relate to their physiology and also their ability to metabolise contaminants. Besides the sensitivity of the specific organism, the key factors influencing impacts are the exposure concentration and duration of exposure. This means that a high concentration may cause effects even over a short exposure period, whereas lower concentrations will generally have a lesser effect over a short period but may result in effects when the exposure is continued for a number of days.

4.4 Different chemicals have different physical and chemical properties, and the environmental fate and effects of the contaminant will be affected by these properties. Transformations of substances in the marine environment may include mechanical transport, emulsification, evaporation, oxidation, dissolution, absorption, adsorption[7] and biodegradation [8, 4].

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[4] Chapman JC and Davies PE (1993) The contribution of laboratory and field research to an understanding of the impact of chemicals on the environment. Proceedings of the Ecotoxicology Specialist Workshop, Wee Waa, NSW. LWRRDC: 29-39.

[5] Connell (1986) Ecotoxicology – a new approach to understanding hazardous chemicals in the environment. *Search* 17:27-31.

[6] IPIECA (1992) Biological impacts of oil pollution. International Petroleum Industry Environmental Conservation Association. London.

[7] Being the adhesion of gas, liquid or dissolved solids to a surface.

[8] Berger (1991) The impacts of South China Sea oil spills on the environment of Palawan. *The Phillippean Scientist* 28:27-54.

4.5 Therefore, exposure of environmental receptors and existing interests to contaminants will depend on the mechanism of transport and fate of the contaminant, the presence of different receptors and how those receptors interact with the environment. For example, pelagic species such as marine mammals, fish and plankton will potentially be exposed to contaminants that disperse into the water column. Benthic organisms would be exposed where the contaminant reaches the seabed via dispersion, sinking or sedimentation. The mechanism of exposure for pelagic and benthic species would be some combination of ingestion (either directly, or through feeding on other organisms that have accumulated the contaminant), or through absorption via dermal contact.

4.6 Potential exposure of human receptors at the location where the activities occur would be through exposure to vapours from floating chemicals (i.e. workers at the site or nearby vessel or platform crews), or ingestion via seafood that has accumulated the contaminant. Given the distance from shore, and the nature and quantities of potential discharges as described below, I consider that exposure of environmental or human receptors outside the Area of Interest ("AOI")[9] is not feasible.

4.7 Exposure levels of marine organisms to the discharges will be a function of both the concentration of the substance, which I consider is likely to be low due to expected small quantities discharged and dilution in the drain system and after discharge, and the duration or frequency of exposure. Prior to discharge overboard any harmful substances will be diluted by the holding tank water content (reported by Tamarind to be approximately 300 m^3).

4.8 Discharges from deck drain holding tanks will occur when water is pumped from the tanks (if a harmful substance has entered the drainage system). The duration of exposure may therefore extend to the period that a particular organism remains in the area when the discharge is occurring.

4.9 As noted by Dr MacDiarmid, it is not expected that there would be significant impacts on plankton, fish or marine reptiles from the deck drain discharges.[10]

[9] The Area of Interest is the area of petroleum mining permit PMP38158 that is in the EEZ.

[10] Refer to the Evidence of Alison MacDiarmid, paragraph 5.1

As noted by Ms Gibbs, the key fisheries target species, jack mackerel is very mobile[11].

4.10 As noted by Dr Childerhouse, marine mammals range and forage over large areas, so any local exposure of these species to any harmful substance is likely to extremely short in duration and unlikely to be repeated[12].

4.11 Some benthic fish species and benthic invertebrates have the potential to remain in the area for extended periods, particularly sedentary invertebrate species, and so are at increased risk of multiple exposure. However, these species will be at water depths that mean concentrations would typically be very low by the time they are exposed.

Characteristics of potentially discharged chemicals

4.12 A total of six harmful substances have been identified by Tamarind that have feasible potential for discharge into the hazardous deck drains as a result of the proposed activities. Of the drilling fluids and cementing chemicals, only one contains a component (comprising 10-30% of the total product) that is classified under the *Hazardous Substances (Classification) Notice 2017* as 9.1A (very ecotoxic in the aquatic environment) and one product contains a component that is classified as 9.1B (ecotoxic in the aquatic environment). The remaining four products contain only ingredients that are ranked 9.1D (slightly harmful to the aquatic environment) or that are not ecotoxic to aquatic organisms. Details of the substances and their constituents are shown in Table 1.

Table 1: Harmful substances that may enter deck drains

Product	Use	Constituents / Core Content	HSNO Aquatic Toxicity Classifications
Saraline 185V	SBM (Planned)	Distillates, C8-C26. Branched and Linear (99-100%)	9.1B
Lime	SBM (Planned)	Calcium hydroxide (100%)	9.1D

[11] Refer to the Evidence of Nicola Gibbs, page 18, paragraph 4.9

[12] Refer to the Evidence of Simon Childerhouse, page 24

Adacide G	Inhibited Seawater (Planned)	Glutaraldehyde (10-30%) Methanol (0.1-1%)	9.1A (algal, crustacean) 9.1D (fish) Not a harmful substance
Baraklean Dual	Wellbore Cleanup (Contingnecy)	Ethylene glycol monobutyl ether (30-60%) Alcohols, C9-11, ethoxylated (10-30%)	Not a harmful substance 9.1D
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
		Isopropanol (10-30%)	Not a harmful substance

Exposure levels as a function of discharge volume and dilution

4.13 Solids in deck drainage will be captured in settlement tanks as described by Mr McCallum[13], therefore only entrained and dissolved substances have the potential to be discharged to sea from hazardous deck drains. Oil or oil-like products that have entered the closed deck drain system will be largely removed by the oily-water separator prior to discharge.

4.14 The marine environment in the area of the proposed activities is characterised by relatively deep (~120 m) open ocean conditions. Annual average wind speeds close to the AOI demonstrate two predominant directions; south-westerly winds during August to February and south-westerly and south-easterly during March to July. Monthly average wind speeds range from 15–19 knots and the monthly maximum wind speeds range from 41–54 knots with the highest wind speeds typically occurring in July[14].

4.15 Surface current speeds and directions in the AOI are variable over time, though with a predominant flow towards the south-southeast and north. The

[13] Refer to the Evidence of Iain McCallum, page 24

[14] RPS (2018) Tamarind Resources Tui Field – Oil Spill Modelling. Report prepared for ERM New Zealand Limited. 3 July 2018.

maximum and average surface current speeds are modelled to be 1.44 m/s and 0.24 m/s, respectively).

4.16 To assess the potential for impacts on environmental receptors, I have considered the lowest effective concentration (EC) for sublethal ecotoxic effects on the most sensitive species that are reported for each substance. These are reported as EC50 values, which refer to the concentration that would cause a sublethal effect (e.g. inhibited growth) on 50% of a population that had been exposed to the substance. Exposure times for these tests ranged from 48 hours to 96 hours, depending on the effect being studied.

4.17 In each case the EC50 concentration (which ranged from 0.26 mg/L (96-hour exposure of algae) to >3,200mg/L) has been used to determine the dilution needed to reduce any harmful constituents below a feasible impact threshold.

