Submission Form

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Submission#: SUBMISSION108676

Trans-Tasman Resources South Taranaki Bight Offshore Iron Sand Project Marine Consent Application

Proposal Name:	Trans-Tasman Resources South Taranaki Bight Offshore Iron Sand Project Marine Consent Application
EPA Reference:	EEZ000004
Applicant:	Trans-Tasman Resources Limited
Re-notification Date:	20 December 2013
Submission Close:	5:00pm, Tuesday 28 January 2014
Further Information:	http://www.epa.govt.nz/EEZ/trans_tasman

This is a submission on the marine consent application lodged by Trans-Tasman Resources Limited with the Environmental Protection Authority (EPA). The consent application is made pursuant to Section 38 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 for the mining of Iron Sand at the South Taranaki Bight.

Part A

This part provides the EPA with information about you as a submitter. ***Sections with an asterisk are mandatory***

1. Submitter Details*

Please provide your name (or company name) and as much contact information as possible. We may need to contact you during or outside of normal business hours. Please advise us if any of your contact details change.

Name of Organisation (if relevant):

Title: ○ Mr ◉ Mrs ○ Miss ○ Ms ○ Dr ○ Other: *(Please tick the appropriate title)*

First name of submitter: KAREN

Surname of submitter: PRATT

Please enter at least one contact number

Home Phone: [redacted]

Work Phone: [redacted]

Mobile:

Fax:

Email:

Confirm Email:

Physical Address:

Address Line 1: [redacted]

Address Line 2:

Address Line 3:

Suburb:

City:

Postal Code:

Country:

[redacted]

Postal Address: ☑ Use Physical Address

Postal Line 1:

Postal Line 2:

Postal Line 3:

Postal Suburb:

Postal City:

Postal Code:

Postal Country:

[redacted]

2. Alternative contact person details (optional)

If you wish to nominate a person to be your point of contact (e.g. a friend, relative, lawyer, professional advisor or any other person), please provide their contact details below. This person will receive all correspondence on your behalf.

I/We wish to nominate someone to be my point of contact ○ *Yes* ◉ *No*

3. Privacy Statement

Your personal information included in Part A of this form will be held by the EPA, 215 Lambton Quay, Wellington. Other than your name, organisation (if applicable) and address for service, your personal contact information in Part A of this form will not be published on the EPA website. All information held by the EPA is subject to the Official Information Act 1982. It will be used by the EPA for the administration of the Trans-Tasman Resources Limited marine consent application process. Copies of your full submission, including all personal information included in Part A, will be provided to the EPA, the applicant, and submitters, and may also be provided to other parties in the process. You have the right to access and correct personal information held by the EPA.

Your name, organisation (if applicable) address for service, the information in Parts B and C of this form and any attached information will be published on the EPA website, and made available to the EPA, the applicant, other submitters and the general public for use in the processing and consideration of the Trans-Tasman Resources marine consent application.

Note: If the submitter is a company then full business contact details will be publicly available.

4. Authority to act*

If this submission is made on behalf of a group, please tick to confirm you are authorised to represent all persons making this submission and write your name below. If you are an individual making this submission, please tick the box and write your name below.

☑ I / We Karen Pratt confirm that I / We have authority to submit this submission on behalf of all persons named on this form.

Part B

This part asks for your position on the marine consent application. ***Sections with an asterisk are mandatory***

5. Do you have an existing interest that may be affected?

Do you have an existing interest that may be affected by the application?

Existing Interest (tick as many boxes as appropriate):

☑ 1. Lawfully established existing activity, whether or not authorised by or under any Act or Regulations, including rights of access, navigation and fishing

☐ 2. Any activity that may be undertaken under the authority of an existing marine consent

☐ 3. Activity permitted by existing resource consent

☐ 4. Settlement of a historical claim under the Treaty of Waitangi Act 1975

☐ 5. Settlement of a contemporary claim under the Treaty of Waitangi as provided for in an Act, including the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992

☐ 6. Protected customary right or customary marine title as recognised under the Marine and Coastal Area (Takutai Moana) Act 2011

If you have an existing interest (confirmed by ticking one or more of the above boxes), please describe your existing interest:

Resident of South Taranaki District, who frequents the Patea beach. Live in a community that could be impacted by environmental effects of this Project. There is an economic impact that needs to be understood for my community. On a national scale I am a member of the public with an interest in the financial and environmental aspects of this Project. Please see my submission which details further my existing interest

If you have an existing interest (confirmed by ticking one or more of the above boxes) which you think may be affected, please provide a brief explanation of how you may be affected by the application:

As outlined in great length in my submission, I am unable to ascertain the environmental impact - but my review of all documentation provided gives me reason to believe the risk evaluations are unsubstantiated and further work is needed on research and modelling to determine the environmental impacts. As a member of the public I need assurances on the long term economic and cash flow impact of this Project and the long term cumulative impact from an environmental perspective.

6. What is your position on the proposed application?*

Please state your position on the proposed Trans-Tasman Resources South Taranaki Bight Offshore Iron Sand Project marine consent application either as a whole, or on any part of it. If you have specific opinions on different aspects of the application then you can detail these in the space provided below.

You may comment on any aspect of the application and there is no restriction on the length of your submission. You can make a general submission and/or respond specifically to any part of the application documentation. The more specific your submission however, the greater the understanding of your views. This will help identify whether meetings and/or mediation are required; how a hearing might be structured; and provide information to inform the final decision. If you are making a detailed submission, it would be helpful if you could state whether or not you disagree with any of the information provided in the application. We have provided boxes for the sections in the document "Supporting Information for Marine Consent Application" compiled by Trans-Tasman Resources (TTR) Limited, dated October 2013.

If you require more space, please attach additional pages as necessary. Please ensure you include your name and 'Trans-Tasman Resources' on each additional document.

	Support in full	Support in part	Neutral	Oppose in part	Oppose in full	Range of views
Position	○	○	○	○	○	◉

Reason(s) See my extensive submission

Section 1: Introduction

○ I / we agree
○ I / we disagree
○ Unsure

Please explain why you agree/disagree with the information in this section

Section 2 Project description

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 3 Unplanned events

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 4 Statutory Regime

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 5 Investigations commissioned

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 6 Description of the project area

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 7 Existing interests consultation

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 8 Economic benefits

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 9 Description of effects on iwi

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 10 Methodology adopted for evaluation

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 11 Evaluation of effects on the physical environment

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 12 Evaluation of marine ecological effects

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 13 Evaluation of effects on the social environment

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 14 Other effects

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 15 Measures to avoid, remedy, or mitigate adverse effects identified

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 16 Consent conditions framework

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 17 Environmental monitoring and management plan initiatives

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Section 18 Overall evaluation

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Appendices

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

Supporting technical reports

- I / we agree
- I / we disagree
- Unsure

Please explain why you agree/disagree with the information in this section

7. Factors the EPA must take into account

When considering the proposal Trans-Tasman Resources South Taranaki Bight Offshore Iron Sand Project marine consent application, the EPA must, among other matters, take into account factors listed in section 59 (2) of the EEZ Act.

You may comment on any of these factors in the box below. If you require more space, please attach additional pages as necessary. Please ensure you include your name and "Trans-Tasman Resources Application" on each additional document.

Please see comprehensive submission attached

8. What decision would you like the EPA to make?*

Please state what decision you would like the EPA to make about the proposed Trans-Tasman Resources South Taranaki Bight Offshore Iron Sand Project Marine Consent Application and provide reasons.
If you require more space, please attach additional pages as necessary. Please ensure you include your name and 'Trans-Tasman Resources' on each additional document.

- ○ Grant
- ○ Decline
- ○ Grant with conditions
- ○ No view
- ◉ Other

Provide reasons including any suggested conditions

Please see my detailed discussion on this matter included within my submission. In essence far more data is required before any decisions can be made. If this will not be done, then I would decline the Application,

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Part C *This part provides the EPA with information to assist with administration of the hearing.* ***Sections with an asterisk are mandatory***

9. How would you like to receive correspondence*?

Formal provision of documents will be by way of the EPA website at www.epa.govt.nz.

For efficiency, as well as environmental and cost reasons, the EPA sends EPA correspondence via email. We usually provide links to documents on our website rather than emailing documents. This saves people the trouble of downloading large files that they may not want. We will send all information and correspondence including copies of the final reports to the email address that is provided in Part A of the Submission Form, unless you state an alternative preference below.

If you choose to receive paper copies and wish to speak at the hearing, we will need to provide you with a lot of information such as evidence, hearing schedules, board directions and reports. It may not always be feasible for paper copies to be posted to you in a timely manner (for example, the hearing schedule may change daily during the hearing).

In some instances, such as when there is a large volume of information, we may refer you to a location where this documentation is publicly available for inspection, such as a library.

- ○ I / We wish to receive paper copies of documents where
- ◉ I / We wish to receive paper copies of only draft and final decisions (all other documents will be electronically provided)possible
- ○ I / We do not wish to receive any documentation

10. Do you wish to speak to your submission*?

A hearing for the application may be held by the TTR decision-making committee.

As a submitter you may speak about your submission (and any evidence you may provide) at that hearing. To assist us with planning, please advise us below if you intend to speak at that hearing.

If you do wish to speak at the hearing, we will contact you prior to the hearing to confirm whether you still wish to speak, and if so, how long you will need for your presentation to the EPA. Many submitters speak on similar topics and issues. If this applies to one or more of your topics of interest then you may consider presenting a joint case at

the hearing. If you would consider doing this, please indicate this by ticking the box.

If you do not wish to speak at the hearing, the next information you will receive from the EPA will be the final decision. All submissions will be considered by the EPA, regardless of whether you speak at a hearing.

If you do not select an option, we will assume you wish to speak about your submission.

- ○ I / we **do not wish speak** about my / our submission. OR
- ◉ I / we **wish to speak** about my / our submission
  - ☑ If others make a similar submission, I/we will consider presenting a joint case with them at the hearing.
  - ☐ I / we wish to present in Maori / Te Reo.
  - ☐ I / we wish to present in NZ Sign Language.
  - ☐ I / we intend to have legal representation.

11. Meetings and/or mediation to resolve matters before decision

The EPA may request that the applicant meets, or enters mediation, with submitters to discuss matters in dispute in relation to the application. In order to assist with scheduling, please confirm your expected availability to participate in meetings or mediation. Timing for meetings will be determined by the EPA TTR decision-making committee and that direction will be conveyed to the applicant and submitters at that time.

- ◉ I / we expect to be available to participate in meetings or mediation (if required).
- ○ I / we expect that we won't be available to participate in meetings or mediation (please provide a brief reason why you expect you won't be available)).

If you expect that you will not be available, please provide a brief reason why

12. Do you intend to provide expert witnesses?

This section only relates to people who want to speak at the hearing.

An expert witness is a person who, through training or experience, is a skilled practitioner in a particular subject and is able to give professional **independent** evidence on that particular subject.

If you consider yourself to be an expert, or you intend to provide evidence from expert witnesses, please tick the box below.

- ○ No, I/we have no witnesses.
- ◉ Yes, I have witnesses (please fill out this section)
- ○ No, I / we do not have expert witnesses, but I consider I have expertise to be considered an expert (please fill in the table below).

If you know the areas of expertise of your expert witnesses and/or their names then please provide these. This information is for provisional planning purposes only. Final confirmation of expert witnesses will not occur until the evidence of the submitters is lodged with the EPA.

Name Of Witness	Area(s) Of Expertise	Phone Number	Email Address
Karen Pratt	Auditing, Accounting & Finance	[redacted]	

Table of Contents

SUBMISSION OVERVIEW

Inaccurate EPA public notice and Impact Assessment Executive Summary – regarding tailings deposited to the seabed.

EPA public notice fails to note 'concentrated metals' in the discharges list, as does 'Expert Risk Assessment of Activities in the EEZ and Extended Continental Shelf'.

To date only TTR's summarised presentation of facts has been given to the public. There is no independent EPA commissioned Impact Assessments available for the public. (EPA have only commissioned reviews of TTR commissioned reports.)

TTR's marine application fails to meet the requirements of section 39 of the EEZ Act

Coming from an audit background, it has taken me the whole submission period to try and reconcile TTR's Impact Assessment & other available TTR media releases - with the data contained within the TTR commissioned supporting reports (prepared by NIWA and others). It has not been an easy process, as many significant findings failed to make their way to Executive Summaries and the Impact Assessment. Making things more complicated was that the limitations involved with the sophisticated models used, modelling capabilities that had been 'turned off', and 'assumptions' were buried within reports rather than being clearly identified in the Executive Summaries. In addition there were a number of numerical errors and invalid statements contained within the Impact Assessment. Best available information was not used in a number of instances.

I do not believe section 39 of the EEZ Act has been met, as important content is missing and there is insufficient information provided in addition to the Impact Assessment to enable the public and the decision makers to understand the nature of the proposal and its predicted effects'.

One extremely important factor that impacts on any understanding of the environmental impact of this Project - is the very fine particles called sediment that remain suspended in the water, rather than falling quickly to the ocean floor as larger particles do. We call this 'the plume'. The fine particles are carried in various directions depending on currents, wind, waves and the terrain of the seafloor. **4,230,059 tonnes per year** (minimum) of this very fine sediment will be pumped into the water column from under the processing ship. The water around Patea where the dredging/mining is to take place only receives **310,600 tonnes per year** on an intermittent basis from the Patea River by comparison. When the fine sediment is pumped out from the ship there will be concentrated metals contained within it. Metals, such as copper & nickel exceed trigger values for the protection of 80% of the species. Other metals such as mercury, known to be found in iron sands, was not tested for by TTR. The environmental impact for fine sediment is well known, it can reduce light – affecting photosynthesis and the ability of fish and mammals to sight prey. It can impact fish gills

and filter feeders on the floor of the seabed. It can also impact on those organisms at the start of the food chain – the 'diatoms' which are particular about water chemistry and suspended sediment.

Now consider the calculations: If 50 million tonnes is mined, and approximately 10% is the iron ore yield (5 million tonnes) this leaves 45 million tonnes. 4.2 tonnes (fine sediment) is pumped out from the top of the deposition pipe. The remaining 40.8 tonnes is pumped from the bottom of the deposition pipe to the seabed.

The EPA public notice states 45 million tonnes is 'tailings' and "will be discharged back to the seabed through a deposition pipe discharging approximately 4 metres above the seabed". This is incorrect as the tonnage discharged at 4 metres is approximately 40.8.

Furthermore the EPA public notice fails to specifically identify metals in the discharge, but restricts themselves to a widely encompassing statement "other discharges including *but not limited to,* brine, fine sediment and freshwater associated with the proposal will also be considered as part of the marine consent application".

Considering the environmental significance of the 4.2 tonnes of fine sediment and concentrated metals – transparency, public interest and factual validity – require the public notice to have been phrased differently.

The Impact Assessment Executive Summary makes the same commentary as the EPA public notice, so is also inaccurate and misleading.

It is pertinent to point out that the general awareness of concentrated metals might be lowered, by the fact that the 'Expert Risk Assessment' by NIWA does not list in its activities of environmental risk associated with iron sand mining the concentrated metals which are a by-product of the beneficiation process. In addition community consultation by TTR with interested parties failed to discuss the concentrated levels of metals, especially copper, exceeding trigger values.

SENSITIVE ENVIRONMENTS and BIOLOGICAL RICHNESS OF THE SOUTH TARANAKI BIGHT

As discussed in the 'Regulatory Impact Statement' prepared by the Ministry for the Environment with input from the Environmental Protection Agency - there are specific environments that are regarded as 'sensitive' (being a combination of vulnerability and recoverability) to disturbances from activities. It was determined that impacts on these environments can be effectively managed by requiring a *cautious approach* to be taken when these environments are encountered. The Act requires the Minister to *favour caution and environmental protection* when making decisions under the Act *if the information available is uncertain or inadequate*, **section 34(2).**

Various scientific commentary noted in the NIWA reports comment on rocky areas containing far larger species diversity and numbers than sandy areas. Despite this, the majority of sampling was conducted in the sandy areas. The rocky areas are where 'sensitive organisms' are to be found. Despite this knowledge there was no NIWA sampling of the North and South Traps or Graham Bank. Numerous other rocky areas remain unmapped and unsampled by NIWA.