4.18 As described in the IA[15], it is intended that any spilled product would be immediately cleaned up and only residual quantities have the potential to enter the deck drainage system. Typically this quantity would be trace amounts only, however for the purposes of conservatism I have considered the potential discharge of up to 20 kg (or 20 L in the case of liquids) of a harmful substance in each case.

4.19 Dilution of product will occur in stages. Firstly any water that washes the product into the slops tank will dilute the product, which will then be further diluted into any water within the slops tank. The slops tank on the 982 Rig, which Tamarind anticipates using, is 297 m^3, and so when full would effectively dilute 20 L of a substance to a concentration of 67.3 mg/L (ppm). Following discharge, the product will be further diluted by the surrounding seawater.

4.20 To illustrate the nature of dilution in the surrounding seawater, even completely undiluted by the water within the slops tanks, 20 litres of product would be diluted to ~1 mg/L (1 ppm) within a receiving water volume of 20,000 m^3. Although in practice dilution will typically not be homogenous, to assist with visualising the approximate area, the cube root (i.e. the side of a

[15] Refer to the IA, page 65.

cube representing 20,000 m³) of this water volume is approximately 27.1 m (i.e. a volume of 27.1 m x 27.1 m x 27.1 m) (Figure 1).

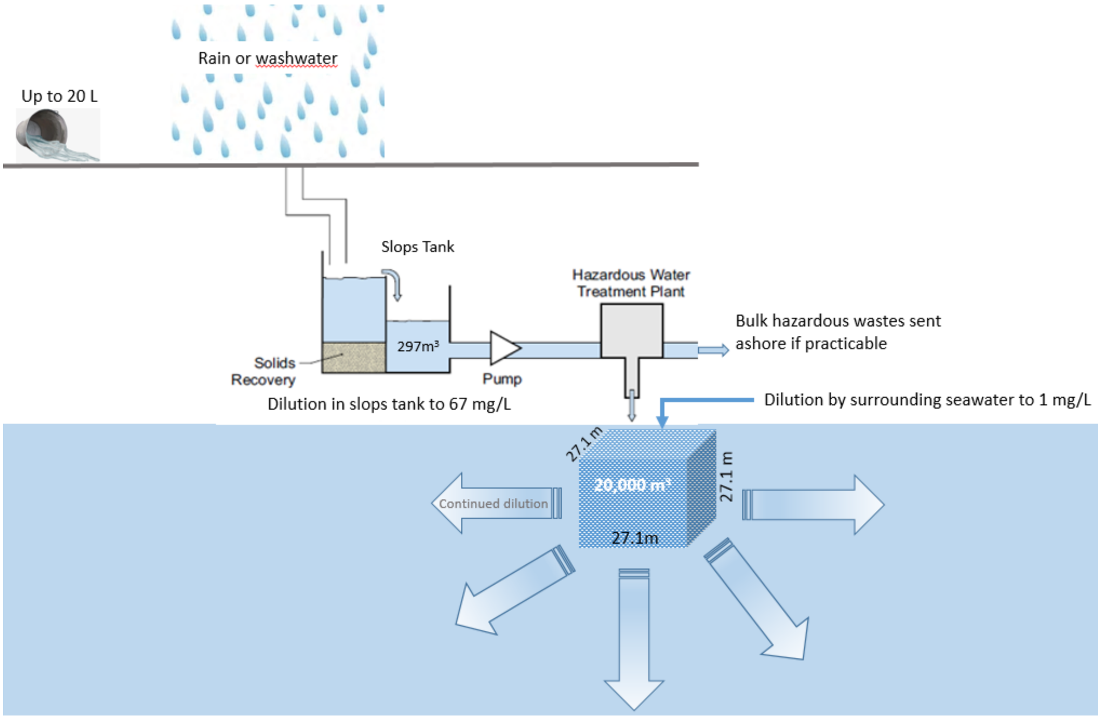

Figure 1: Conceptual Model showing Transport and Dilution of Spilled Substances

4.21 The required volume of receiving seawater to dilute each substance is shown in Table 2. Where only a proportion of the product is harmful (e.g. the 9.1 chemical makes up 30% of the whole product), a discharge of the whole product will equate to a lesser discharge of the toxic component. I have taken this into account in considering the required dilution of each harmful substance in Table 2.

Table 2: Ecotoxicity and assessed dilution requirements for harmful substances

Product	Reported Ecotoxicity (mg/L)	Assessed Required Dilution (mg/L)	Required Receiving Water Volume (m^3)	Cube Root (m)
Saraline 185V	>100	100	200	5.85
Lime	49	49	408	7.42
Aldacide G	0.35 (Gluteraldehyde ≤30%) = 1.17 whole product	1.17	17 094	25.76
Baraklean Dual	0.26 (Alcohols C9-11 ≤30%) = 0.86 whole product	0.86	23 256	28.54
NF-6	>3,200	3200	6	1.82

Cleanbore B	0.26	0.26	76 923	42.53

4.22 As noted above, EC50 values are based on tests where the organism is exposed for an extended period (between 48 and 96 hours). In practice, any discharge will be very rapidly diluted in the surrounding seawater and exposure at the initial discharge concentration will be of an extremely brief duration (e.g. not more than a few minutes). As ecotoxicity is a function of both exposure concentration and the duration of the exposure, this means that a short exposure at the reported EC50 concentrations is unlikely to result in impacts.

4.23 Given the localised water volume in which EC50 values may be reached and the expected extremely short duration that these concentrations would occur, the potential effects of the discharge of harmful substances in the deck drainage is considered to be negligible, consistent with the IA findings.

4.24 Any potential for human health impacts from harmful substances in offshore processing drainage would be dependent on exposure levels. There would be a 500 metre non-interference zone established around the operating drilling rig, meaning that vessels not directly engaged on work in the Tui field will not be operating near to the discharge activities.

4.25 The distance of the activities from shore means that recreational water users, including recreational fishers, will be located many kilometres from the activities and I consider that, with the resulting dilution of any discharge over these distances, exposure of people to harmful substances in the water is extremely unlikely.

4.26 The mobility and low potential exposure of commercial fish species, as discussed above, means there is negligible risk of accumulation of harmful substances in fish that could impact on consumers.

4.27 It is my assessment that any harmful substance present in offshore processing drainage is likely to be rapidly diluted and reach very low concentrations, below any ecotoxic threshold for even sublethal effects on sensitive species within a short distance from the discharge point. This is due to the combination of.

4.27.1 the expected small quantity of any harmful substances within offshore processing drainage (i.e. residual amounts from intermittent splashes etc. where bulk material is expected to have been manually cleaned up); and

4.27.2 the significant water depths and hydrodynamic conditions at the drilling locations.

4.28 Due to the small volumes of discharge and high rates of dispersion, as well as the removal of settled solid materials prior to discharge, I consider it highly unlikely that substances discharged through the deck drains will accumulate in marine sediments at the drilling site.

4.29 The low concentrations and rapid dispersion also significantly reduce the potential for cumulative effects where marine species are exposed to more than one contamination source. Any direct exposure is likely to be one-off and of a short duration due to the nature of the discharge and the mobility of the marine fauna and seabirds in the area.

4.30 Potential impacts on specific marine species and habitats are addressed in detail in the evidence of Dr Thompson, Dr Childerhouse, Dr MacDiarmid and Dr DeLuca, all of whom conclude that there is negligible potential for impacts on marine fauna or ecosystems.

4.31 Based on the above analysis, I consider that there would not be any measurable effect on marine fauna or ecosystems as a result of offshore processing drainages. Any impacts would be restricted to localised effects on planktonic species which would not impact on the broader population or any species that depend on plankton as a food source.

5. Potential impacts of unplanned spills of fuel, oil or chemicals

5.1 Drilling activities carry with them a risk of accidental occurrences that may lead to small discharges of hydrocarbons or other substances into the marine environment. These include the following unplanned events:

5.1.1 Spills of chemicals or fuel during transfer, handling, storage and use; or

5.1.2 Diesel, lubricating oil or chemical spills from a vessel incident.

5.2 The extent of the potential impact of a marine spill resulting from the above-mentioned events will be determined by the nature and severity of the event, and the specific harmful substances that are spilled during the incident. A wide range of different products or spill volumes may be involved in an unplanned event. Below I address spill sources, risks and potential impacts associated with the following substances potentially lost during an unplanned event:

5.2.1 Harmful substances other than oil;
5.2.2 Diesel;
5.2.3 Lubricant and hydraulic fluids.

Harmful substances other than oil – spill sources and risks

5.3 A range of harmful substances are likely to be used on a drilling rig as part of normal operations. Potential events leading to the accidental discharge of these substances are splashes and spills during handling and use, the majority of which are expected to be contained or cleaned up on deck, but which may enter the offshore processing drainage system and are addressed in the earlier sections of my evidence.

5.4 In addition, spills may occur during transfer of chemicals during re-supply by support vessels, or as a result of more significant events, such as a vessel collision. A spill in conjunction with the transfer of chemicals is considered unlikely and in respect of a vessel collision, extremely unlikely.

5.5 In general, and as noted in the IA, all harmful substances used by Tamarind are stored in sealed containers in accordance with the substance-specific requirements in the relevant hazardous substances Safety Data Sheet[16] when not in use. In the case of these substances, the potential for release during an incident would require damage to the storage container. As set out in the IA, harmful substances are also loaded into, and stored in, fully bunded areas so that spills can be contained and cleaned up[17]. Undamaged containers lost overboard will either float or sink. There is some potential for them to be recovered before their contents are released into the environment. These factors all mitigate against the potential for accidentally spilt material being lost into the marine environment.

5.6 As discussed earlier in paragraph 4.12 of my evidence, Tamarind has identified six harmful substances products that will be present in the drilling fluids and cementing products. In addition, other chemicals may be present on the drilling rig or support vessels, such as lubricants, hydraulic fluids, paints and cleaning and maintenance products.

5.7 The marine environment in the area is characterised by relatively deep water (~120 m), and high energy wind and wave conditions. In the event that chemicals are accidently lost overboard I would consider these substances would be subject to rapid breakup and dilution under the typical hydrodynamic conditions described above.

5.8 Exposure to spilled substances would typically be in the form of a short-term pulse, except in circumstances where a dropped container was damaged and was slowly discharging its contents.

5.9 Any impacts from spills of harmful substances are likely to be localised in nature, with the greatest risk being to sensitive water column species such as plankton or juvenile fish if these are present in the immediate area at the time of the spill.

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[16] Safety Data Sheets (SDS) are a widely used system for cataloging information on chemicals, chemical compounds, and chemical mixtures. SDS information may include instructions for the safe use and potential hazards associated with a particular material or product.

[17] Refer to the IA, page 146.

Diesel spill sources and risks

5.10 Diesel is used as fuel on a drilling rig for on-board equipment such as power generators. There is an unlikely potential for small spills to occur overboard during refuelling of this equipment. However, refuelling is undertaken in bunded areas or areas where any spill would be directed to the segregated hazardous drainage system. Closed drains pass through oil separation systems prior to discharge.

5.11 As set out in the IA[18], any diesel spill during re-fuelling of equipment would be mitigated through containment and immediate clean-up using on-board spill kits in accordance with the vessel or rig's Oil Pollution Emergency Plan. These kits contain sorbent materials suitable for recovery of hydrocarbons. Any oil-contaminated drainage water will be directed through the oily water treatment system, mitigating the potential for impacts.

5.12 Where there is a requirement for re-supply, diesel is pumped directly into fuel storage tanks on board a drilling rig via flexible hoses from support vessels (referred to as 'bunkering'). This activity poses a risk of diesel discharge into the sea only in the unlikely event of a hose or coupling failure. The use of dry break couplings is standard industry practice, and is expected to be used by Tamarind to mitigate the risk of spills by reducing the potential volume of diesel lost. Dry break couplings provide an automatic mechanism to seal off both the hose and the fixed pipe end when the hose is disconnected. All fuel transfer activities will also be closely supervised by crew on the supply vessel and drilling rig in accordance with standard marine operational practices.

5.13 Support vessels used on the project will also use marine diesel as fuel. A major vessel incident such as a collision, while extremely unlikely to occur due to the navigational and safety controls around operations in the field, has the potential to result in a diesel spill from one or more of the vessels' bunker tanks. The amount of diesel lost in such an incident depends on the location and extent of any damage and the size of the vessel. The worst credible case spill from this source has been estimated at 150 m3, which would

[18] Refer to the IA, page 146.

represent the loss of the entire contents of the largest bunker tank of an anchor handling vessel operating in the field. Spill modelling was conservatively undertaken for a 200 m^3 diesel release[19].

5.14 Hydrocarbon "fractions" are useful descriptive divisions used to describe a hydrocarbon based on its molecular properties that influence factors such as evaporation or persistence. The usual nomenclature system refers to hydrocarbons based on the number of carbon atoms in each hydrocarbon molecule (e.g. C10 means there are 10 carbon atoms per molecule, each of which will also be associated with one or more hydrogen atoms). Diesel is generally comprised of hydrocarbon fractions in the range of C10-C28 [20] and is characterised by a large mixture of low and semi-low volatile compounds (95%) and persistent hydrocarbons (5%)[21].

5.15 If spilled at sea, diesel will spread out rapidly and form a continuous slick on the water's surface, generally not more than 50 microns (0.05 mm) thick[22]. This will then be broken up into smaller slicks by wave and wind action. Weathering of diesel spilled at sea is dominated by evaporation and natural dispersion into the water column in response to wave energy. As shown in Figure 2 below, under all but exceptionally low wind conditions no diesel remains on the water surface within one day of the release. The remaining diesel is lighter than seawater and will not sink or accumulate in sediments, although droplets entrained in the near surface waters by wave action can adhere to suspended sediments if these are present. This resurfacing would however be unlikely to occur in an open ocean environment [23].