The 'high energy environment' is commented on frequently by TTR, but the important context not discussed by TTR is that whilst the ocean floor in sandy areas has less diversity and abundance of species than the rocky areas, there is still high productivity of sea life in the waters compared to other similar coastal regions. The enhanced biological productivity is due to the upwelling of

nutrients from Cape Farewell in the South Island. The South Taranaki Bight contains one of the highest biomasses of plankton in NZ, this promotes squid as well as providing one of only five feeding grounds in the Southern Hemisphere for the endangered blue whale. The Project site lies on the border this plankton mass.

Of the significantly few rocky areas sampled by NIWA – a number of 'sensitive' organisms were found – the bryozoan, red algae and sponges. The extract below shows how the sandy soft sediments record far fewer 'sensitive' organisms.

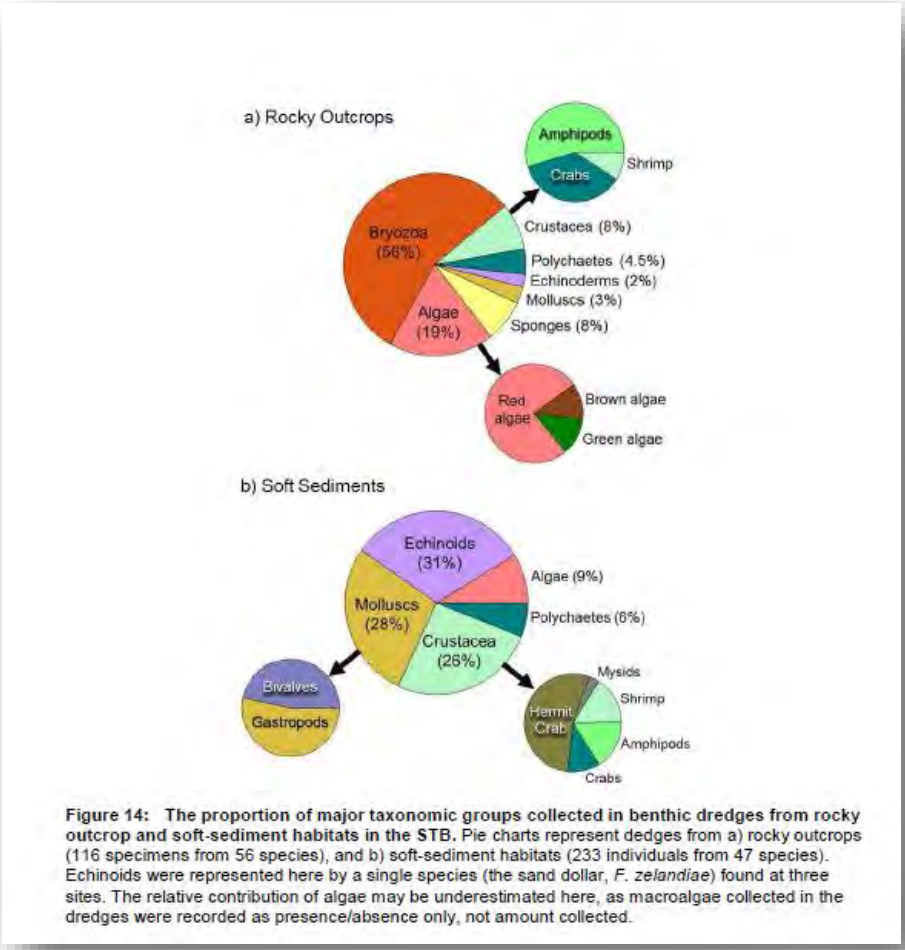
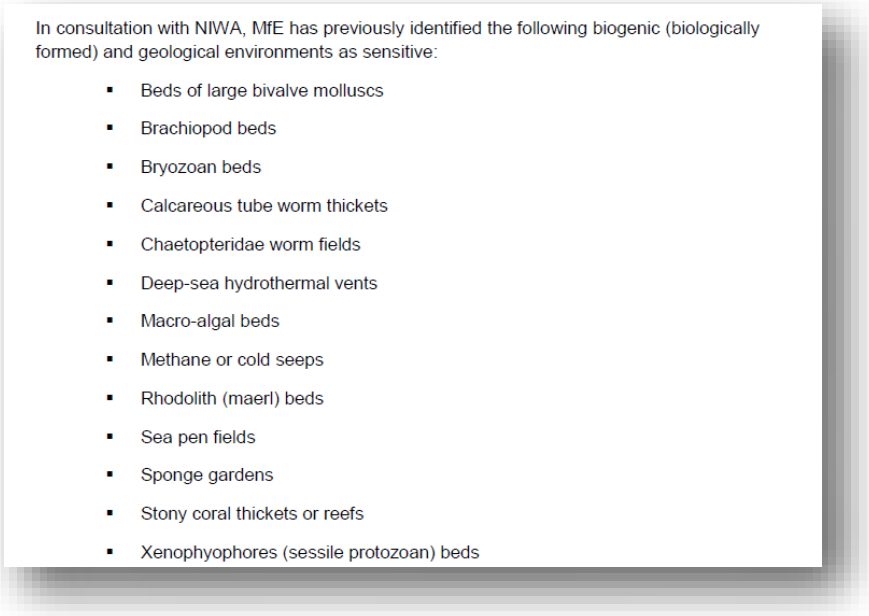


Figure 14: The proportion of major taxonomic groups collected in benthic dredges from rocky outcrop and soft-sediment habitats in the STB. Pie charts represent dedges from a) rocky outcrops (116 specimens from 56 species), and b) soft-sediment habitats (233 individuals from 47 species). Echinoids were represented here by a single species (the sand dollar, *F. zelandiae*) found at three sites. The relative contribution of algae may be underestimated here, as macroalgae collected in the dredges were recorded as presence/absence only, not amount collected.


In consultation with NIWA, MfE has previously identified the following biogenic (biologically formed) and geological environments as sensitive:

- Beds of large bivalve molluscs
- Brachiopod beds
- Bryozoan beds
- Calcareous tube worm thickets
- Chaetopteridae worm fields
- Deep-sea hydrothermal vents
- Macro-algal beds
- Methane or cold seeps
- Rhodolith (maerl) beds
- Sea pen fields
- Sponge gardens
- Stony coral thickets or reefs
- Xenophyophores (sessile protozoan) beds

Due to the bias in sampling towards sandy areas to date, and the poorly sampled rocky areas providing indications of 'sensitive species' – any decisions must favour caution. In this instance the rocky areas must be scientifically assessed for 'sensitive' species. Then most importantly, the plume modelling must be re-run to address present under-estimations, and the predicted biological impacts from sediment levels assessed.

CONDITIONS

1. The most effective way for the EPA to monitor compliance is on board observation. Recommend monthly random visits to obtain metal discharge samples. Where breaches are observed, visits to be increased. The EPA should publish metal analysis on their website. This will assure the public of appropriate regulatory oversight.
2. Biological testing at and near the Project site, to evaluate long term exposure of benthic organisms to copper and other metals of concentrations exceeding ANZECC/ARMCANZ trigger values for 99% species protection. At least bi-annually.
3. As Maritime NZ & the High Hazards unit (Worksafe NZ) have no legislative jurisdiction to regulate air emissions and the health impacts (for workers on the ship or for recreational sea users) and as the EEZ Act is a 'gap-filling' piece of legislation – a condition to be imposed it that Workplace Emissions Standards are used as a guideline to workplace practise on board the FPSO. The monthly random visit to include air emission testing with results published on the EPA website.
4. No further processing of the marine permit until there is an independent assessment of 'sensitive' species within the rocky environments and the impacts on them from sediment loads.
5. Consider 'green valve' options or other engineering options to remedy plume and metal discharge environmental concerns, as discussed in 15.1.4 of the Impact Assessment.

TTR's marine application seen 'in a wider context'

The EEZ Act and Regulations are part of the Government commitment to 'building natural resources work stream' of the Business Growth Agenda.

The positive economic effects from proceeding with iron ore extraction are that it helps to meet the goals of improving New Zealanders standard of living, improves the balance of payments deficit and enhances international relations with our important trading partner China, who needs iron ore to feed her increasing levels of steel production.

It is perhaps this latter point that is the true economic driver, as NZ now exports $7billion to China. If the context of TTR royalties alone was looked at the economic value seems relatively small (an estimated $8m) in comparison to the $400m annual royalties from the petroleum industry.

Understanding TTTR's marine application in terms of the objectives of the EEZ Act

The EEZ Act has four high level objectives –

1. Meeting its international objectives (UNCLOS)
2. The natural resources of EEZ and Continental Shelf are *sustainably managed*
3. Permit classifications and conditions are cost effective, with the cost proportional to the level of environmental effects
4. Non-environmental impacts – 'existing interests' 'Iwi' and 'other matters' are effectively managed

'Sustainably managed' (point 2) requires four criterion to be considered.

1. Immediate economic benefit to the NZ economy and users
2. Sustaining natural resources, like fish stocks, for future economic benefit
3. The ecology is safeguarded – looking at a 'bigger scale'
4. Adverse effects to the environment are avoided, remedied or mitigated 'smaller scale habitats'

The first criterion 'immediate economic benefit' is considered to carry more weight because it is the primary objective in the purpose of the act against which the other matters are balanced.

The Act is a 'gap-filling piece of legislation and its scope is restricted to managing those environmental effects that are not currently subject to environmental regulations.

'Existing Interest' section 4 (1) (a)

I am aware that the 'Regulatory Impact Statement' (point 96) states **"seabed mining in all forms has been rated by NIWA to have high-extreme environmental risks."** This Project impacts on the environment in which my community lives and which future generations will live.

My community swims and fishes in the sea at Patea. My community relies on the domestic spend associated with recreational fishing. The health of my community relies on non-toxic emissions to the sea and air. As a member of 'the larger public' I have an interest in ensuring sustainable fishing quota from the sea, protecting the feeding habitat of the endangered blue whale and minimising acoustic disturbances of marine mammals frequenting the shores. As a

member of the public I am also interested in the comprehensive financial implications arising from mining iron sands off the North Island's west coast.

The Marine Application does not meet the requirements of s39 of the EEZ Act

The EPA regards a marine consent application as complete when 'it meets the requirements of section 39 in terms of content and it has sufficient information provided in addition to the Impact Assessment to enable the public and the decision makers to understand the nature of the proposal and its predicted effects'.

The Marine Application can be regarded as incomplete due to the following points:

1. The various reports prepared for the EPA by Sinclair Knight Merz (SKM) and COVEC point to numerous fundamental limitations to the data provided by TTR, which result in an inability to understand the nature of predicted effects.
2. I have identified numerous other limitations in the data provided by TTR, in addition to those noted by SKM, which means predicted effects are unknown.
3. Important aspects contained within SKM reports were not always listed as a 'key finding' in the SKM report, despite their importance to an understanding of the limitations of data provided by TTR. There is the risk that the public rely on the key findings as a comprehensive summary of all important findings.
4. NIWA reports, commissioned by TTR, were comprehensive – but there were a number of instances where significant 'worst case scenarios' and modelling limitations failed to be identified in the Executive Summary.
5. The Impact Assessment did not in a number of instances reflect the findings contained within commissioned reports.

Conclusion: Despite reading all the Impact Assessment and supporting reports, as well as EPA commissioned reviews I am unable to understand the nature of predicted environmental effects from this Project. Furthermore, from the data I have read, I believe the Impact Assessment understates many of the environmental impacts, basing the risk assessments on incomplete data.

Nor do I believe there is a defence under section 61(1) of the EEZ Act for the deficiencies in information. The limitations could have been addressed without unreasonable cost, effort or time.

SUMMARY of FINDINGS:

The size of the Table of Contents attached to my submission (14 pages) attests to the number of issues I have identified. I cannot summarise all the issues, but some aspects are discussed below:

1. Ecologically the major impact from this Project is due to the very fine sediment that stays suspended in the water column and is transported to various depths along the South Taranaki Bight. Consequently it is imperative that effort is made to calculate the 'worst case scenario' for this Project. This has not been done. There are **significant parameter limitations in the plume modelling** for 'the patch'. The first of these is the fact that the 9 metre high mounds, 10 pits and 1 metre slumping were not accounted for in the plume modelling. The mounds could stretch up to 14.5km's. The second major limitation was that the full area to be mined was not modelled – rather a subset of the area (11%) to be mined has been modelled - a 3x2 km area (6.05km²)– when the mining application is for an area of 65 km² with 53.63km² to be mined. The third significant limitation was that a modelling run of 10 years was used – but if a greater mean depth than 5 metres is used (and it could be a twofold increase from 5 metres) the Project could extend out towards 20 years. The fourth significant parameter limitation to the modelling is that the 'natural suspended source' could be over inflated, so the comparative differences between mining results and natural results appears less. The critical limitation, in the lack of data to support 'natural suspended sources' needs to be addressed. Table 3-1 of the Plume Modelling, has 72% of the natural seabed as *fine/medium sand* – despite the Geological Desktop Summary Appendix stating the majority of project area is *gravelly sand rich in shell material.*

   Recommendation: Plume modelling needs to be re-run with significant limitations having been addressed.

2. Current research (2013) indicates the South Taranaki Bight could be an important foraging ground for the endangered blue whale. In addition NIWA identified that the South Taranaki Bight has a high habitat suitability for other endangered species such as the killer whale, southern right whale and Maui dolphin. Despite the research indicating that such mammals feed or migrate within proximity of the Project area and its acoustic footprint, the approach taken by TTR to identify the acoustic impact on the mammals has been **woefully inadequate**. This is clearly illustrated by the fact that the Impact Assessment (6.13) on noise fails to provide any conclusion or discussion. Compounding this lack of effort to determine noise impacts on mammals, has been the fact TTR have used old data sets which underestimate the mammal sightings within the South Taranaki Bight.

   Recommendation: 'Acoustic propagation modelling' needs to be undertaken in order to predict levels of noise emitted into the environment from all aspects of this Project. The broadband noise (range of frequencies) must be modelled. The Project environment must be used for this modelling, as the seabed bathymetry, sediment coverage and oceanographic conditions have a decisive impact on where the sound goes and the level of sound at a particular location.

Acoustic impact modelling must be done for the particular species frequenting the South Taranaki Bight. An assessment needs to be made of the range at which an animal may be affected or damaged by the sounds determined in the 'acoustic propagation modelling'.

A condition of any marine permit must be that a Remote Underwater Noise Evaluation System (RUNES) should be deployed by the FPSO and remain in-situ for extended periods. This is an autonomous seabed recorder which can provide data for analysis – to compare against the acoustic propagation modelling.

3. Ecologically the habitats with the greatest diversity and greatest number of species occur in the rocky areas located along and off the shore. Despite this, the sampling effort **did not concentrate** on these areas – for example the NIWA 'benthic near shore habitats' report had 36 sampled areas with only 5 rocky areas in this total. Despite this bias, 2 of the 5 rocky areas sampled accounted for 61% of the total species recorded! An ecologically significant rocky area – the Graham Bank – which falls within the path of some of the highest levels of the sediment plume – was not included in any NIWA research. Rocky areas are characterised by high proportions of organisms that filter feed and are immobile, such as bryozoans and sponges, which are susceptible to small increases in sediment.

   Recommendation: Sampling of rocky areas needs to be conducted

4. The Impact Assessment has **no information** on the thresholds of marine life within the South Taranaki Bight to cope with anticipated sediment levels from the Project. The ecological life is effected by fine sediment smothering the sea floor and also suspended sediment in the water column reducing light which is important for plant life and also for the ability to see and catch prey. The significance of this has been stressed in NIWA reports.

   Recommendation: A report on the impacts of predicted sediment levels on sensitive environments and marine life impacted by the Project needs to be commissioned.

5. The TTR process of obtaining concentrated iron ore also results in concentrated levels of copper – at levels which exceed water guidelines. Copper is highly toxic to most aquatic species, especially fish and algae. TTR need to dilute the concentrated copper 160-fold to enable protection of 99% of the species. Staggeringly, despite the significance of this, **no mention** is made in the Impact Assessment of any Reports addressing the issue of copper concentrations, dilution processes and possible ecological impacts. Queries I made at the start of the first submission period identified that both the TRC, STD and the fishing community were unaware of the copper issue – which brings into question the degree of transparency TTR has brought to the consultation process.

   Recommendation: There could be double or triple grinding of sand, in order to reach the market specifications for the iron ore. Each grind concentrates the metals, such as copper and nickel. Once grinding specifications are determined, the EPA needs to work with TTR to obtain engineering solutions for the predicted high concentrations of metals, so that water quality standards for the protection of species is met.

6. Within a few weeks I obtained mammal sightings data of orcas, dolphins and whales from the public (not reported to DOC) that were significant in comparison to sightings data reported by TTR. This reinforces the recommendation by NIWA scientist Dr Torres that it is essential that a 'systematic survey' for marine mammals is conducted, as that is the **only way to obtain a non-biased** distribution pattern of mammals.

   Recommendation: The populations of endangered species frequenting the South Taranaki Bight, especially those feeding or transiting in affected distances from the Project, can only be determined by a 'systematic survey'. Until this is done, there can be no objective assessment of risk.

7. Section 59 of the EEZ Act requires the effects on human health to be taken into account. Power for the project is generated on ship and one of the options is to use reciprocating turbines. Despite the Executive Summary of the Impact Statement stating the project *will not involve discharge of contaminants which might potentially result in adverse effects on human health*, Impact Assessment (11.9.3) shows ground level concentrations offshore of **sulphur dioxide exceeds 1 and 24 hour air quality standards**, close to the FPSO. No mention has been made in the Impact Assessment of the health effects for employees working on the FPSO. Onshore ground level concentrations of sulphur dioxide **exceed** World Health Organisation guidelines. Workplace Emission Standards (WES) get no mention in the TTR Impact Assessment or the Tonkin & Tonkin Report. Employees on the TTR Project ship the FPSO will be exposed to levels of sulphur dioxide that majorly exceed WES. The Department of Labour High Hazards unit have no jurisdiction over ships, so the H&S Act will not be enforced. Maritime NZ has no jurisdiction over 'foreign flagged ships', which the FPSO is likely to be. Even if a 'NZ flagged ship' Maritime NZ does not have jurisdiction for air emissions. The EPA is the only one who can in some way protect workers on the ship, or fishermen in proximity to elevated emissions – if suitable conditions are imposed as part of the marine permitting process.

   Recommendation: The EPA imposes conditions on the permit to ensure 'work place emission' guidelines are met for employees living on the FPSO ship, and also to impose conditions so that the work place emission guidelines for short term exposure for fishermen are not exceeded.

8. A very concerning aspect, is the 'natural suspended sediment concentrations' have little data to show what quantities of river inputs were incorporated into the model, and how the choice of rivers coincided with the nested domains used. This is of critical importance, as much importance is placed as to how the Project impact will change the 'natural' levels of SSC. There needs to be further information provided on this.

   Recommendation: There needs to be reporting on the modelling data input quantities used for predicting the 'natural levels of SSC'.

9. The 'Coastal Stability Report' predicts at 50m depth it will take around 500 years for the 10m pits to reduce by 90% and 350 years for the mounds to reduce by 90%. At 35m the time factor is less, 100 years and 20 years. Critically the cumulative effect of having up to 14kms

in pits and mounds has not been modelled. The particle sizing of mounds used in the modelling was not the same as deposited sand from the Project.

Recommendation: Re-run pit and mound modelling to consider the cumulative 'worst case' impacts – ensuring the particle sizes reflect those of deposited sand.

When you consider TTR has spent $50 million since inception on exploration, engineering, studying the physical and ecological environment and identifying potential impacts – I would suggest addressing the limitations I have identified would financially be insignificant in terms of the spend to date.

Where a Company fails to 'place all the cards on the table' at the start of the application process – the inevitable question arises as to the level of transparency on environmental matters that can be anticipated during the life of the Project.

10. The cash flow impacts of the Project for the region needs determining. The local community has failed to challenge/question the environmental impacts presented to them by TTR, due to the focus on the $240 million predicted increase in regional GDP figures presented to them. There also seems to be some thought in the community that royalty streams might be able to divested to the region – despite no evidence available that support this desire. The majority of the public will not understood that GDP is an economic measure that bears no resemblance to the cash flow impact for the region. The Company whilst NZ registered, is over 90% foreign owned so profits flow overseas. All processing is done on ship, so no use is made of NZ ports or infrastructure. A very small percentage of operating expenditure will be spent domestically – the majority will be spent overseas (freight, fuel, insurance etc.). Labour opportunities for the region may be insignificant, when factors such as: increased automation of processes, foreign chartered vessel possibilities, skill base requirements and fly-in fly-out policy are factored into the equation.

    Recommendation: The regional cash flow needs determining, before any economic benefit is attributed to the region.

11. A cash flow analysis of the future benefit of sustaining fish stocks and the cash flow impact should the fish stocks be damaged needs to be done. The present value of long term cash flows from our fisheries, especially in light of global pressure on fishing stocks and the resulting impacts on pricing, needs determining. The results need comparing to the present value of the medium term cash flows from royalties and taxes. Cash flow analysis will require crown mineral regulations for the calculations of royalties and current taxation legislation to be used.

    Recommendation: A national cash flow analysis needs to be done, before the economic impacts from this Project can be known.

12. The social impact mitigation measures outlined in the Impact Assessment incorrectly state that NIWA modelling assumed a worst case liberation of all fines from seabed deposited de-ored sand (15.4.5). Discussion in 3-2 of the Plume Modelling report clearly show this is not the case.

A FEW FACTS – all of which could be significantly more extreme, if limitations in modelling are addressed

SURFACE SUSPENDED SEDIMENT	8KM FROM SOURCE	MEDIAN INCREASE 375% MAXIMUM INCREASE 38%
SURFACE SUSPENDED SEDIMENT	WITHIN A FEW KM OF SOURCE	20-40 MG/L

(TTR wrongly state the result in the Impact Assessment Executive Summary as 10-20 mg/L)

NEAR BOTTOM SEDIMENT	AT THE SOURCE	100 mg/L

PATEA SHOALS: **observed** 500 mg/L – but **model result** showed 100 mg/L – because seabed geometry can change sediment concentrations by a factor of 20.

'Bed load transport was only used for the 'patch' and not for the other plume modelling. For the 'patch' it resulted in a 20% increase in the rate at which medium sands were transported

WAVES	AT THE VACINITY OF THE OPERATION	44 cm change – 12.6%

(TTR wrongly stated in the Impact Assessment 28cm change)

WAVES	AT THE 10M ISOBAR	11.6 cm decrease at Patea
WAVES	BETWEEN MANAWAPOU AND PATEA	8cm increase

PITS AT PROJECT SITE, 7KM LONG, 4.5KM LONG, 3.0KM LONG	MODELLING USED 300m x 500m

VERY FINE SEDIMENT	4.2MILLION TONNES per annum from the Project
VERY FINE SEDIMENT	310,000 TONNES per annum from the Patea river

Workplace Emission Standard for Sulphur Dioxide	Short term exposure limit: 13mg/m^3

Project Reciprocating Turbine 1 hour	453mg/m³
Project Gas Turbine 1 hour	211mg/m³

MINING SITE VISIBILITY **(zeu)** DROPS FROM 25m to 5m

MINING SITE **vertical visibility** DROPS FROM 10M to 1m

WAVE CONDITIONS at the beach couldn't use sophisticated SWAN model

WAVE CONDITIONS for the month of NOVEMBER used for modelling purposes – misses the storm events of winter

WORST WAVE EVENT (using November) was 30cm INCREASE IN WAVE HEIGHT NORTH OF PATEA AND 30CM DECREASE AROUND PATEA

(TTR showed the wrong diagram for the worst case, as 10cm)

SEVERE PARAMETER LIMITATIONS IN PLUME MODELLING *plus* IMPORTANT FINDINGS IN THE BODY OF THE NIWA REPORT, ARE MISSING FROM THE NIWA & IMPACT ASSESSMENT EXECUTIVE SUMMARIES

Severe limitations in the plume modelling have been identified.

1. Restricted parameters used in the sophisticated models. This results in the **full range of likely outcomes having not been determined.** Consequently **risk assessments** are based on an **incomplete** set of outcomes and need to be re-evaluated.
2. 'Patch source' modelled only 11% of total Project patch.
3. The 'natural' SSC data inputs for modelling of river tonnage is **missing** from the Report
4. Missing from the plume modelling, is the extra fine particle sizes generated from the **second grind**. Particle Size Distribution (PSD) data was for first grind.
5. 37% of the total Project fine sediment (<90µm) was **not plume modelled (MTI 'patch modelling)** equating to 213 tonnes/hour or **1.86 *million* tonnes** per annum. To put this figure in perspective - the Patea River deposits 310,000 *thousand* tonnes per annum.
6. **3.12%** mud was used for modelling despite RC cores indicating significantly greater mud percentages - STH023 and STH024 at depths 1-8m showed **mud 10-22%**.
7. **Cumulative impact not modelled** for the 'patch source'.
8. Source **B** (seaward end of Project) **not modelled for 'recovery'**.
9. **Lack of confidence** in Particle Size Distribution (PSD) possibly 80% understated
10. **Sediment cores not independently obtained**
11. No **geographical coordinates** for later sediment cores
12. '**Down-core iron variability**' and variable mining depths not used in modelling.
13. **Erosion factors** have been ignored for 'patch' plume modelling.
14. **80% 'uptime'** for modelling **not independently verified**.
15. NIWA **doubles deposition rate** compared to MTI Holland
16. Surface and Bottom SSC results **not reflected** in NIWA and IA Executive Summaries
17. **Cumulative impact** of deposition rates not modelled
18. **Patea Shoals modelling deposition rates uncertain**
19. Source B (seaward end of Project) **SSC results missing** from NIWA and IA Executive Summaries
20. No reports on brine discharge and **change to salinity** of the ocean
21. Sediment plume from **re-anchoring** every 10 days not modelled
22. Plume modelling report and Optical report don't give **ecological impact**

This marine application is the first to be dealt with by the EPA under the EEZ Act. Indications are that many more marine applications from TTR and other Companies could be received in the future - TTR has indicated there is a **JORC compliant recoverable iron sand resources of 4.6 billion tonnes** at 6.23% iron – this permit application is a small percentage of that, at **50 million tonnes** at 10%. As such it is vitally important that the methodological approach is comprehensive – as this will 'be the acceptable bar' for subsequent applications.

Sediment modelling underpins much of the environmental impact assessment – so modelling must be comprehensive, including the 'worst case' scenarios and the cumulative impacts (s59 (2) (a) (i) EEZ Act) – then section **61 (1) of the EEZ Act** will have been met i.e. decisions (such as risk assessments) can be based on the best available information.

The EEZ Act section **39(2) (b)** requires sufficient detail in the Impact Assessment, so that there is the ability to understand the nature of the activity and its effects of the environment. Due to the significant limitations identified below - the intention of section **39(2) (b)** fails to be met.

Extract below, is from the Impact Assessment section 10.2 – which effectively is recognising the requirements under section 6 of the EEZ. However, due to the numerous limitations identified – 'the full range of likely outcomes' has not been determined.

Stage I: Identify Potential Effects

All environmental effects likely to arise from both routine operations and unplanned events have been assessed in this IA in terms of the following broad categories:

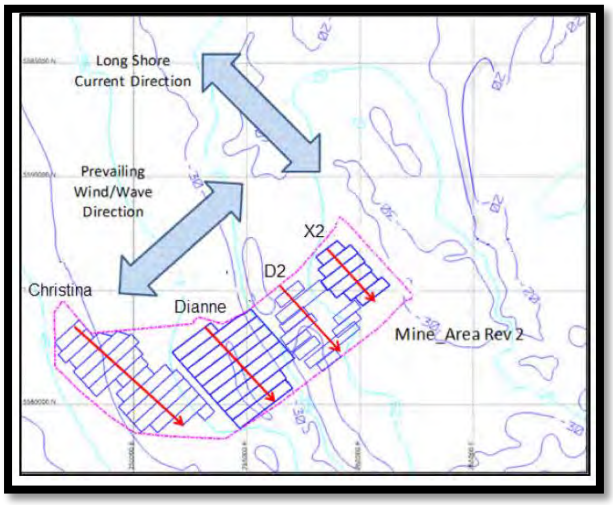
Nature of Impact	Duration of Impact	Scale of Impact	Type of Impact
• Negative	• Temporary	• Local	• Direct
• Positive	• Short-term	• Regional	• Indirect
	• Long-term	• National	• Cumulative.
	• Permanent	• International	
		• Trans-boundary	

In all cases evaluation has been made relative to extraction across the entire project area. In some cases, such as evaluation of pit infilling and mound deflation, consideration has been given to particular scenarios (such as extraction and redeposition at the ends of "lanes"), and plume modelling has been based on extraction at the shoreward end of the applications area and extraction at the seaward end to provide the full range of likely outcomes for predictive purposes.

Restricted modelling parameter 1: Cumulative Impact for sediment 'Patch' missing

Section 59 (2) (a) (i) of the EEZ Act requires the cumulative impact to be identified. The output of sediment for modelling was represented by two sources, the suspended source and the 'patch source'. A significant omission from the modelling of the patch, was that a patch representing 11.3% of the total area of 53.63km² was used (53.63km² = total of all mining blocks in the permit area as per the Geological Desktop survey, pg. 27). The 11.3% of the total mined area was 6.05 km², represented as a 3x2km rectangular patch in the Plume Modelling Report, section 3.2.3.

The Impact Assessment incorrectly states in 10.2 that the *full range of likely outcomes* has been considered. As the 'worse-case environmental impact' of a fully mined 'patch source' has not been modelled – the full range of outcomes is unknown.



Mine Plan – alignment of extraction "strips", per 2.6 of Impact Assessment

Shown above are the four areas of highest grade iron sand within the License Area 50753 that form part of the total Project area of 65.76 square kilometres. :

The four areas of highest grade iron sand within the License Area 50753 that form part of the total Project area of 65.76 square kilometres are:

- *"Xantia Extension (X2)"*
- *"Christina"*
- *"'D2"*
- *"Dianne"*

Restricted modelling parameter 2: Two 'sediment sources' were used for plume modelling, but only one sediment source (source A) was simulated to find the 'recovery situation'. Source B located at the seaward end was *not* simulated for 'recovery'.

Section 6 (1) (c) of the EEZ Act states 'effect' as including the future effect. Despite two source locations being used for the modelling (Table 3-5 Plume Modelling report) – site 7 (source A) at the inner end of the mining area, and site 10 (source B) at the outer end of the mining area – only source A was used to determine the 'recovery situation'. No explanation was provided as to why source B was not modelled. Geo-physically sources A and B are quite different, so it could have provided useful insight to have run the simulation for source B as well.

Section 10.2 of the Impact Assessment states using sediment source A and B '*provides the full range of likely outcomes for predictive purposes'*. This statement is not reflective of the full situation, as the 'recovery situation' for source B was not modelled.

Recovery Simulation

A "recovery" simulation was set up to investigate the sequence of events when the suspended source is turned off (i.e. when extraction ceases). After 800 days of simulated extraction operation there is an extensive patch of deposited mining-derived sediment up to a thickness of 10 mm near the source and around 2–3 mm in a secondary maximum between the Whanganui and Manawatu Rivers. Over the following two years this extraction derived "patch" is eroded away (Figure 88) and the associated near-bottom SSCs reduce considerably (Figure 89).
Sands move away from the initial patch location for a distance of up to 10 km over two years.

Impact Assessment 11.5.4

Restricted modelling parameter 3: There is a lack of confidence in model predictions due to 'particle size definitions' (PSD) supplied by TTR carrying considerable uncertainty.