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[19] RPS (2018) Report *Tamarind – Tui Field Oil Spill Modelling (Vessel Spill and 45-day Loss of Well Control)*. MAQ0648J. 21 March 2018.

[20] ALS (2015) Petroleum hydrocarbon ranges. http://www.caslab.com/Petroleum-Hydrocarbon-Ranges/. Accessed 11/02/2015.

[21] Wang Z, Hollebone BP, Fingas M, Fieldhouse B, Sigouin L, Landraiult M, Smith P, Noonan J and Thouin G (2003) Characteristics of spilled oils, fuels and petroleum products: 1. Composition and properties of selected oils. EPA/600-03/072 July 2003.

[22] Bonn (2016) The Bonn Agreement Oil Appearance Code. https://www.bonnagreement.org/site/.../special_on_volume_calculation_20160607.doc.

[23] NOAA (2015) http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/small-diesel-spills.htmlPeters et al 1997.

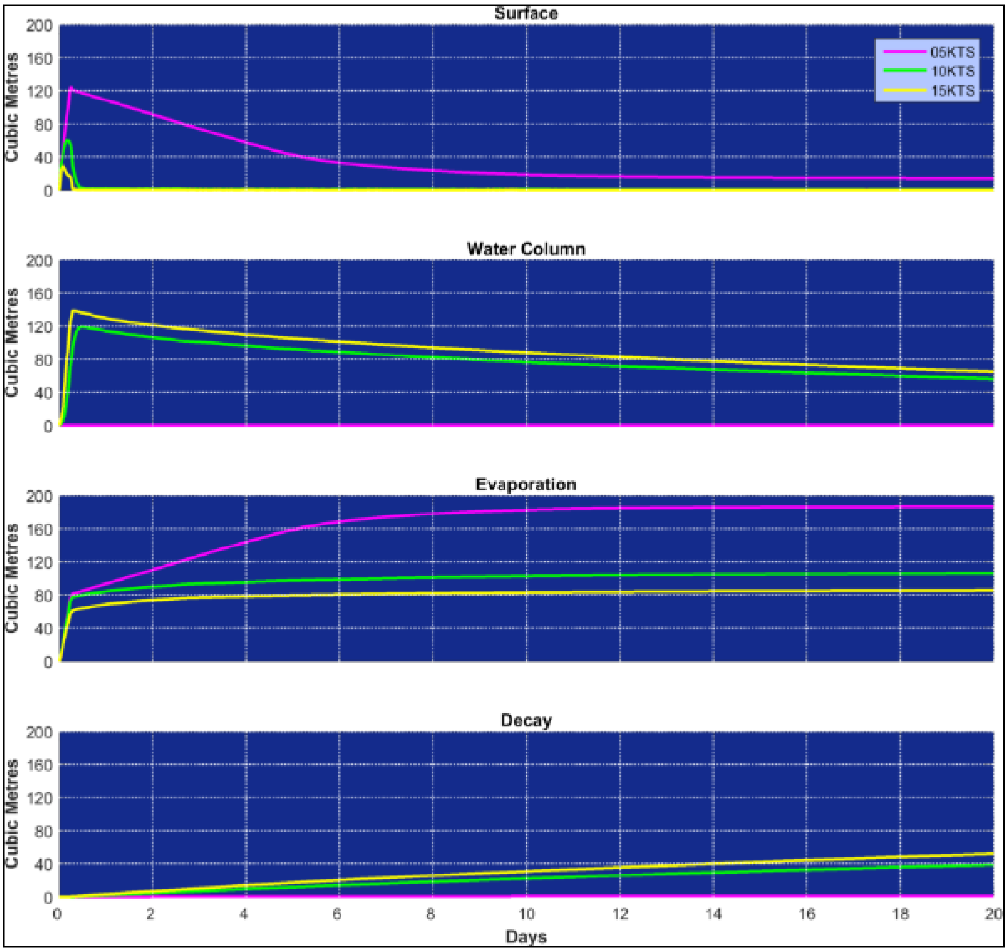

Figure 2 Weathering of Marine Diesel under Three Static Wind Conditions (200m^3 spill released over 6 hours)

5.16 A visible surface slick from a 200 m^3 diesel spill was modelled to potentially extend a maximum of up to 64 km (34 km for the 99th percentile). The extent of moderate and high surface exposures was a maximum of 18 km and 6 km, respectively[24].

5.17 In summer conditions there was no predicted shoreline impact from a 200 m^3 diesel spill, however in winter conditions there was a 1% probability of shoreline contact (South Taranaki), although the minimum time for oil to accumulate on the shoreline was 86 hours and the volume of oil to reach land was found to be 2 m^3 affecting no more than 1 km of shoreline[25].

[24] Refer to the IA, page 150

[25] Refer to the RPS Reports, Annexure F of the IA, and the RPS (Winter) Report

5.18 The likelihood of a major diesel spill resulting from a vessel incident has been identified by Tamarind as being extremely unlikely. However, there is potential for significant effects on pelagic species or birds that directly contact marine diesel. The potential for impacts from a diesel spill is reduced due to the localised area where harmful levels of contamination (i.e. above the moderate exposure threshold) could be present. I therefore consider that the assessment of a potential medium impact severity is justified.

Lubricant and hydraulic fluids spill sources and risks

5.19 Hydraulic and lubricant fluids used in equipment can be a source of small hydrocarbon spills, for example, as a result of hose failures or minor spills during servicing. In the event of a significant collision there is also potential for equipment damage to result in small spills of these hydrocarbons. It is expected that response on the deck of a jack-up rig to such small spills would be immediate using the on-board spill kits.

5.20 Spills that are contained on deck and do not reach the ocean do not pose a risk of harm to the marine environment. However, some equipment using hydraulic fluids is positioned in locations where containment would not be possible, such as cranes, and hydraulic fluid could enter the sea from these sources. A review of safety data sheets for a range of hydraulic oils shows that these products are considered to pose a low risk of ecological effects and are of low toxicity. Lubricant oils exhibit high solubility with nearly all lubricant base oils being non-flammable and having high volatility and low toxicity[26]. Lubricant oils are also considered to pose a low risk of ecological effects due to the limited amounts that may be spilled and the rapid evaporation and dispersion of such products.

5.21 The likelihood of a minor spill of products such as lubricants and hydraulic fluids has been identified by Tamarind as being unlikely. Given the low toxicity and rapid dispersion of these products I consider that any potential effect would be highly localised and only very sensitive species such as plankton would potentially be impact. I consider that the assessment of a potential medium impact severity is justified.

[26] Rudnick, L.R (2013) Synthetics, mineral oils, and bio-based lubricants: Chemistry and Technology, Second Edition. Florida, United States: CRC Press.

Loss of Well Control

5.22 Tui crude is a reasonably light crude oil with a density of 808 kg/m^3 and a dynamic viscosity of 2.5 cP at 40ºC, and has a high wax content of 17.3%. As a result, Tui crude turns into wax after extended periods (weeks) in the marine environment[27].