SKM Point 8 notes this as an area of uncertainty. SKM Point 19 in their review on 'oceanographic processes and the physical environment' clearly highlights in section 3 the uncertainties regarding particle size definitions and that the significance of this uncertainty is that sediment plumes could be ***significantly more intense and spatially widespread.*** SKM Point 20 states the uncertainty could be addressed by clarifying how the sediment PSD's were arrived at and determining if they are representative of actual PSD in the sand layers.

1. **The 'particle size distribution' for fines in the modelling could be 80% understated. The** 'particle size definitions' (PSD) provided by TTR and used for simulations either come from a grab (from cyclone) or a spear (from a polyweave bag). It is unclear whether a grab or spear was used for the PSD provided for Plume modelling. The NIWA report 'Schedule AG' identified that between 50-80% of fines are lost from the spear sample – should the spear results have been used in the PSD provided for Plume modelling, there would be a significant under-estimation of the fines effect.

   SKM note this as an area of uncertainty in point 11 of their report.

   Reference:
   http://www.epa.govt.nz/Publications/TTR_Schedule_AG_Sediment_Characterisation_Comparison_of_grab_and_spear_samples.pdf see page 5

2. **3.12%** is the mud percentage used in the modelling for the de-ored sand discharge. As SKM in Point 19 of their review of the 'oceanographic processes and physical environment' rightly point out – there is no discussion on how the sediment plume changes when a mud layer is reached.

   NIWA'S REPORT 'SCHEDULE AG: SEDIMENT CHARACTERISATION FROM GRAB AND SPEAR SAMPLES' (4.2) shows the percentage of mud for five samples that have been laser-sized. On average the laser-size fractions for grab mud results shown below, are greater than the 3.12% used in modelling. If you averaged the Schedule AG results it would result in 7.2% mud.

   Laser-size fractions (%) <63 µm (mud)

   1. STH015RC 8-9 grab **14**
   2. STH016RC 4-5 grab **1**
   3. STH019RC 2-3 grab **2**
   4. STH023RC 4-5 grab **13**
   5. STH024RC 6-7 grab **6**

   The SKM report point 9 notes as an area of uncertainty "*results from five other cores also show intervals with mud content >10% and up to 79% depending on sampling method".* SKM is referring to the grab and spear samples in Schedule AG. SKM go on to say *"this is a significant piece of information that does not appear to have been given adequate discussion, assessment or further description in the context of the Impact Assessment"*

   NIWA'S REPORT ' SCHEDULE AG: SEDIMENT CHARACTERISATION FROM GRAB AND SPEAR SAMPLES' (4.1.1) Shown below are samples from grabs with mud percentages greater than 10%. I have identified in red those depths that correspond to the 'indicative mine depth thickness' shown in Table 5-1 of the Geological Desktop Summary.

   The mud components of STH023RC and STH023 *throughout all depths* ranges from 10-22% mud- significantly more than the 3.12% used for modelling.

   It would be insightful if the geographical coordinates for the samples had been given, as had been for earlier samples STH010 & STH012.

   References:
   http://www.epa.govt.nz/Publications/TTR_Schedule_AG_Sediment_Characterisation_Comparison_of_grab_and_spear_samples.pdf page 9, Table 4-1

   http://www.epa.govt.nz/Publications/TTR_Geological_Summary_Report_no_appendices.pdf Page 27, Table 5-1

NIWA CORE DATA FROM TABLE 4-1: FRACTION OF GRABS >10%MUD

1. **STH015RC** *Moderately well sorted medium sand; very coarse silty fine sand*
8–9 m (14%) 9–10 m (31%)

2. **STH016RC** *Variable: poorly sorted coarse sand; moderately well sorted medium sand; medium silty fine sand*
10–11 m (30%) 11–12 m (21%) 12–13 m (33%) 13–14 m (15%), 14–15 m (18%), 18–19 m (10%), 19–20 m (23%)

3. STH019RC *Moderately well sorted fine sand; moderately well sorted medium sand*
16–17 m (42%)

4. STH023RC *Variable: poorly sorted medium sand; moderately sorted fine sand; very coarse silty fine sand; medium silty coarse sand; fine sand coarse silt*
1–2 m (14%) 3–4 m (18%) 4–5 m(13%) 6–7 m (10%) 7–8 m (19%)
8–9 m (56%) 9–10 m (11%) 10–11 m (18%)

5. STH024RC *Well to moderately well sorted fine sand; very coarse silty fine sand; medium silty fine sand; fine to very fine sandy coarse silt*
2–3 m (12%) 2–4 m (18%) 4–5 m (16%) 5–6 m (21%) 7–8 m (13%) 8–9m(22%), 9–10 m (37%), 10–10.7 m (79%)

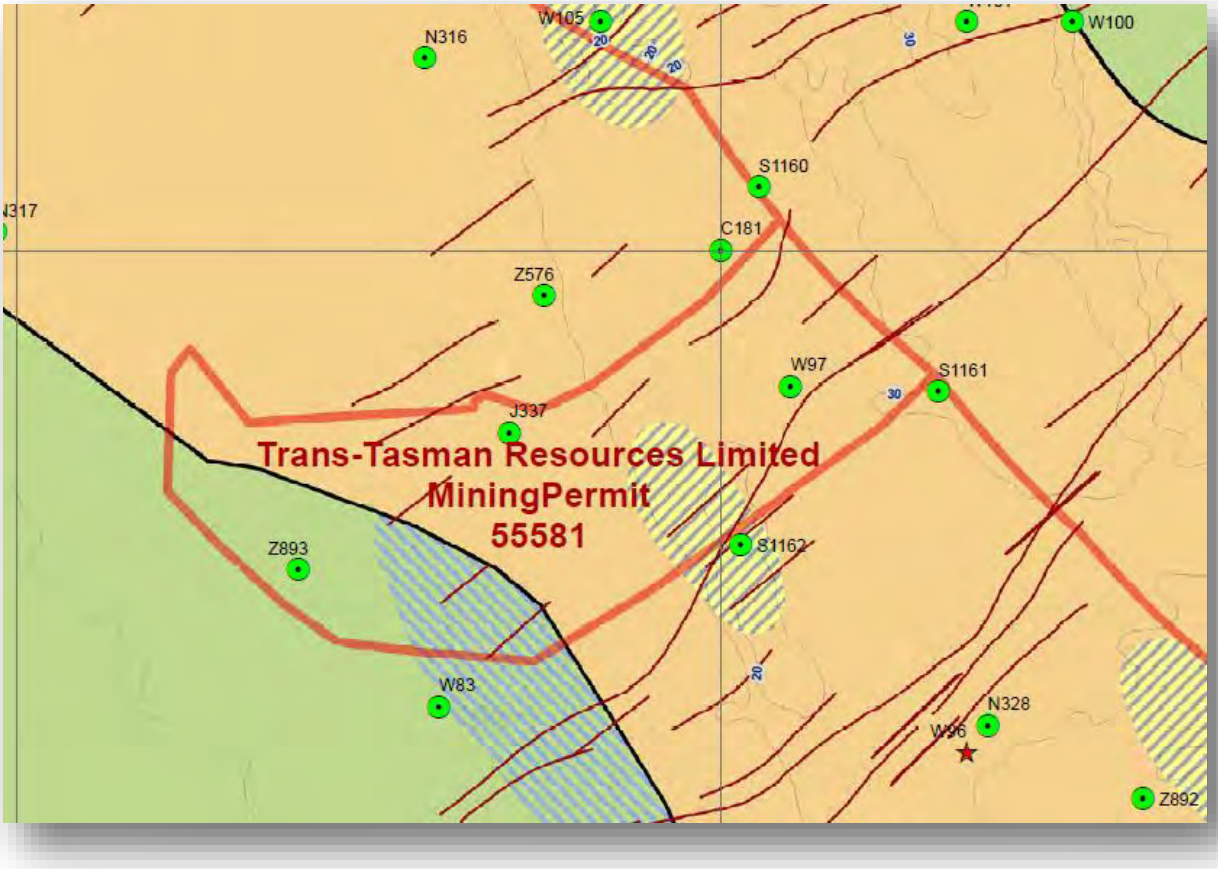
A minor **gravel fraction** occurred in some of the core intervals, but rarely exceeded **25%.** The exceptions were the basal sections in STH016RC (20–21 m) and STH023RC (10–11 m) where the gravel component exceeded ~40%.

Mining Block	Area (km^2)	Indicative Fe head grade (%)	Estimated concentrate (megatonnes)	Indicative mine block thickness (m)	Water depth (m)
Xantia	14.96	9.75	10.8	3.3	17 - 32
X2	4.96	12.78	7.7	7.5	25 - 38
Dianne	15.53	10.41	19.9	8.4	21 -41
D2	3.00	< 9.00	3 - 4	2 -5m	19 -25
Christina	15.16	8.75	15	7.8	35 - 42

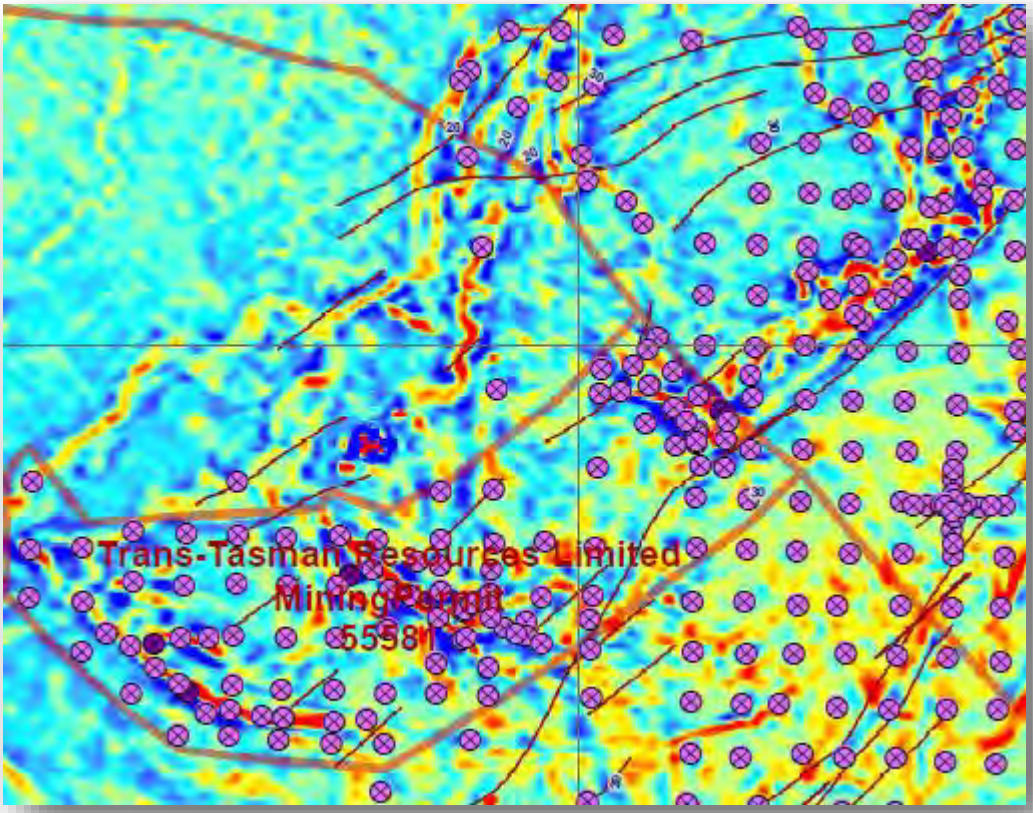
Table 5-1: Statistics for each of the five mining areas identified by TTR.

Geological Desktop Survey: Table 5-1, showing indicative mine block thickness

NIWA grab and spear sample numbers in Table 4-2 of NIWA schedule AG, differ to the core data numbers shown in Appendix C of the Geological Desktop Summary. There is an inability to determine the latitude and longitudes that the samples came from. The diagram below shows green dots representing grabs, and red stars representing cores.



Extract from Appendix B of the Geological Desktop Summary – grabs (green dots) & cores (red stars)



Extract from Appendix F: Geological Desktop Summary – shallow core (light purple) and deep core (dark purple)

The Geological Desktop Summary 5.3 states 777 short cores (maximum 16m core length) and 15 long cores (maximum 30m core length) have been done and are shown in Appendix F

(note that there does not appear to be 15 long cores shown in Appendix F.)

Restricted parameter modelling 4: Reliance on plume modelling results are compromised when the RC samples were not independently obtained by NIWA and no information on geographical coordinates of those samples have been given.

The SKM report, Point 8 notes that the PSD inputs were provided by TTR, but fails to consider/address in their report the perceived lack of independence. The SKM report point 10 discusses the fact that the use of two cores is inadequate to give a sufficiently detailed description of the distribution of mud layer throughout the Project. This point is not *explicitly* mentioned in the SKM 'key findings', rather a generalised comment is made 'further explanation and justification for the PSD applied to modelling would increase confidence in model predictions'. The SKM report doesn't comment on the RC samples

Earlier RC cores, STH010RC and STH012RC, *did* have their geographical location identified in the report (NIWA Schedule N, part 2). This is insightful data to provide, as it can be seen that both areas fall in the bottom southern area of the extraction site, in areas identified as 'gravelly sand'. The cores are not in the extraction area identified as 'gravelly mud' – where the 'Christina' extraction area will be. If the STH010 & STH012 RC cores were used for modelling, it will underestimate the sediment plume generated whilst mining 'Christina' in the seaward side of the Project extraction area.

Location data for the earlier two cores:
STH010RC from 33 m water depth (39° 52.612' S, 174° 07.654' E)
STH012RC from 29 m water depth (39° 50.289' S, 174° 10.954' E).

Looking at the results of STH010RC and STH012RC below, the percentages of mud are higher than the 3.12% used for plume modelling of the patch when you add the mud and silt percentages together ★

	STH010 004005 RC Av	MIN	MAX	STDEV	STH010 010011 RC DUP Av	MIN	MAX	STDEV	STH012 06007 RC Av	MIN	MAX	STDEV	STH012 014015 RC DUP Av	MIN	MAX	STDEV
MEAN	268	265	270	2	194	184	206	9	115	83	135	20	160	151	180	11
MODE 1 (µm):	224	224	224	0	329	245	430	84	255	245	269	13	224	224	224	0
D10 (µm):	139	138	141	1	5	5	6	0	4	4	5	0	10	9	11	1
D50 (µm):	225	224	226	0	101	82	130	20	42	31	55	9	169	164	176	4
D90 (µm):	363	353	370	6	512	493	537	16	312	247	345	38	284	275	305	12
% SAND:	97%	97%	97%	0%	54%	53%	57%	2%	42%	36%	48%	5%	75%	73%	76%	1%
★ % MUD:	3%	3%	3%	0%	46%	43%	47%	2%	58%	52%	64%	5%	25%	24%	27%	1%
% V.C. SAND:	2%	2%	2%	0%	1%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
% C. SAND:	6%	6%	6%	0%	10%	9%	10%	0%	2%	0%	3%	1%	1%	0%	3%	1%
% M. SAND:	29%	29%	30%	0%	22%	21%	23%	1%	16%	9%	20%	4%	18%	17%	19%	1%
% F. SAND:	55%	55%	56%	1%	16%	15%	18%	1%	17%	15%	18%	1%	45%	43%	46%	1%
% V.F. SAND:	4%	4%	4%	0%	6%	6%	7%	0%	7%	7%	8%	1%	11%	10%	11%	0%
★ % V.C. SILT:	1%	1%	1%	0%	11%	10%	11%	0%	13%	12%	14%	1%	6%	6%	7%	0%
★ % C. SILT:	1%	1%	1%	0%	12%	11%	13%	0%	15%	13%	17%	1%	6%	5%	6%	0%
★ % M. SILT:	1%	0%	1%	0%	9%	8%	9%	0%	12%	11%	13%	1%	5%	5%	5%	0%
★ % F. SILT:	0%	0%	0%	0%	6%	6%	7%	0%	9%	8%	10%	1%	4%	4%	4%	0%
★ % V.F. SILT:	0%	0%	0%	0%	4%	4%	4%	0%	6%	5%	6%	1%	3%	3%	3%	0%
★ % CLAY:	0%	0%	0%	0%	3%	3%	3%	0%	3%	3%	4%	0%	2%	2%	2%	0%

Table 7: Summary of sample analysis variability for replicate samples from cores STH010RC and STH012RC.

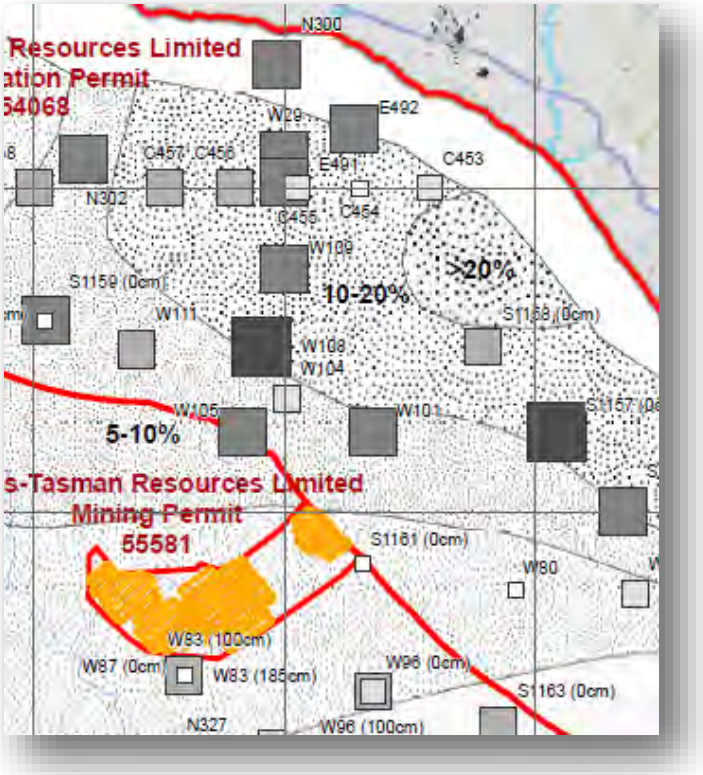
Extract above from NIWA report, Schedule N – Table 7

Restricted parameter modelling 5: Despite the fact that dredging will occur at various depths reflecting the 'down-core variability' of mineral concentrations over the mining permit area, as well as sand wedges, a 'mean' mining depth of 5m was used for modelling and the simulation was run for 10 years. The Impact Assessment discusses a maximum depth of 11m might be mined – though there is little evidence in reports to support why this would be so.

Data obtained indicates a 'down-core variability' for concentration of minerals. The appendices to the Geological Desktop Summary show the variability of mining thicknesses and resources over the projected permit area. As this data is available the modelling could have been broken into sections to reflect this variability. For example 'Dianne' extraction area is 29% of the area to be mined and has an indicative mine block thickness of 8.4m. 'Xantia' is 28% of the area to be mined with an indicative mine block thickness of 3.3 and 'Christina' is 29% of the area to be mined with an indicative mine block thickness of 7.8m.

There is no discussion linking the percentages of iron, sand extraction wedges and indicative mining depths. SKM in point 10 note the uncertainty surrounding the 11m proposed depth and the need to define the spatial distribution, depth and thickness of the mud layer.

The Impact Assessment discusses a 10% iron ore concentrate will be extracted but no details are contained in the Impact Assessment about depth to be mined to get that percentage extraction rate i.e. 'down-core variability'. The extract from Appendix 10 shows the predicted 5-10% iron ore concentrate for the project.
http://www.epa.govt.nz/Publications/TTR_Geological_Summary_Appendix_D_IRONSANDS_CONC.pdf



The depth of dredging has an impact on the life of the Project. At a mean depth of 5m, the patch-source simulation ran for 3,000 days (10 years @ an 80% uptime). If a deeper mean depth was dredged the simulation needs to run for a much longer time e.g. 6,000 days (20 years @ an 80% uptime).

3.2.3 Patch source

To model the fate of de-ored sand buried at the mining site we consider a rectangular patch representing one year's worth of ironsand extraction and populate this patch with material that reflects the composition of the combined hydro-cyclone and de-ored sand discharge streams, minus all the material that was released in the suspended source (Section 3.2.1).

The area of this source is calculated as follows: Assuming a volume extraction rate of 1.195 m3/s at full operation (mass extraction rate 8000 tonne/h with a bulk density of 1860 kg/m3) and an **up-time of 80%,** the annual volume extracted is 30.15 × 106 m3. At a **mean mined depth of 5 m, this implies that an area of 6.05 km2 would be mined in one** year. (There are various sources of uncertainty in this number but the largest is the mean mined depth, which could differ from the assumed value by a factor of two.) This area is represented in the model as a 3 × 2 km rectangular patch centred on the mining site, which is taken to be mining site A.

The sediment classes for the patch source are listed in Table 3-6. **There is no < 38 µm class** because all this material is assumed to have been released in the suspended source. The fractions in the right-hand column sum to 100% and are in proportion to the deposition rates.

The material in the seabed around the patch is assumed to be unmined sand, with a **composition based on data from the client describing the run-of-mine (ROM) feed**. The sediment classes (Table 3-7) are the same as the patch classes, with the addition of a 5th < 38 µm class. The fractions in the right-hand column are in proportion to the mining rates. Compared to the surrounding seabed, the patch has a lower proportion in the 38–90 µm range, and none at all < 38 µm, with somewhat more in the remaining size ranges.

The simulation was run on the smaller (Patea Shoals) inner domain with no river input. (This is a reasonable approximation as the footprint of the patch source tends to be limited to a small area and there should be no interaction with the rivers.) The model was initialised at 2000 days with seabed sediments (Table 3-7) filling the domain, then at 2200 days the 3 × 2 km patch area was replaced with the patch-source sediments (Table 3-6). The simulation was continued to 3000 days

Extract from NIWA Plume Modelling Report, page 33

Restricted parameter modelling 6: The 'patch' sediment modelling underestimates erosion – this means the bathymetry 'recovery' time is presently under-estimated, and 'patch source movement of 10km in 2 years is also under-estimated

The patch modelling *underestimates* erosion, as NOT factored into modelling was:

- the higher porosity of the patch compared to the surrounding seabed
- bio-stabilisation inactivity
- the patch sits at a slump of 1m leading to turbulence generation
- and the patch does not have the high density titanomagnetite grains.

Rather than explicitly noting the reasons, the NIWA Plume Modelling Executive Summary (third to last paragraph) states there were 'various reasons' why the NIWA 'patch source' simulation may *under-estimate* the extent to which patch material is eroded and transported. ***The 'various reasons'*** *were listed above and* ***are detailed in the NIWA report (3.2.3) attached below.***

Significantly amongst the four points outlined – is the third bullet point discussing the fact that the '*patch surface may sit at a different level from the surrounding seabed leading to turbulence generation and potentially faster erosion*'. What this means is that the 8-9m mounds and pits 9-10m, as well as the patch slump of 1m – has *not* been used in the NIWA 'patch' simulation.

If the 'patch source' modelling were to include the erosional factors presently missing from the modelling – the movement of 10km in 2 years will be greater.

> The original motivation in setting up the patch source was to estimate the change in suspended sediment concentrations resulting from the difference in sediment properties between the patch and the surrounding seabed. (As noted above, the main difference is that fine sediments are lower in the patch.) However it is likely for several reasons that the deposited patch would be eroded more readily than the surrounding seabed:
> The patch material when it is first deposited will be unconsolidated, with a higher porosity than the surrounding seabed.
>
> Any biostabilisation in the surrounding seabed will not be active in the patch.
>
> The patch surface may sit at a different level from the surrounding seabed, leading to turbulence generation and potentially faster erosion.
>
> The patch will be depleted of the very high density titanomagnetite grains, which may act to stabilise the seabed against erosion. (It has also been suggested that titanomagnetite may stabilise sediment beds by means of its magnetism, but this suggestion is not well supported—K. Bryan *pers. comm.*).
>
> In view of these reasons, analyses of the patch simulations have considered only the patch material itself, to give an order-of-magnitude estimate of how readily this is eroded, transported and deposited.

NIWA Report on Sediment Plume Modelling, extract 3.2.3

Deposition from the suspended source was characterised by two statistics, **the maximum 5-day deposition (i.e. the maximum amount of material accumulated over any 5-day interval)** and the maximum 365-day deposition. As with SSC, the deposition footprint of the mining-derived sediments can be distinguished from the natural background in the vicinity of the source, but not near the coast.

A "recovery" simulation was set up to investigate the sequence of events when the suspended source is turned off. After 800 days of operation (the beginning of the recovery phase) there is an extensive patch of deposited mining-derived sediment to a thickness of up to 10 mm near the source and around 2–3 mm in a secondary maximum between the Whanganui and Manawatu Rivers. Over the following two years of recovery this patch is eroded away and the associated SSCs reduce considerably.

With the patch source, sands **move away from the initial patch location for a distance of up to 10 km over two years.** There is no extensive plume of suspended sediment. **For various reasons the patch source simulation may underestimate the extent to which patch material is eroded and transported, but even allowing for this bias no extensive plume is expec**ted.

Extract from the NIWA Plume Modelling: ***Executive Summary***

Restricted parameter modelling 7: The plume modelling has been done with the sediment source turned off 4 days in every 20 (an 80% uptime) with no independent verification of the plausibility of this percentage.

The **assumption of an 80% uptime** for the purposes of Plume modelling is a **significant one and can significantly affect determining the 'worst case scenario' for plume modelling**. Because of this, an independent engineering report needs to be obtained to ascertain the plausibility of this.

The Impact Assessment itself contradicts this uptime figure, with 2.19.1.2 (Marine Vessel Operations – FPSO) stating "seabed extraction and processing operations are planned to be undertaken continuously 24 hours per day". Tucked away in 11.5.3.1 of the Impact Assessment is the point that the source operates with a 20% downtime.

Restricted parameter modelling 8: The NIWA plume modelling for the 'patch' doubled the deposition rate, compared to MTI Holland.

The reasoning for NIWA opting for a different deposition rate to MTI Holland was not discussed in the report. As can be seen below the NIWA deposition rate is double that of MTI Holland. This means the plume transport factor for sediment is reduced compared to MTI Holland.

Grain size 38-90µm & 50.3 kg/s – at 100m downstream from source

MTI HOLLAND: *In suspension*	*Deposited*	**NIWA:** *In suspension*	*Deposited*
32-43 kg/s	*7.3 kg/s*	*35.0 kg/s*	*15.3 kg/s*

The partitioning of the material with a grain size that falls between these two limits, the 38–90 µm class, was addressed with the aid of simulations with a high-resolution computational fluid dynamics (CFD) model of the de-ored sand plume carried out by Svasek Hydraulics (MTI Holland 2013a,b). With this model, for a range of scenarios representing high-energy conditions, it was estimated that of the **50.3 kg/s of 38–90 µm** material discharged in the de-ored sand (see) between 32 and 43 kg/s would still be in suspension 100 m downstream from the source, with the **remainder deposited on the bottom.** For the present modelling, it was assumed that the 38–90 µm class in the de-ored sand had a release rate of 35.0 kg/s in the suspended source, with the remainder being **deposited at a rate of 15.3 kg/s**.

Extract detailing patch deposition rates from the NIWA Plume Modelling report 3.2

NIWA Executive Summary & the Impact Assessment Executive Summary do not reflect important SURFACE SEDIMENT findings contained in the NIWA plume modelling report – breaches intention of s6 EEZ Act.

1. Results for the surface sediment plume for the Wanganui sample site (figure 5-1) show a maximum **increase of 17%.**
2. The '8km from the sediment source A' sample site (figure 5-2) shows a maximum increase of **38%**.

The NIWA Executive Summary summarises these results with the statement ***'at the Wanganui site, natural sediments dominate over mining-derived sediments; at the 8km from source A site, mining-derived SSCs were larger than natural SSC's.'***

- This statement fails to give any recognition to the significant percentage increases noted above. In effect the Executive Summary fails to discuss the 'worst case scenarios' resulting from maximum mg/L increases at these two sample sites.
- If the tables (5-1 & 5-2) of the Plume Modelling report are reviewed – they do not indicate that the natural sediments are **'dominating'** over mining sediments.

To 'prove' that the Executive Summaries 'fall short' – this is the approach taken:

First I have included some pertinent extracts from the NIWA report and discuss their relevance.

Second I have attached below the graph results (pre & post mining) for Wanganui and the site 8km from the source. I have then taken the numbers in those graphs and listed them to show the increases and percentage increases in suspended *surface* sediment.

Thirdly, the results from the graphs can be compared to the Executive Summary extracts on *surface* SSC – to illustrate that the Executive Summaries falls short in detailing the *surface* SSC results obtained in 5.1.

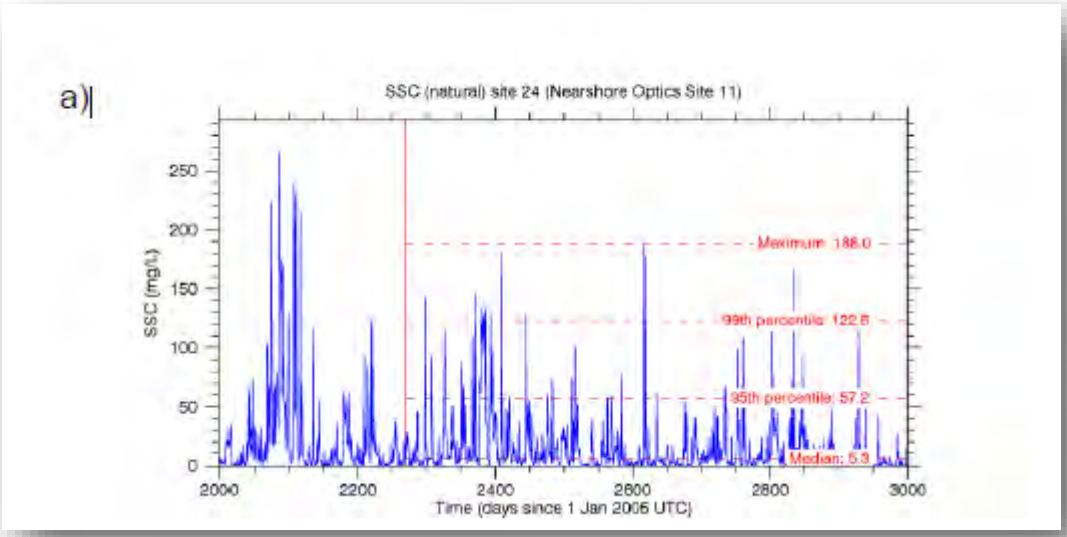
***Firstly**: Extracts from NIWA plume modelling report **section 5.1**:*

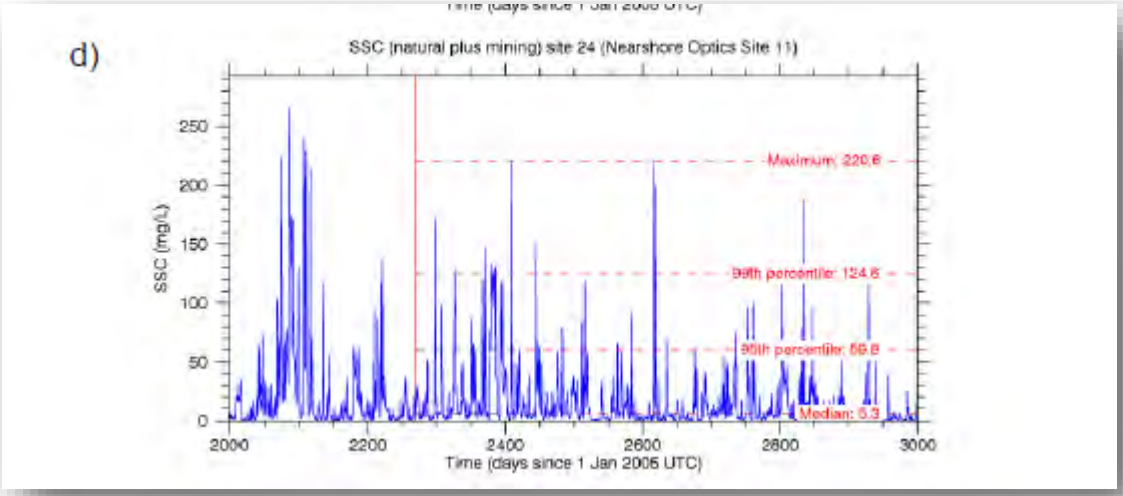
The sediments in the model affect the currents, though normally by a small amount, by altering the water density and also the bottom roughness (which affects bottom drag). **Any change, however small, in a model like this then affects the transport processes, which can have a large effect on the concentration at any given point in space and time**. In this sense **the model—like the real world—displays "chaotic" behaviour.**

In principle the **net effect of the additional mining-derived sediment on the SSC can be calculated by taking the differences in the respective statistical parameters between panels a and d**. By these calculations: the median has stayed the same at 5.3 mg/L; the 95th percentile has increased from 57.2 to 59.8 mg/L; the 99th percentile has increased from 122.5 to 124.6 mg/L; the **maximum has increased from 188.0 mg/L to 220.6 mg/L**. **The increase in the maximum is moderately large as a percentage**, but appears to be a manifestation of the chaotic behaviour of the model. For all the other parameters the effect of the mining-derived sediment is small in relation to existing sediment concentrations.