5.23 Modelling has been undertaken for a loss of well control releasing crude oil for a period of up to 110 days. In practice Tamarind has noted that well intervention to stop a release is expected to occur within 45 days, but the longer period has been modelled to allow for damage to the drilling rig that would necessitate an alternate rig being brought in from overseas. The RPS Oil Spill Modelling Reports (refer to Annexure F of the IA and RFI Response) show that the greatest potential for surface slicks or shoreline exposure occurs during winter conditions (June to January), with visible surface slicks potentially extending up to over 300 km to the north-northeast in the worst case. The potential for moderate and high sea surface exposure levels extended for 67 km and 58 km from the spill site, respectively.

5.24 There was a very high probability of low levels of contamination on shorelines from a loss of well control, with the southern Taranaki and Whanganui/Manawatu regional shorelines being most at risk. Shoreline accumulations at a visible threshold were predicted to take at least 61 hours, meaning that any oil would be partially weathered by the time it reaches shore and reducing the potential for toxicity.

5.25 Zones of potential low and moderate exposure occurred in the top 40 m of the water column in winter conditions and the top 30 m under summer conditions. The highest exposure to dissolved aromatics was a moderate exposure occurring in the top 10 m of the water column (potentially impacting average sensitive species) and occurred adjacent to the South Taranaki shoreline.

[27] Refer to Evidence of Brian King

Potential effects on environmental receptors

5.26 Impacts can occur in each of the phases where hydrocarbons are present including the water column, the air layer immediately above the slick surface where vapour concentrations may be elevated from the surface slick on the water, or any residue of the slick that makes landfall. The species that will be affected and the nature and extent of effects is dependent on its habitat and behaviour that will determine where exposure occurs and the duration of that exposure.

5.27 Due to the evaporation of light hydrocarbon fractions, exposure of marine species to the most toxic volatile fractions of spilled diesel or oil will depend on their proximity to the spill site.

5.28 While hydrocarbons on the water surface and entrained in the water column have the potential to cause impacts on species that are directly contacted, the extent of effects (as with any contaminant) is dependent on both the concentration and the duration of exposure.

5.29 Seabirds will be at risk where they feed and rest on the water surface in an area contaminated by surface slicks. For marine mammals in the area of a spill, there is potential for harm in the event that they surface through the fresh spill. In this instance animals may be affected by direct exposure of sensitive tissues (e.g. eyes) to the condensate or inhalation of the volatile products as they evaporate.

5.30 In the case of both seabirds and marine mammals, impacts are dependent on them coming into direct contact with the surface contamination. The risk of this occurring will be heavily influenced by the density of animals in the area (noting there are seasonal patterns in the distribution of these species as discussed in the evidence of Dr Childerhouse and Dr Thompson) and the extent to which the surface slick is broken up by wind and water movement.

5.31 The most sensitive organisms that are likely to be exposed to hydrocarbons in the water column in New Zealand waters include early life stages of fish and invertebrates as well as phytoplankton and zooplankton, as described in the evidence of Dr MacDiarmid.[28] Adult fish are more likely to suffer non-lethal impacts, and effects will be limited to shallow water zones where elevated entrained and dissolved aromatic hydrocarbons are present. Dissolved aromatics above the medium threshold were limited to the top 10 m of the water column, reducing the potential for exposure of adult fish. For fish in very close proximity to the well site it is possible that the duration of exposure may be 48 hours or longer, but the continuous exposure of fish further from the spill site to consistently high concentrations of hydrocarbons is less likely due to dilution of the plume with increasing distance and time. Fish also have the capacity to metabolise and excrete hydrocarbons. Studies following actual spills have found recovery of fish and elimination of hydrocarbons that may cause tainting within two months in most cases [29] [30] [31] [32] [33] [34] [35].

5.32 Studies conducted to determine the level of oil impacts on marine organisms following the Montara light crude spill in August 2009 found no evidence of hydrocarbons within the tissue of fish[36] or marine turtles[37] and while daily aerial and vessel-based surveillance observed dolphins in the vicinity of the oil spill, no confirmed reports of impacts were received[38].

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[28] Refer to evidence of Alison MacDiarmid, page 21, paragraph 6.3

[29] Challenger G and Mauseth G (2011) Chapter 32 – Seafood safety and oil spills. *In Oil Spill Science and Technology*. M. Fingas, (ed) 1083-1100.

[30] Davis HK, Moffat CF and Shepherd NJ (2002) Experimental tainting of marine fish by three chemically dispersed petroleum products, with comparisons to the *Braer* Oil Spill. *Oil Spill Science and Technology Bulletin* 8(5-6):257-278.

[31] Gagnon MM, and Rawson C (2011) Montara well release, Monitoring Study S4A - Assessment of effects on Timor Sea Fish.

[32] Gohlke JM *et al*. (2011) A review of seafood safety after the Deepwater Horizon blowout. *Environmental Health Perspectives* 119(8):1062-1069.

[33] Jung J, *et al.* (2011) Biomarker responses in pelagic and benthic fish over 1 year following the Hebei Spirit oil spill (Taean, Korea). *Marine Pollution Bulletin* 62(8):1859-1866.

[34] Law RJ, *et al.* (1997) Hydrocarbons and PAH in fish and shellfish from southwest Wales following the Sea Empress oil spill in 1996. *International Oil Spill Conference Proceedings* 1997(1):205-211.

[35] Rawson C, Gagnon M and Williams H (2011) Montara well release: Olfactory analysis of Timor Sea Fish Fillets.

[36] Burns, K., Slee, D., Lloyd, J., Hanlon, M (2013) Montara well release, Monitoring Studies: S3 Assessment of fish for the presence of oil.

[37] Guinea, M.L (2013) Montara well release, Monitoring Study on Sea Snakes and Sea Turtles on Reefs of the Sahul Shelf.

[38] Australian Government Department of the Environment (2015) Marine megafauna assessment surveys. http://www.environment.gov.au/marine/marine-pollution/montara-oil-spill/scientific-monitoring-studies. Accessed 18/2/2015.

5.33 Shoreline invertebrate species such as shellfish, crustaceans and worms, will be at risk where low thresholds of shoreline contamination are exceeded. Concentrations of shoreline oiling in at least some areas may result in lethal and sublethal effects on these species. The coarse-grained mobile sediments on many of Taranaki's shorelines means there is potential for oil to become buried or entrained into sediments or boulders, where it will be more difficult to clean up and may result in repeated exposure of some areas as oil is mobilised by subsequent tides. While the high wave energy on open shorelines in the region will assist to rapidly dilute any oil released from sediments and oil will progressively weather over time, if oil accumulates in sediments in sheltered areas such as estuaries, longer term effects may be possible. I therefore consider that the potential for high impact severity reported in the IA is justified.

Potential effects on existing interests and human uses

5.34 The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) requires that the EPA take into account effects on existing interests[39]. In this section of my evidence I consider the potential effects of a potential spill on the following general existing interests within the AOI or within its vicinity:

5.34.1 Fisheries interests, including customary, commercial and recreational fisheries and recognised customary fishing rights under the Fisheries (Kaimoana Customary Fishing) Regulations 1998.