It is important to compare total surface sediment before and after – not to just look at the levels attributable to dredging/mining alone. This is because of the reasoning shown in the first box below. In other words there is a 'chaotic' behaviour that occurs when sediment enters the water – effecting water density and bottom drag – which then effects how the sediment is transported and consequently the concentration of sediment at a certain point. The Wanganui results illustrate this point: showing a **17% increase in the maximum SSC – from 188.0 mg/L (pre-mining) to 220.6 mg/L (32.6mg/L increase).**

***Secondly**: Graphs a and d below are from NIWA plume modelling report, Figure 5-1 – Wanganui surface SSC*

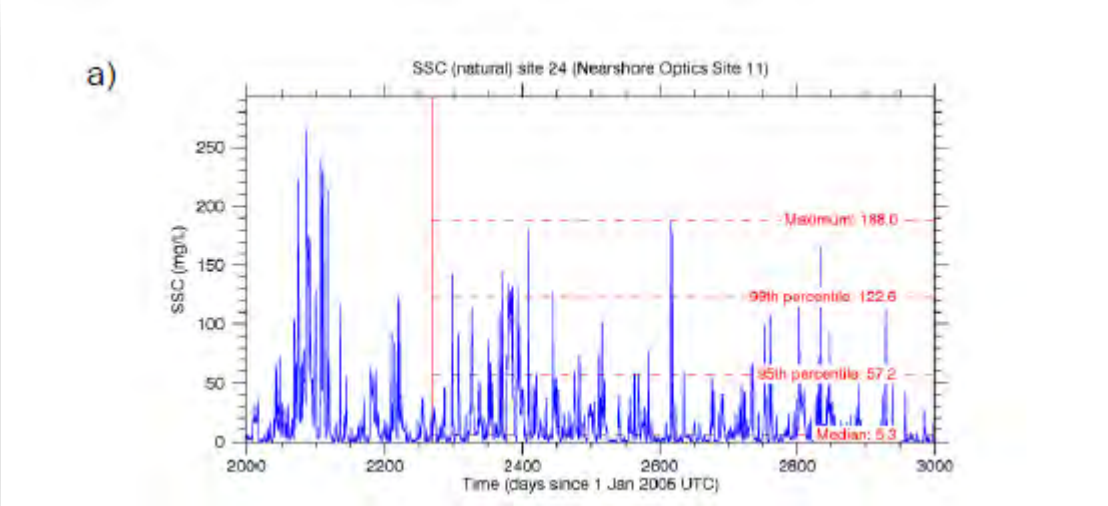


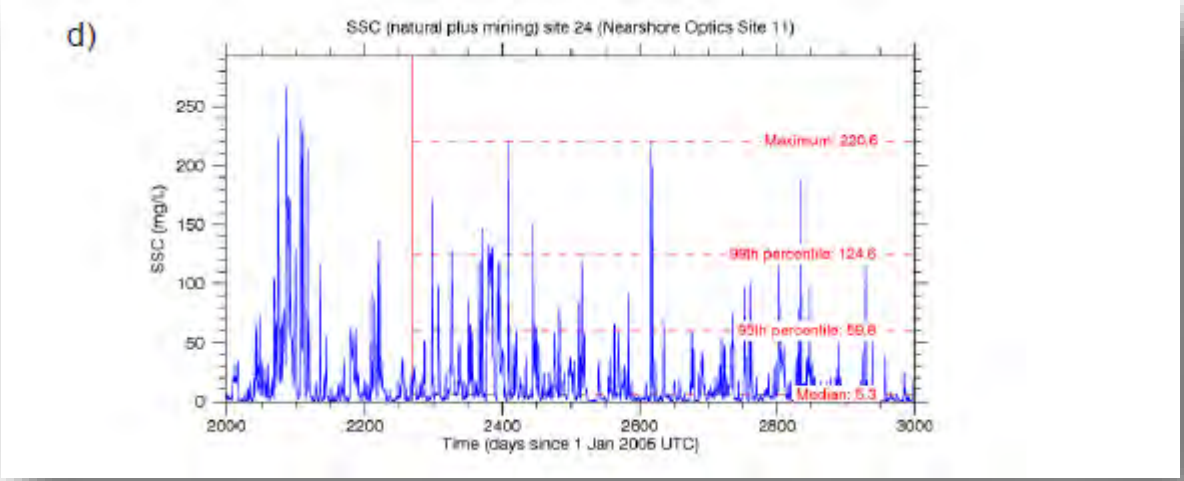


Comparing the SSC pre and post mining we see that:

- The median has stayed the same at 5.3 mg/L
- The 95th percentile has *increased* from 57.2 to 59.8 mg/L (2.6 mg/L diff.);
- The 99th percentile has *increased* from 122.5 to 124.6 mg/L (2.0 mg/L diff)
- **The maximum has *increased* 17% from 188.0 mg/L to 220.6 mg/L (32.6 mg/L diff)**

Graphs a and d – are from NIWA plume modelling report Figure 5.2 – ***8km from mining source A****, surface SSC*





Comparing the SSC pre and post mining we see that:

- The median has ***increased 375% f***rom 0.8 mg/L to 3.8 mg/L (3.0 mg/L diff)
- The 95th percentile has ***increased* 216% f**rom 3.7mg/L to 11.7mg/L (8.0 mg/L diff)
- The 99th percentile has ***increased* 92%** from 8.2 mg/L to 15.8 mg/L (7.6 mg/L diff)
- **The maximum has increased 38% from 17.3 mg/L to 23.6 mg/L (6.3 mg/L diff)**

These percentage increases are significant when you consider that organisms in the '8km from the source area' have a pre-mining habitat with lower sediment levels than in comparison to onshore habitats and as such may be more vulnerable these percentage increases in sediment. A biological investigation into the sustainable load of SSC for organisms in this habitat needs to be done before any commentary on whether the percentage increases will have a minor effect or not. 'Key performance indicators' could be then developed and used for monitoring purposes.

SSC can directly affect aquatic organisms and habitats, blocking gills and filter feeders and smothering sedentary aquatic plants, animals and their eggs. SSC can have other significant impacts such as reduced light penetration inhibiting photosynthesis & burying coarse bottom sediments leading to a loss of habitat and spawning sites for gravel bed dependent fish. This can produce flow on effects through food chain linkages.

Where the supply of sediment exceeds the 'normal habitat' flushing capacity, this material will accumulate and smother bed habitats.

An importantly factor that has been overlooked in all the NIWA reporting, is emphasis on the ecologically important area, the Graham Bank, which lies in the direct path of elevated levels of sediment plume.

***Thirdly**:* Determine if results are reflected in NIWA & Impact Assessment Executive Summaries.

As can be seen in the final sentence of the NIWA Executive Summary extract below the statement is: "*At the former site, natural sediments dominate over mining-derived sediments; at the latter site, the mining-derived SSCs were larger than the natural SSCs". T*here are two aspects not covered - first the **17% increase in the maximum SSC for the Wanganui site** and secondly the substantial percentage increases for SSC in the **'8km from source' results (38% - 375% increases).**

The Impact Assessment Executive Summary fails to note the percentage changes from pre to post mining and restricts itself to giving SSC concentrations. There is an obvious reason for doing so, as the percentage changes are significant. The '8km from source' results are not mentioned – indeed a very bland comment 'for extraction further offshore, the plume is located further offshore' is given. No mention of the 38%-375% increases in SSC!

The Impact Assessment 99th percentile values ARE WRONG as can be shown with the NIWA report extract below – the results were actually 20-40 mg/L within a few kilometres of the source NOT 10-20mg/L.

The Impact Assessment Executive Summary fails to mention 99th percentile values up to 20km from the source are above 10mg/L.

The Impact Assessment Executive Summary fails to mention that the median result of 2.5-5 mg/L occurs not only at the source, but also extends up to 5km.

The Impact Assessment Executive Summary fails to mention the geographic extend of the plume in terms of the **extensive plume based on median results of 0.6 mg/L extending from near Hawera to near Wanganui**

Missing from the Impact Assessment Executive Summary:
Commentary on the natural *plus* mining **median** sediment – which as discussed earlier is important due to the 'chaotic behaviour' that sediment creates i.e. the effect is more than the sum of the parts: There is a clear signature of sediment **> 2.5 mg/L** which extends considerably more offshore than pre-mining – **beginning at the 8-10 km** from shore mark. *This can be seen by comparing extracts a and c from Figure 5-3 below - where it shows the green area has moved further out to sea.*

I WOULD CONCLUDE BY SAYING THE IMPACT ASSESSMENT EXECUTIVE SUMMARY HAS FAILED TO GIVE FULL EFFECT TO SECTION 6 OF THE EEZ ACT – DUE TO THE FACT THAT IMPORTANT SSC EFFECTS NOTED ABOVE WERE NOT INCLUDED AND ONE SSC RESULT GIVEN WAS INCORRECT.

It is very important to remember that SKM and myself, have identified that there are a number of reasons why modelled SSC levels may be significantly understated – so the percentages shown above could be conservative estimates of the impacts.

The suspended source was introduced in a simulation of 1000 days on the South Taranaki Bight domain, with the source operating for 800 days (with 20% down-time) and statistics calculated over the final two years. The analysis of SSC focussed on the median and 99th percentile, comparing values for natural sediments, mining-derived sediments and the combination of the two. There are conceptual complications in carrying out these comparisons, owing to the effects of the sediments on the flow and the interactions between different sediments. These issues are investigated in terms of time series of surface SSC at two sites: a near-shore site near the Whanganui River and an off-shore site 8 km from source location A. ***At the former site, natural sediments dominate over mining-derived sediments; at the latter site, the mining-derived SSCs were larger than the natural SSCs***

*Extract from the **NIWA** plume modelling report **Executive Summary***

Sediment Plume and Sediment Re-Suspension
Plumes from TTR Project activities extend to the east-southeast, reaching the coast between Patea and Whanganui and with a long tail of low concentrations following the coast towards Kapiti. **For extraction at the 12 nm limit** (inner boundary of application area) **the highest surface concentrations occur at the source location and are 2.5–5 mg/L (median) and 10-20 mg/L (99th percentile).**
For extraction further offshore, the plume is located further offshore and the nearshore concentrations are somewhat lower.
In both cases the **mining-derived sediment plume contributes markedly to the total suspended sediment concentrations within a few kilometres** of the source but is insignificant relative to the natural suspended sediment concentrations near the coast.

*Extract from the **Impact Assessment Executive Summary**[i]*

The mining-derived SSC (panel b) shows an extensive plume with the 99th percentile above 10 mg/L (dark blue) up to 20 km southeast of the source and values over 20–40 mg/L (magenta) within a few kilometres of the source.,

*Extract from the **NIWA report** 5.2.1, Table 5-4, 99th percentile near-**surface** concentration of SSC mining source A*

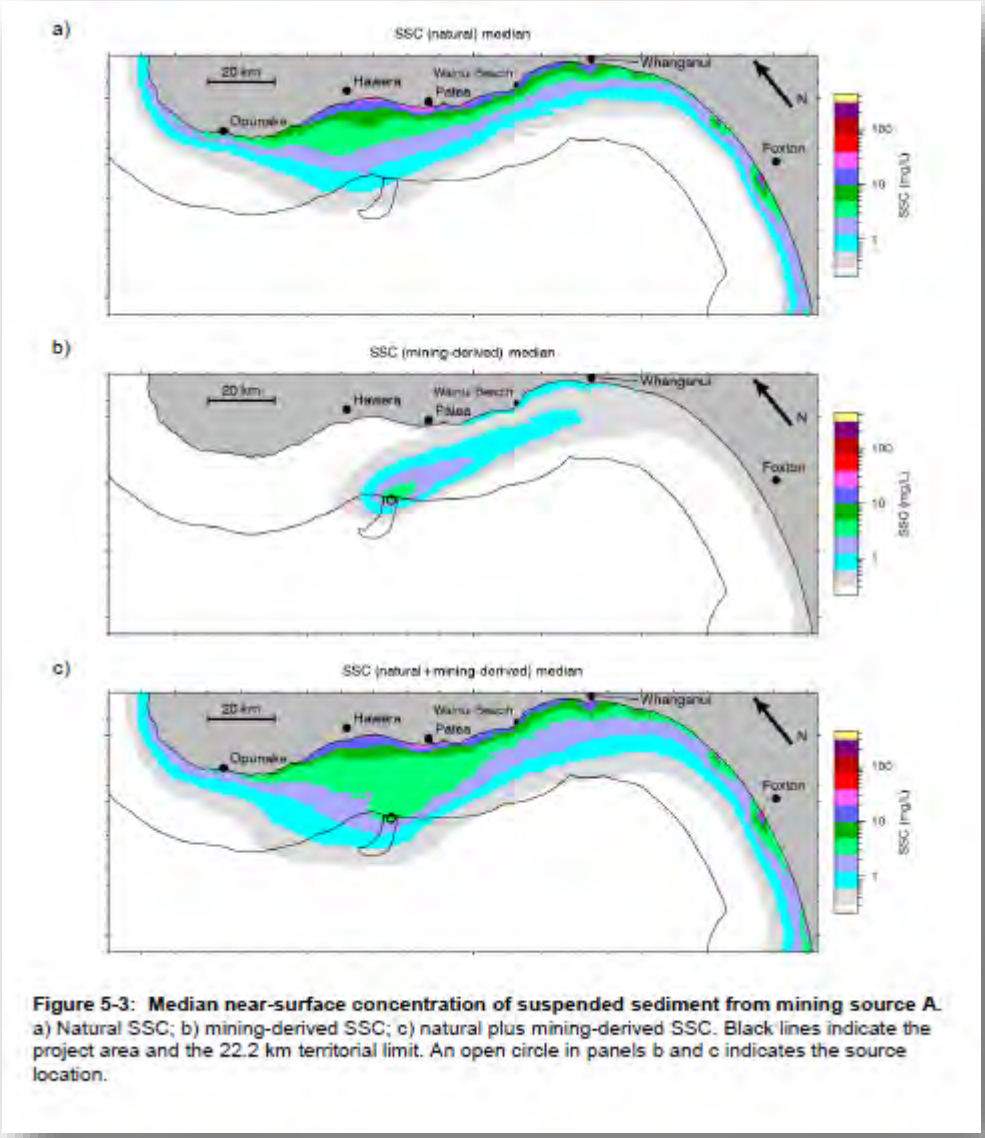


Figure 5-3: Median near-surface concentration of suspended sediment from mining source A. a) Natural SSC; b) mining-derived SSC; c) natural plus mining-derived SSC. Black lines indicate the project area and the 22.2 km territorial limit. An open circle in panels b and c indicates the source location.

Median surface sediment per NIWA plume modelling report 5.2.1
Also Figure 8.2 of the Impact Assessment 11.5.3.1

NIWA Executive Summary & the Impact Assessment Executive Summary do not reflect important NEAR BOTTOM SEDIMENT findings contained in the NIWA plume modelling report – breaches intention of s6 EEZ Act.

- SSC contribution due to mining, at the source is around 100 mg/L
- SSC contribution due to mining results in a doubling of the sediment levels near the source and parts of the Patea shoals. There is a 100% increase from up to 10 mg/L (pre-mining) to up to 20 mg/L with mining.
- **The 99th percentile** near-bottom sediment (NIWA 5.2.1 & Figure 85 of the Impact Assessment 11.5.3.1) shows a larger area to the north-west of the project affected by **200+ mg/L** levels due to mining.

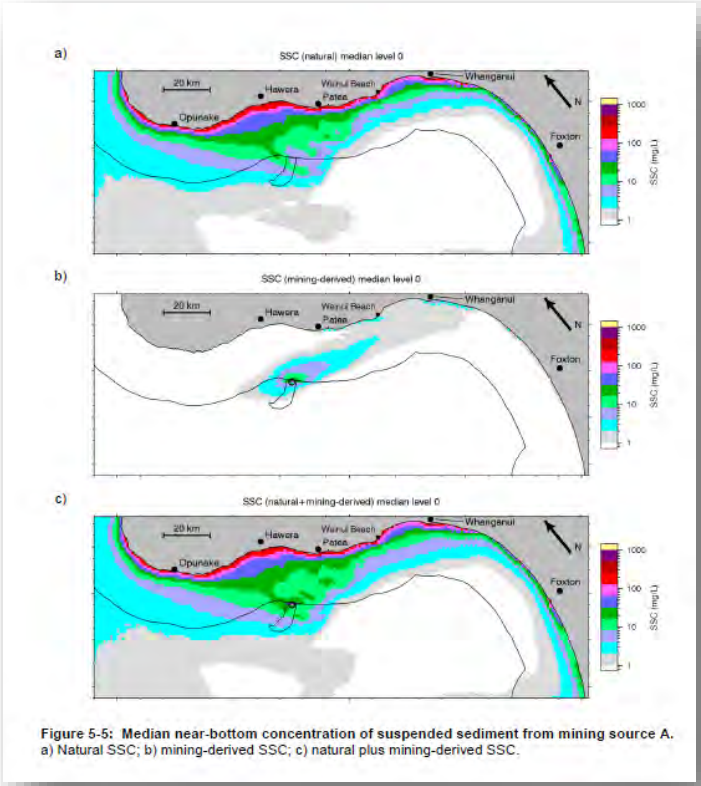


Figure 5-5: Median near-bottom concentration of suspended sediment from mining source A. a) Natural SSC; b) mining-derived SSC; c) natural plus mining-derived SSC.

Median *near-bottom sediment per NIWA Plume modelling report 5.2.1, Figure 5-5 & Also figure 84 of the Impact Assessment 11.5.3.1*

I WOULD CONCLUDE BY SAYING THE IMPACT ASSESSMENT EXECUTIVE SUMMARY HAS FAILED TO GIVE FULL EFFECT TO SECTION 6 OF THE EEZ ACT – DUE TO THE FACT THAT THE THREE IMPORTANT SSC NEAR-BOTTOM EFFECTS NOTED ABOVE WERE NOT INCLUDED.

I WOULD ALSO CONCLUDE THAT THERE IS A MISLEADING EMPHASIS ON COMPARING RESULTS TO 'NEARSHORE' SSC LEVELS. THE 'NEARSHORE' IS A DIFFERENT GEOGRAPHICAL AREA, AND IMPACTS ARE BEST SHOWN BY COMPARING PRE AND POST SSC LEVELS BY LOCATION/HABITAT AREA – NOT BY ALWAYS COMPARING TO A 'NEARSHORE' ENVIRONMENT.

It is very important to remember that SKM and myself, have identified that there are a number of reasons why modelled SSC levels may be significantly understated – so the percentages shown above could be conservative estimates of the impacts.

Restricted Parameter Modelling 9: The NIWA sediment plume modelling 'deposition' rates are calculated for 11% of the 'patch' having been mined – and therefore does not reflect the 'worst case' scenario or the 'cumulative effect' as required by section 6 of the EEZ Act.

Section (6) (1) (d) requires the 'cumulative effect' to be determined. The cumulative effect has not been modelled. For modelling purposes only a year's worth of 'patch source' of SSC was calculated. Missing therefore is the impact when one year's SSC falls on top of the previous year's SSC deposition. In addition there is the impact of the surrounding bed, which for the modelling was assumed to be unmined sand – if the cumulative effect was modelled this would no longer always hold true.

Source A: The 5 day sediment increment is between 0.2 – 2mm, the 365 day sediment increment is between 3 – 5mm, as shown by the increased dark green areas. Between Foxton & Wanganui is a deposition centre which is dark green, indicating between 3 – 5mm deposition.

> The deposition footprint of the mining sediments (panel b) is a narrow strip, some 100 km long, that approximately follows the 22.2 km territorial boundary, with maximum 5-day increments of between 0.2 and 2 mm. The deposition pattern of natural plus mining sediments (panel c) is similar to the pattern for natural sediments only, but modest increases can be seen relative to panel a along the territorial boundary line.
>
> For the mining-derived sediments (panel b) the 365-day deposition shows the same pattern as the 5-day deposition, with somewhat larger values, up to a few millimetres.
> Panel c (natural plus mining-derived) is similar to panel a (natural only), but panel c shows larger values around the source location and also in an area 10 km from the coast, about mid-way between Foxton and Whanganui, where there appears to be a deposition centre for the mining-derived sediment

NIWA Plume Modelling report, 5.2.2

Restricted parameter modelling 10: The impact of deposition rates for the Patea shoals is uncertain due to modelling limitations, but no mention of this important limitation is made in the Impact Assessment.

The behaviour of the seabed in the Patea shoals region means the modelling is limited in its ability to simulate long term sediment deposition.

Figure 5-8 shows the maximum 365-day deposition. For the natural sediments (panel a) there is an area shaded white on and south of the Patea Shoals. Over most of this area the maximum 365-day deposition is negative (which cannot be represented on a logarithmic scale). The negative values occur because the seabed in this area undergoes slow but progressive erosion over the course of the model run**. This behaviour limits the model's ability to simulate long term sediment deposition, as it is not possible to run the model to equilibrium** on a time scale of a year or two.

Extract from NIWA plume modelling report (limitation not discussed in Impact Assessment 11.5.3.1)

NIWA Executive Summary & the Impact Assessment Executive Summary do not reflect important MINING SOURCE B (outer boundary of Project area) findings contained in the NIWA plume modelling report – breaches intention of s6 EEZ Act. The Impact Assessment places mining source B results in Appendix 7 – but mining source A is in the body of the Impact Assessment.

The **impact** of sediment in the **mining source B will be more noticeable,** due to the fact it is an area barely affected by sediment plumes in its natural state.

The only commentary in the Impact Assessment is in 11.5.3.1 below - no mg/L figures are given.

For the Impact Assessment 11.5.1.3 to state the source B plume is "*insignificant relative to the natural SSCs near the coast*" is a futile comparison, as the habitat and environment at source B has in its natural state a lower SSC than close to shore. **Biological life is adapted to the natural state of minimal SSC – so an increase in SSC is unlikely to be 'insignificant'.**

Below are the list of results that are not reflected in the Executive Summaries;

- The **median** *near-bottom SSC* has increased from an average of 3-10 mg/L to 10-20 mg/L (200% increase)
- The **99th percentile** *near-bottom* SSC at source B has increased from 50-70 mg/L to 100-200 mg/L (285% increase)
- The maximum 365 day increment in sediment bed thickness has increased from nil mg/L at the mining source and west of the mining source to 5-7 mg/L (**a totally different environmental condition** for this area).
- The maximum 365 day increment in sediment bed thickness north east from the project (covering a wide area) has increased from up to 3 mg/L to up to 7 mg/L. (230% increase)
- The maximum 365 day increment shows southeast of Wanganui there is a large area affected with increases from 1-3 mg/L to 3-5 mg/L and from 0.5-1.0 mg/L to 1-3 mg/L (60% increase).

However it is noticeable that differences between panel c (natural plus mining-derived sediments) and panel a (natural sediments) tend to be somewhat more noticeable for source B than source A, because source B is further offshore, in an area that has generally lower natural concentrations.

NIWA plume modelling report 5.3.1

For source B the plume was located further offshore and the concentrations somewhat lower. In both cases the plume of mining-derived sediment contributed significantly to the total SSC within a few kilometres of the source but was insignificant relative to the natural SSCs near the coast.

Impact Assessment 11.5.3.1

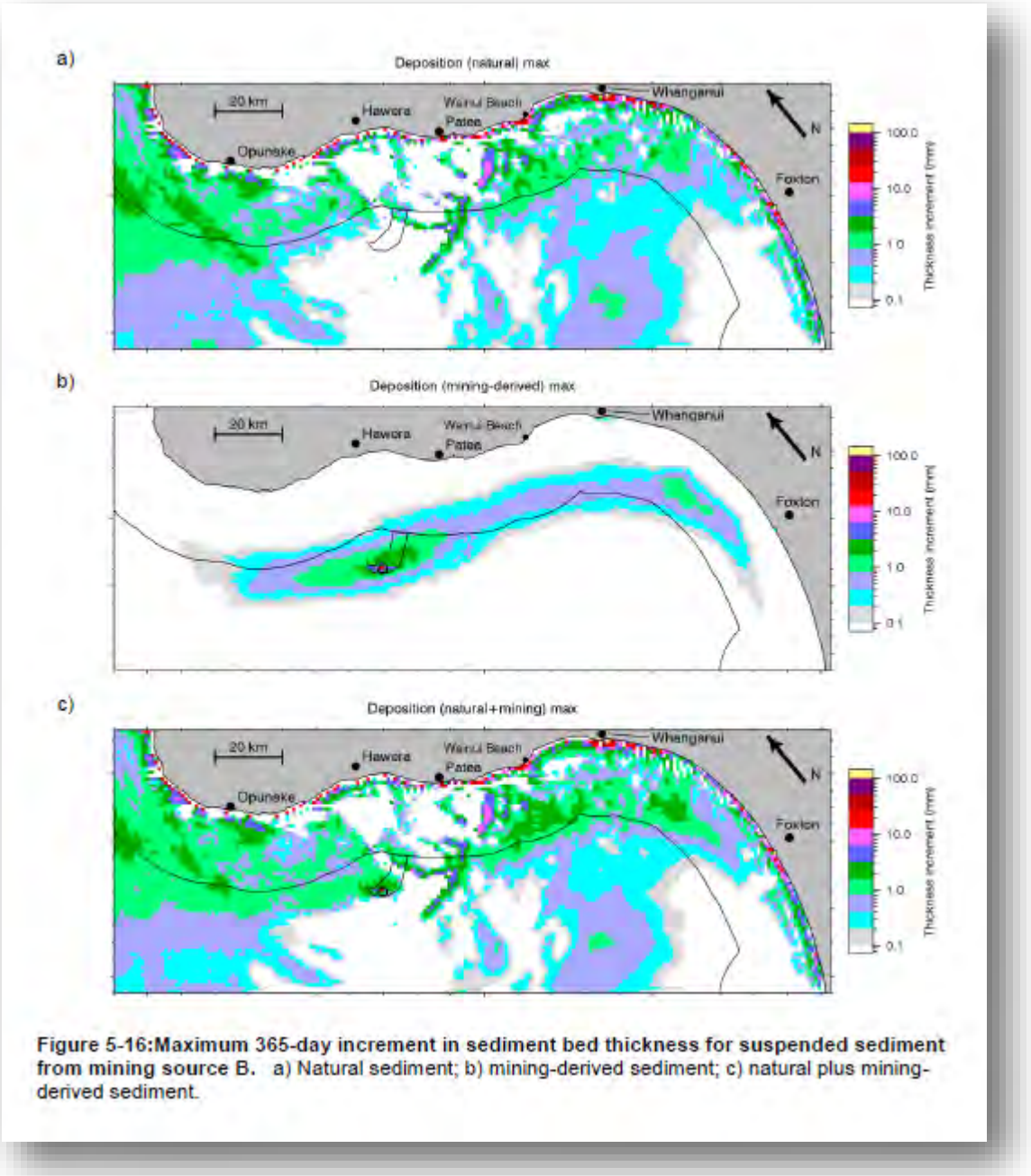


Figure 5-16:Maximum 365-day increment in sediment bed thickness for suspended sediment from mining source B. a) Natural sediment; b) mining-derived sediment; c) natural plus mining-derived sediment.

NIWA plume modelling report 5.3.2

Restricted modelling parameter 10: The plume modelling does not reproduce the wide range of variation in sand re-suspension between different locations in the Patea shoals – for instance the under-prediction at site 7 which modelled 100 mg/L but observed 500 mg/L. – the Impact Assessment fails to note this important factor.

The Impact Assessment does not make this limitation clear.

Differences in seabed geometry can change sediment concentrations by a factor of 20 – so it is important to be mindful of this limitation when accepting 'near-shore' results.

Site 7 mentioned in the extract below refers to the 'X2' area shown in the diagram at the start of this section on plume modelling. At this site, the *observed* SSC reached 500 mg/L on occasions verses the *modelling* predicting 100 mg/L.

Figure 4-9 of the NIWA plume modelling report – showing the difference in modelling (red) verses survey (blue) results

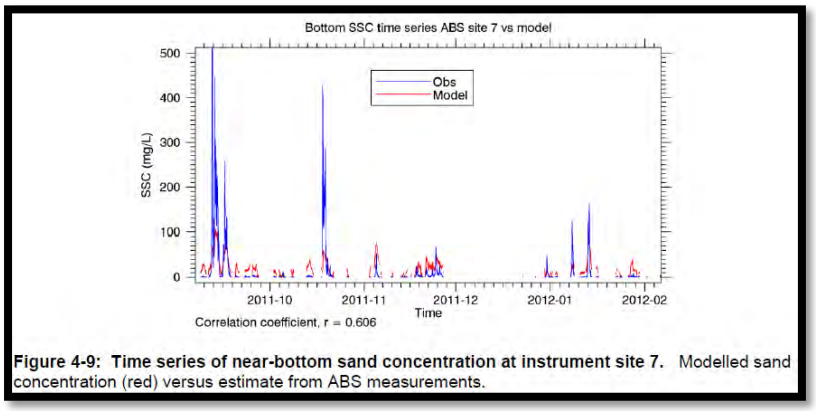


Figure 4-9: Time series of near-bottom sand concentration at instrument site 7. Modelled sand concentration (red) versus estimate from ABS measurements.

The large difference in sand concentration measured by the ABS between the shallower sites, 6 and 7, was noted by MacDonald et al. (2012) and **attributed to the complex bedforms around Site 7** (their Figure 3-56). They quote Green and Black (1999) who show that, given the same wave forcing, **differences in bed form geometry can give rise to concentration differences of a factor of 20.** Meanwhile at the deeper sites, biostabilisation by polychaete tube worms may be an important factor stabilising the bed (Beaumont et al. 2013).
Our conclusion from the comparison is that the **sediment model does not reproduce the wide range of variation in susceptibility to sand resuspension between different locations on Patea Shoals, and furthermore could not do so without a lot of tuning to local conditions**.

NIWA plume modelling report 4.3

There are no reports on the impact of BRINE from the hydro-cyclone discharge and the change to the salinity of the ocean. Biological impacts are unknown, despite aquatic organisms adapting to a narrow range of salinity.

If oceans have a salinity of around 35 parts per thousand, and the brine has a salinity of 54 parts per thousand – it appears from the Impact Assessment 2.12.6 that a net effect of 37 parts per thousand will be achieved.