5.34.2 Holders of existing marine consents or coastal permits.

5.34.3 Recreational users of the marine environment and shorelines.

5.34.4 Marine vessels navigating in the area.

5.34.5 Iwi and customary cultural values.

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[39] Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012, s 59(2)(a).

5.35 The modelling results identified potential for surface slicks to be visible in areas offshore from the south west coast of the lower North Island.

5.36 Knowledge of contamination, including surface slicks, has potential to negatively impact commercial or customary fishing operators. This would include any fishing quota holders within the AOI or within its vicinity, iwi commercial and customary fishing interests and charter fishing operators. If there is any risk that fish have been exposed to contamination, this can result in voluntary or compulsory closure of the fishery (rāhui) while the safety of the seafood is tested and confirmed. This issue is complicated by human perceptions, as even where scientific testing shows that there is no risk, public confidence in the fishery can take some time to recover as was seen during the Macondo Spill in 2009[40].

5.37 However, as noted by Ms Gibbs, the principal commercial fishery (jack-mackerel) in the area of the Tui permit extends over a very large statistical area[41].

5.38 Due to the anticipated dispersion and surface breakup of any spill, I would anticipate any surface contamination is unlikely to pose any negative impact on vessel movements, which will generally be occurring at some distance from Tamarind's activities as a result of the various safety zones and precautionary areas already in place. Therefore, it is unlikely to negatively impact on any support vessels for other operators in the area, including other marine consent holders.

5.39 I do not consider there is a risk posed by bioaccumulation of hydrocarbons in seafood that would present a risk to human health. Bioaccumulation to a concentration of significance could only occur where contamination was widespread and at levels above which fish and other species could effectively metabolise and depurate the hydrocarbons, and then for very high levels of consumption of contaminated species by higher order predators (including humans). Most risk assessment studies conducted show that there is a sufficient safety margin between measured seafood contamination after

[40] http://www.epa.gov/tribal/pdf/mabus-report.pdf

[41] Refer to evidence of Nicola Gibbs, page 11, paragraph 3.15

large spills and levels that would be a concern for public health, even for subsistence consumers (those people completely dependent on the seafood as a food source)[42]. In the case of the likely small volumes and rapid dispersion and dilution of any spill of oil or harmful substances as described above, I consider it highly unlikely that bioaccumulation would occur that may affect seafood safety. Extensive monitoring of fish following the Deepwater Horizon[21] and *MV Rena*[43] spills did not identify any levels of PAH contamination in fish that were above the very conservative levels prescribed for human health risk.

5.40 As discussed in the IA, the area where the drilling will occur is within the rohe of Te Kahui o Taranaki Trust and Ngāti Tara hapū.[44] The iwi and hapū have expressed that their specific interest in the application relates to a range of environmental and cultural values in the area. Some of these values relate to physical and biological features, including Ngā Taonga Koiora (including marine mammals, fish, benthic communities); Ngā Moana (coastal and offshore waters), Parumoana (seabed) and economic development and sustainability. Other less tangible values include Ngā Taonga Tuku Iho (traditional Māori values and practices) and Taha Wairua (Spiritual health and well-being obtained through a maintenance of a balance with nature). The sensitivity of these various values is considered by the iwi and hapū in terms of the health of the mauri (life-force) and the various receptors. As described in the previous section, there is potential for impacts on environmental and ecological receptors from a significant marine hydrocarbon spill and this would potentially impact on the mauri of these receptors.

5.41 I am not a medical specialist, but I note that as a result of the weathering of the hydrocarbons prior to reaching land and the predicted low concentrations in most locations I would therefore expect there to be a limited risk of health impacts to users of the shoreline and coastal areas (noting that this does not constitute a medical opinion). Risks to human health from marine

[42] ITOPF (2011). Effects of oil pollution on fisheries and mariculture. Technical Paper 11. London, United Kingdom, The International Tanker Owners Pollution Federation Limited.

[43] Rena Recovery Organisation (2013) Rena long-term environmental recovery monitoring programme. renarecovery.org.nz Accessed 15 March 2015.

[44] Refer to the IA, page 13

hydrocarbon spills are most commonly identified as being associated with benzene and other volatile fractions, with reported effects from exposure to fresh crudes and fuel oils commonly including irritation or nausea associated with odour, nose and throat irritation and headaches. Skin irritation can also occur as a result of direct contact[45]. As with any hydrocarbon, direct ingestion or inhalation of the volatile components of the product would be considered a medical hazard. As discussed previously, the lighter hydrocarbon molecules most associated with toxic impacts are expected to have evaporated prior to oil or diesel reaching the shore.

5.42 Separate to the risk of toxicity, hard shorelines may become slippery and pose a safety risk as a result of waxy residue being present, and it is standard practice in a marine spill incident to recommend that the public do not directly contact contaminated areas. This may affect use of these areas by the public or commercial operators.

6. Spill response planning

6.1 Offshore operators are required to develop emergency spill response procedures for Tier 1 responses (those that can be managed within the capability of the operator) and also for responses to larger spills (Tier 2 and Tier 3) of oil and chemicals that require support from external agencies, such as the Regional Council or Maritime New Zealand. These emergency response plans are reviewed and must be approved by Maritime New Zealand and the Environmental Protection Authority. In the case of offshore activities, the spill response plan also includes a Well Control Contingency Plan that describes measure required to manage a loss of well control, and details how these measures would be implemented. The Well Control Contingency Plan must be approved by Maritime New Zealand as part of the spill response plan.

6.2 Maritime New Zealand is the owner of the National Marine Oil Spill Contingency Plan (the National OSCP), which guides the response to major oil spills and has been developed with input from a range of experts and stakeholders including regional councils and the Department of

[45] CDC (2010) Interim guidance for protecting Deepwater Horizon response workers and volunteers. Centers for Disease Control and Prevention, US Department of Health and Human Services.

Conservation. Additionally, the New Zealand Oil Spill Response Strategy: 2015-2019 identifies that Maritime New Zealand will take steps to engage as appropriate with iwi authorities and iwi during spill responses. Annex 7 of the National OSCP specifically refers to offshore petroleum production and exploration activities.

6.3 Taranaki Regional Council is the owner of the Tier 2 Taranaki Regional OSCP. The Regional OSCP identifies offshore oil and gas production activities as a spill risk for the region and Taranaki Regional Council accordingly includes offshore spill scenarios exercise schedule. Taranaki region holds the largest reserve of spill response equipment designed for offshore use (e.g. large booms and skimmers suited for deployment in offshore conditions) of any region in New Zealand. In addition to the regional equipment stockpile, additional skimmers, pumps, booms and shoreline clean up equipment are available for rapid mobilisation from the Maritime New Zealand facility located in Te Atatu. Offshore support vessels based at the Port of Taranaki have been used in exercises to deploy offshore response equipment and would be utilised in the case of a spill response. Helicopters based in both New Plymouth and Eltham have been identified to provide support for aerial surveillance and dispersant spraying where this is deemed an effective response option.

6.4 Tamarind currently has an approved spill response plan for its operations in the Tui field. This plan incorporates an Oil Spill Contingency Plan (**OSCP**) and an Emergency Spill Response Plan (**ESRP**) for chemicals, and has been approved by Maritime New Zealand and the Environmental Protection Authority.

6.5 The protocols for spill management and response in the existing response plan will form the basis of an activity-specific response plan for the proposed drilling. This plan will be submitted to Maritime New Zealand and the Environmental Protection Authority for approval prior to works commencing. The new response plan will include a detailed Well Control Contingency Plan.

6.6 Tamarind conducts regular spill exercises to test the implementation of its spill response plan and improve processes as needed and maintains a team of trained spill responders who would also be mobilised to support any Tier 2 or Tier 3 spill response that was being managed by the Regional Council or Maritime New Zealand. In my view Tamarind is well prepared to deal with all three tiers of spill response and to provide first-strike support in the event of a larger incident.

6.7 In New Zealand the spiller is responsible to pay all reasonable costs associated with the spill response and clean up.

7. Environmental monitoring

7.1 Environmental monitoring has been conducted regularly in the Tui permit area since 2011. Routine monitoring is used to assess potential impacts on benthic sediments and infauna as a result of ongoing operations of the FPSO *Umuroa*, with six monitoring events conducted to date (2011, 2012, 2013, 2014, 2016 and 2018). In addition, targeted monitoring in the past has assessed post-drilling effects on sediments and infauna associated with drilling the Oi-1 and Oi-2 exploration wells and the Pateke-4H development well in 2014 (surveys conducted 2014 and 2015). Water quality assessments have been undertaken in the Tui field in 2016 and 2018, and are now included in the ongoing annual sampling programme.

7.2 In the case of the routine monitoring, sampling is conducted in accordance with Tamarind's approved Ecological Effects Monitoring Plan ("EEMP"). The EEMP defines 16 sample sites plus two far field-control stations within the Permit. These sites are arrayed around the FPSO and existing wells at varying distances out to 4 km along the major and minor current axes.

7.3 At each of the sample sites benthic grab samples are collected and are analysed for sediment characteristics (e.g. grain size) and chemistry. Sediment samples from each site are also sieved and the benthic fauna (e.g. crustaceans, worms and shellfish) are identified and recorded in terms of abundance and diversity measures to provide an indication of the ecological health of the site. Seawater samples are collected from a total of four sites within the field, including the two far-field control sites and are assessed for water chemistry indicators of contamination.

7.4 The results of the EEMP annual surveys are compared to previous survey results and a full report is provided annually to the EPA for review and comment.

7.5 As a result of the ongoing monitoring studies in the field the benthic environment including sediment quality and characteristics and benthic communities are well characterised.

7.6 There are no routine fish monitoring studies undertaken in the Tui field, and I understand that such studies would be severely constrained by safety considerations. Any sampling programme would need to avoid the extensive subsea infrastructure (e.g. wellheads, flowlines, gas lift lines and umbilicals and the FPSO mooring system) in order to avoid risk either to the survey vessel or the infrastructure itself.

7.7 Tamarind undertakes biannual routine subsea inspection campaigns, during which video footage of the subsea infrastructure is collected. I have seen footage from Remotely Operated Underwater Vehicle (ROV) surveys of the subsea equipment, which does show a range of fish species and also fur seals swimming around the structures on the seabed, but the nature of these ROV surveys would not allow for quantitative studies of fish in the area.

7.8 Given that there is no evidence of sediment or water contamination, or impacts on benthic communities that could be a source of prey for fish species, I consider it unlikely that any significant impacts on fish from the presence of the infrastructure and activities are likely and this is supported by the evidence of Dr MacDiarmid.[46] Any impacts on fish would likely be limited to behavioural change relating disturbance from noise and other activities.

Adequacy of established monitoring for assessing drilling impacts

7.9 The current monitoring programme provides robust scientific data on the sediment and seawater characteristics and sediment infaunal communities

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[46] Refer to the evidence of Alison MacDiarmid, page 23

in the Tui field, including around the existing well sites as far as possible given the need to avoid subsea infrastructure.

7.10 Tamarind have identified that there will be no discharge of drill cuttings or SBM drilling fluids during the side-track drilling campaign. Disturbance of benthic communities will therefore be limited to the direct disturbance from anchoring of the drilling rig. It is my view that the current extensive monitoring programme as described in the EEMP is adequate for assessing significant changes in benthic communities in the Permit area and that specific monitoring relating to the current project would not provide additional benefit.

7.11 It is my view that fisheries catch data remains the most viable method for assessing abundance of commercial fish species in the region. I therefore do not consider that additional studies of fish communities in the field are justified from the perspective of assessing impacts.

8. Cumulative effects

8.1 As described in section 4 of my evidence, any discharges of harmful substances in offshore processing drainage would by rapidly diluted to extremely low concentrations. Where there is overlap between discharge plumes from the FPSO during ongoing Tui field operations and deck drain discharges, this does have potential to increase the overall concentration of harmful substances to which near-surface pelagic species are exposed, but I would not expect this to result in significant additional impacts on these organisms. With the distance from the drilling operations to other offshore operators that may be discharging harmful substances, I do not consider it is feasible that there would be cumulative impacts associated with operations outside the Tui field.

8.2 Routine monitoring of sediment and water quality in the Tui field does not indicate an accumulation of contaminants resulting from the ongoing operational discharges in the field. In this deep ocean environment and with the controls described to remove solid materials prior to discharge of drainage water, I do not consider there is a feasible likelihood of measurable accumulation of harmful substances in deck drain discharges or of cumulative effects on benthic organisms.

9. Response to EPA Key Issues Report and Technical Reviews

EPA Key Issues report

9.1 The EPA Key Issues Report dated 10 July 2018 raises a number of points regarding matters associated with the offshore processing drainage. The drilling rig specifications, harmful substances and types of drilling muds in offshore processing drainage have been further clarified by Tamarind and is discussed in section 4 of my evidence and in the evidence of Mr McCallum.

9.2 The EPA report also notes that there is uncertainty regarding the “content and quantity of harmful substances to be used and stored on the drilling rig” and that this is relevant to the potential effects of these substances. As above, Tamarind has now confirmed the nature of the potential extent of discharges of harmful substances. Beyond that, I consider that the storage and use of harmful substances on the drilling rig is not relevant to impacts from planned activities, which would be a result only of the actual discharge of these substances, as discussed in section 4 of my evidence. It is my understanding that a complete list of all harmful substances and oils held onboard the drilling rig (including quantities) and potential impacts associated with the unplanned discharge of harmful substances (e.g. resulting from an incident causing damage to the drilling rig) would be addressed in an Emergency Spill Response Plan (ESRP) to be developed and approved by the EPA under the Discharge and Dumping Regulations prior to any works being undertaken.

9.3 With respect to the classification system to be used by Tamarind in assessing harmful substances, as noted in section 4 of my evidence, Tamarind is now applying the New Zealand hazardous substance classifications as defined in the *Hazardous Substances (Classification) Notice, 2017.*

Seapen report

9.4 The SEAPEN Report (paragraph 19(a)) notes the limited amount of seawater quality data collected by Tamarind. As discussed in paragraph 7.3 of my evidence, seawater samples are now routinely collected as part of the EEMP annual programme. I concur with the recommendation of Seapen that environmental sampling would be justified in the event of an unplanned release of hydrocarbons or chemicals, although this should be targeted through the use of real-time modelling to understand the potential movement and fate of spilled products.

9.5 Throughout the SEAPEN Report it is noted that the application of sensitivity criteria in the IA is not always strictly in accordance with the criteria descriptions. In most cases this results in no change to the overall impact significance, although in some cases an increase in the sensitivity ranking of particular receptors would result in an increase the overall residual impact significance, other than impacts from deck drain discharges which remain negligible.

9.6 While I agree that the strict application of the criteria as worded in the IA would result in a change in some values, I do not consider that these higher classifications would realistically represent the vulnerability of the receptor to the specific aspects (e.g. contamination). As noted in the evidence of Dr MacDiarmid, Dr Childerhouse, and Dr Thompson, there is very limited potential for significant exposure of fish, seabirds or marine mammals to the various activity aspects due to the distribution and mobility of these animals. I concur with the other environmental experts that the overall assessment of residual impacts in the IA is sensible given the actual sensitivity and potential impact magnitude from the activities.

10. Response to issues raised by submitters

Te Korowai o Ngāruahine Trust (TKONT)

10.1 In its submission dated 30 May 2018, TKONT raises concerns about the toxicity of waste materials that will have a negative effect on marine life and associated habitats, and serious and long-term effects from a spill. Specifically, with respect to spill impacts, TKONT suggests that a spill could contaminate and affect the abundance of fish stocks, affect commercial fishing operations, and access to kaimoana gathering sites and other sacred grounds and could affect human health.

10.2 As noted in Section 3 of my evidence, Tamarind has now confirmed the nature of potential extent of discharges of harmful substances. I consider that these discharges will not pose a credible risk to marine life or associated habitats due to the small quantities involved, the limited number of ecotoxic substances that may be discharged, and the dilution effects in the immediate area of any discharge. The avoidance by Tamarind of discharge of drill cuttings and SBM drilling muds also significantly reduces the potential for contamination or increased turbidity that may impact marine life during the activities.

10.3 With respect to spill impacts, I concur that in the extremely unlikely event of a major spill during the activity there is potential for people conducting activities in the coastal area to be impacted if oil comes ashore. As discussed in Section 4 of my evidence, I consider that these impacts are most likely to be in the form of temporary closures of fisheries or recommended avoidance of contaminated shorelines until these have been verified as being safe.

10.4 Commercial fisheries may be affected by the perception of contamination or temporary statutory or voluntary closures of specific areas until seafood safety had been tested and verified. However, given findings from overseas I do not consider there is a feasible risk to the actual contamination of fish stocks or on the abundance of fish stocks. As noted in the evidence of Ms Gibbs, the commercial fisheries quota in the area operate over large area, of which only a small proportion would potentially be affected.

10.5 TKONT has recommended a condition relating to monitoring fish in the AOI. As noted in Section 5 of my evidence, there are logistic challenges to execution of any fish survey programme that could meaningfully assess changes in populations in the areas immediately surrounding the activities. Noise impacts on fish are likely to be temporary in nature as fish move in response to changing noise levels. To assess changes at this scale would require very high resolution studies and I do not consider this to be a practical measure or warranted by the potential scale of the impacts.

10.6 With respect to the suggestion that marine mammal surveys should be conducted, I note that Tamarind has proposed conditions requiring observations of marine mammals during the activities to be recorded and reported to the Department of Conservation and the EPA. Dr Childerhouse has made recommendations in his evidence for measures to support this monitoring.

Climate Justice Taranaki Incorporated (CJTI) and other submitters

10.7 CJTI and a number of submitters who used the CJTI on-line submission template have raised concerns that the impact assessment lacks information about the deck drain discharges, including an assessment of cumulative impacts. As described in Section 3 of my evidence, the nature and manner of potential discharges of harmful substances has been clarified by Tamarind and that there will be no discharge of SBM drilling fluids on cuttings. My conclusion in this assessment is that there is a very low risk of any impacts on marine fauna or habitats associated with these discharges.

10.8 A number of submitters, including a number of those who used the CJTI on-line submission template, have raised concerns regarding the potential for impacts from an oil spill. This matter is addressed in detail in Section 4 of my evidence, including the measures that are in place for a response to a marine oil spill. Additional comment is also provided above in paragraphs 10.3 and 10.4.

11. Proposed consent conditions and mitigation measures

11.1 I have reviewed the proposed conditions provided by Tamarind at the time of their consent application, specifically as these relate to the mitigation or avoidance of effects from the discharge of harmful substances or unplanned spill events. I consider these conditions and the mitigation measures in section 11 of the IA to be appropriate and commensurate with the level of risk posed by these activities.

12. Conclusion

12.1 Based on the information provided by Tamarind regarding the potential for discharges of harmful substances in deck drainage, I conclude that the risk of any impact on marine environmental receptors or existing uses would be negligible. This conclusion is based on the following key matters:

12.1.1 the extensive on-board controls that would limit the potential for discharge of these substances;

12.1.2 the limited number of harmful substances that have potential to be discharged and the fact that only two of these substances trigger the classification of being ecotoxic in the aquatic environment, with the other substances being classified as harmful or slightly harmful;

12.1.3 the dilution of any product that was discharged in deck drainage that would mean concentrations would be reduced below ecotoxic thresholds over a short distance from the point of discharge.

12.2 With respect to the potential for impacts from an unplanned spill event I conclude that there is potential for only localised effects from small discharges of chemicals or hydrocarbon products, such as may occur during transfer of these substances between a support vessel and the drilling rig or equipment failures.

12.3 The potential for environmental harm does exist in the extremely unlikely event of a worst case vessel spill of diesel or a loss of well control. In the case of a large spill of this nature, the key risk would be to sensitive planktonic organisms, but there would also be a threat to seabirds or other wildlife that came into direct contact with a surface slick. Fish would be vulnerable to impacts if they were present in the water layers where moderate thresholds of dissolved hydrocarbons occurred.

12.4 Modelling identifies there is potential for shoreline stranding of oil, with a high probability of this occurring in a worst case loss of well control. Impacts from such an incident could occur harm to organisms on the shore and contamination of shoreline sediments. Human uses, including existing fisheries rights, may be affected due to temporary closure of beaches or fisheries areas while any spill was cleaned up and seafood safety was verified. Additionally, the perception of contamination from a major spill incident may temporarily affect fisheries in the area.

12.5 With respect to the monitoring of effects within the AOI from the drilling activities I consider that the existing monitoring programme under the approved EEMP is fit for purpose and that further monitoring is not warranted.

ALISON LANE
20 July 2018