Without a report being commissioned – the accuracy of the 37 parts per thousand prediction is unsubstantiated. Most aquatic organisms are able to adapt to only a very narrow range of salinities (they are known as stenohaline organisms).

2.12.6 Outputs from the RO Process
Process outputs from the RO plant are freshwater and brine. The freshwater will be used to slurry the concentrate onto the FSO. The brine will arise from extraction and concentration of chlorides from the seawater. The RO brine will have a salinity of around 54 parts per thousand ("**ppt**"), and a flow rate of around 2,208 m3/hr. This will be added to the hydro-cyclone discharge stream (around 17,400 m3/hr), and will **change the salinity of that discharge stream from a nominal 35 ppt to around 37 ppt.**

Restricted modelling parameter 11: The re-anchoring of 4 Stevpris-type anchors *every ten days* was not included in Plume Modelling

The Impact Assessment section 2.7.4 'FPSO repositioning' discusses the details of the anchoring.

The NIWA plume modelling does not account for the sediment plume arising from this activity.

Restricted modelling parameter 12: Omitted from Plume modelling was 'bed load transport', other than for the 'patch' where it resulted in a 20% increase in the rate at which medium sands are transported http://www.epa.govt.nz/Publications/NIWA_sediment_plume_modelling_report.pdf page 16

value, user-specified for each class.

Bedload transport (Warner et al. 2008 Section 3.4) is optionally calculated with the Soulsby and Damgaard (2005) formulation. This process has been included in only one of the simulations described below (the patch source simulation, Section 5.5) where it results in a modest increase, around 20%, in the rate at which medium sands are transported out of the patch area, relative to a simulation with bedload transport excluded.

Restricted modelling parameter 13: The ROMS model facility was turned off, for allowing the depth at the base of the water column to be adjusted as the total sediment bed thickness changes

Section 1.6 of the Plume Modelling report gives the 'model set up'. For the simulations the ROMS model can allow for the depth at the base of the water column to be adjusted as the total sediment bed thickness changes. But this facility was turned off. When you have 9m mounds and 10m pits and 1m slumping – this is a significant factor to be taken into account.

For the simulations described below the total sediment bed thickness was set initially to 1 m, with eight layers. Initial layer thickness was 0.125 m, but this adjusts after the first time step. Incidentally, the ROMS model optionally allows for the depth at the base of the water column to be adjusted as the total sediment bed thickness changes, but this facility was turned off for the present simulations.

Omitted from the NIWA Plume modelling and the NIWA Optical report, is any linkage to the ecological impacts of predicted SSC levels on the various ecologies – be it in terms of light impacts or smothering and feeding impacts. THIS OMISSION breaches the requirements of section 6 of the EEZ Act

Extract from NIWA Plume Modelling Report, Executive Summary

> The ROMS sediment model predicts the suspended sediment concentration, i.e. the mass of sediment per unit volume, normally expressed in mg/L. However many of the potential effects of suspended sediment involve the interaction of the sediment particles with light. These effects include the visual appearance of sediment from above the water, reduction of underwater visibility and reduction of underwater light levels. These aspects are assessed in a separate report

Restricted Modelling Parameter 14 : Erosion of bottom sediments in high wave events are shown by the ROMS model to increase by four times the active layer thickness – there has been no discussion of this influence on the 9m mounds, 10m pits and 1m slumps

As the particle sizing of the mounds, the porosity of the material and the kilometres of dune involved – modelling the impacts during large storm events – is a necessity if the 'worst case scenarios' are to be known.

IMPORTANT FINDINGS IN THE BODY OF THE NIWA REPORT 'COASTAL STABILITY IN THE SOUTH TARANAKI BIGHT – PHASE 2' ARE MISSING FROM THE NIWA EXECUTIVE SUMMARY & IMPACT ASSESSMENT EXECUTIVE SUMMARY

The NIWA Executive Summary fails to note a number of important results and as such fails to comply with section 6 of the EEZ Act.

One of the Executive Summary's key finding was *'extraction will not adversely affect physical drivers and processes that cause coastal change – WAVES'*

WHAT HAS BEEN **MISSED FROM THIS KEY FINDING** AND THE DISCUSSION ATTACHED TO THE KEY FINDING, WAS THE FOLLOWING IMPORTANT POINTS:

1. In 7.5 of the Coastal Stability Report, the conclusion for the 'scenario based modelling' was that **the effect excluding case 1** will only have minor effect on waves. (Case 1 represents the 'worst case' bathymetric scenario)

Extract from 'Coastal Stability Report – Phase 2' page 125

> The overall conclusion from the scenario-based modelling is that the proposed sand extraction operations will have only minor effects **(discounting case 1)** on the physical driver of waves by refraction (bending the wave path) and diffraction (lateral dispersion of wave energy) and locally by shoaling (changing the wave height) them as they pass over the modified seabed

2. The key finding only discusses the 10m isobaths and fails to discuss the results from the 'vicinity of the Operations' which shows a 4.6 to **12.6%** change (9-**44cm**) in significant wave height compared to the baseline. *See extract below*

3. The 10m isobaths results in the key finding discussion were only given as a percentage (9.2 %,). The maximum absolute change in significant wave height was **11.6 cm.** It occurs at **Patea and is a decrease in wave height**. *See figure 5-15 & 5-17 and page Table 5-2*. Discussion in the key finding about Patea waves, is restricted to discussing the mean, not the maximum.

4. There is an 8cm increase in wave height between Manawapou and Patea which is not mentioned in the key findings for waves.

5. The mean absolute change in significant wave height was 6cm (3.5%). *See figure 5-18*

6. The results for all scenarios, including full domain results are shown below – the NIWA Executive Summary did not discuss 'full domain' results. The maximum absolute change in **significant wave height was 44cm** change **(12.6%)** which was Case 01 .

NIWA extract page 75
http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp48-135.pdf

Summary of effects of sand extraction on waves

The maximum changes in significant wave height predicted for the eight bathymetry modification cases and reported as the difference in wave height between the baseline and modified bathymetry are summarised in Table 5-2. The table shows maximum changes in wave height over all six environmental scenarios, and either over the whole modelling domain or along the 10 m isobath.

In the full model domain the maximum changes are 0.44 m in wave height or up to 13%.

Table 5-2: Maximum changes in significant wave height predicted for the eight bathymetry modification cases. Changes are expressed in absolute terms (metres) and relative terms (%), either over the full model domain or along the 10 m isobath.

Extraction case	Full domain H max (m)	Full domain H max (%)	10 m isobath H max (m)	10 m isobaths H max (%)
1	0.436	12.6	0.116	9.2
2	0.232	9.0	0.045	3.8
3	0.348	10.9	0.050	3.5
4	0.245	10.0	0.050	4.3
5	0.228	9.1	0.052	4.8
6	0.239	7.9	0.018	1.4
7	0.177	6.6	0.022	1.9
8	0.096	4.6	0.010	0.9

7. The Impact Assessment incorrectly records the results of the NIWA table for Extraction scenario 01. The full domain results were 0.436m (44cm) **not 0.282m (28cm)**. Fortunately the percentage results for the full domain were fairly close, so the comments in the Impact Assessment that the maximum change in wave height was 12% is valid.

In the full model domain and seawards of the 10 m contour the maximum changes are 0.2 to 0.3 m in wave height or 7 - 12%. Some local effects, nearer to the sand extraction areas, are larger than effects seen at the 10 m isobath.

Extraction case	Full domain H max (m)	Full domain H max (%)	10 m isobath H max (m)	10 m isobaths H max (%)
1	0.282	11.3	0.104	8.6
2	0.222	8.3	0.042	3.6
3	0.284	12.7	0.044	3.3
4	0.263	7.1	0.046	4.1
5	0.219	7.2	0.050	4.5
6	0.249	7.2	0.016	1.3
7	0.173	6.0	0.021	1.8
8	0.092	4.1	0.009	0.8

Table 30: Maximum changes in significant wave height predicted for the eight bathymetry modification cases.

Note: Changes are expressed in absolute terms (metres) and relative terms (%), either over the full model domain or along the 10 m isobath.

mpact Assessment
xclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 208

Scenario-based simulations

This first part of this work considered eight potential cases of bathymetry modification consistent with the sand extraction plan. Of these, case 1 represented the "worst case" with the most extensive possible modifications at the completion of all extraction operations. Other cases represented a range of possible intermediate seabed configurations.

The effects of these bathymetry modifications on wave conditions were then tested by running short model simulations under six scenarios of offshore wave conditions, representing a range of input directions and representing storm as well as moderate conditions (Table 5-1). It also compared the resulting wave parameters with those in a corresponding baseline simulation (i.e., unmodified bathymetry).

The maximum changes in significant wave height, observed in the vicinity of the extraction operations, were found to range between 0.09 and 0.44 m, or 4.6 – 12.6% of the baseline values, for the eight bathymetry modification cases.

At the 10 m isobath, which is about the seaward edge of the surf zone, **the changes in wave characteristics due to extraction are much smaller than the changes further offshore.** The magnitude of change as a percentage of the baseline value show changes in significant wave height remain **less than 9.2% for the maximal case 1 bathymetry modifications, and less than 4.8% for other cases.** Case 1 is a worst case situation where large pits and mounds occur at the start of every lane.

http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp48-135.pdf

Page 124

Restricted parameter modelling 1: Worst storm conditions have not been used

There is a strong seasonality to waves (*noted in 5.1*) with significant wave heights over 3m occurring 15% of the time in winter. Only one of the three 'storm conditions' used in modelling was over 3m, as can be seen in the extract below.

Interestingly the narrative states November was used, but the data indicates September.

5.3.2 Scenario-based simulations - Wave transformations on the inner shelf
Selection of wave conditions to model

A limited set of offshore wave and wind conditions was selected from **November 2011** in order to perform the sensitivity studies.

Table 5-1: Wave parameters at (40.00°S, 174.0°E) for the six scenarios used in the wa sensitivity studies.

Scenario No.	Date & time	Subset of record	Height H_{m0} (m)	Direction θ_{peak} (°)
1	03Z 11/09/2011	NW	2.12	321
2	01Z 12/09/2011	NW	4.76	295
3	15Z 17/09/2011	SW	2.00	254
4	10Z 19/09/2011	S	1.87	173
5	14Z 19/09/2011	S	2.42	162
6	08Z 25/09/2011	SW	2.43	254

The six scenarios were selected by first choosing three subsets of the record:
_ records with north-westerly waves (peak direction greater than 290°)
_ records with south-westerly waves (peak direction between 225° and 255°)
_ records with southerly waves (peak direction less than 225°)
then choosing from each subset the record with: 1) the highest significant height and 2) the record with significant height closest to a target value of 2 m.

http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp48-135.pdf

'SWAN WAVE MODEL SIMULATION – data for 'accepting' sand extraction, based on one-half a standard deviation about the mean – has not been shown for wave height, wave direction and bed orbital velocity. Maximum absolute changes in wave height have not been given.

It is very important to realise that the SWAN model simulated all wave conditions over 12 months at 10m isobar and not the 'nearshore'.

It is hard to determine impacts, as the results are for **the mean** only, not the **maximum absolute change** in significant wave height.

In addition to knowing maximum, it is very useful to consider Kelly et al. (2004) - the magnitude of change alone doesn't determine the significance of change, **you need to judge the impacts due to the Project, *relative to the natural variability***. Impacts that fall within 0.5 of a standard deviation envelope about the mean, will have effects indistinguishable from natural variations. There is a criterion for **"accepting" a potential sand extraction site – based on a one-half the standard deviation about the mean.**

THE NATURAL VARIABILITY that the impact of the Project will be compared to are discussed in 5.3.4.

At the 10m isobaths, the considerable variation in baseline wave conditions throughout the year is shown by one standard deviation about the mean (68% of the variability of a random variable) to be:

- wave height plus or minus 0.7m
- mean wave direction plus or minus 25 degrees
- mean wave period plus or minus 1 second
- bed orbital velocity plus or minus 0.15m/s
- With the exception of mean direction, all the other aspects shown a trend of decreasing alongshore to the SE, as the environment becomes more sheltered.
- But the *complex bathymetry in nearshore and coastal alignment and a weakening of the westerly swell results in the mean direction not following the same trend.*

In order to understand the impact of this Project the following recommendations are given:

Recommendation:

1. The results for wave height, wave direction and bed orbital velocity need to be graphed in a similar fashion as has been done for Figure 5-26, 5-27, 5-28 ('breaking wave height, net onshore flux and net longshore flux') in order that you can see the mean difference (case 1 minus baseline) plotted against lines showing plus and minus 0.5 of the baseline standard deviation.

2. The Executive Summary needs to comment on results in terms of the Kelly methodology, rather than limit comment to 'the natural range of variability'. It is not the 'range' that determines 'acceptability' but whether the changes fall within 0.5 standard deviation of the baseline mean.

'NEARSHORE AND SURF ZONE IMPACTS' – empirical methods used, not the sophisticated SWAN modelling. The 'Coastal Stability Report' Executive Summary fails to mention the Manawapou site result that didn't fall 'well within the envelope of one-half a standard deviation of the natural result.

SKM in their review of the 'oceanographic processes and physical environment' fail to note in their key findings that **empirical methods** were used to determine nearshore and surf impacts.

The biological areas of interest are the rocky areas. To meet the requirements of the EEZ Act, the 'best available information' would have been accurate and highly resolved bathymetric data – in order that the sophisticated SWAN modelling could have been used. Instead, reliance has been placed on empirical methods to estimate the behaviour on the nearshore and surf zone.

Recommendation:

1. Obtain accurate and highly resolved bathymetric data. Failing that, obtain an independent review of the empirical methods used, ensuring that the report clearly outlines the impacts on results due to assumptions made and limitations involved.

2. Exclude the ability to state 'generally less' and 'overall' – and instead require results to also express the exceptions – which need to give change results as a percentage of one standard deviation – so that the impacts relative to the natural variability can be clearly known (as per Kelly et al (2004)) . Results falling within 0.5 of one standard deviation are criterion for 'accepting' the Projects impacts.

Mostly, the results fall within 0.5 of one standard deviation, the criteria for 'acceptance' – however the exception is the localised negative westward sediment transport event near Manawapou. This is where the Fonterra outfall is, so may have benefitted from a little more informative discussion.

1. Breaking wave height, mean value reduction of less than 5cm and an increase of 2.5cm further west – 'generally less' on a root mean square difference (RMS) than **0.20 of one standard deviation.**
2. Onshore energy flux, shows between Manawapou and Patea with larger values of change due to the Project. But **'generally less' than 0.20 of one standard deviation** (RMS difference).
3. Longshore energy flux, is for Patea up to 0.10 of a standard deviation and **'overall' the change lies well within 0.5 of the baseline standard deviation". The exception** is shown in Figure 5-31 with a localised increase in magnitude of the negative westward sediment transport event near Manawapou.

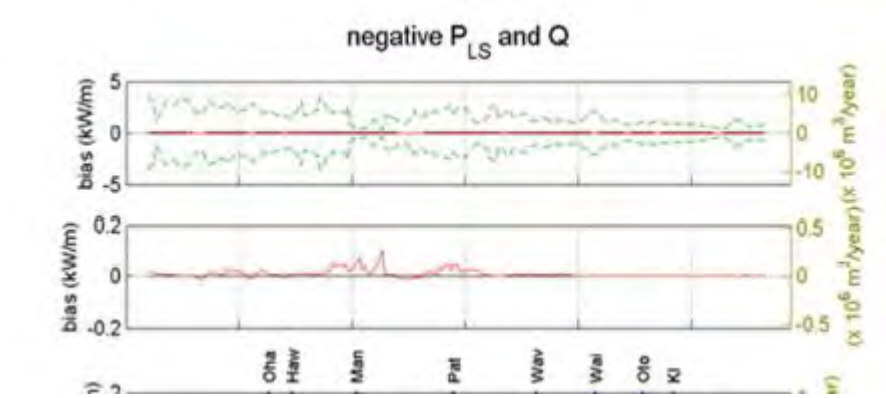


Figure 5-31: Magnitude of the longshore wave energy flux factor *Pls* (black scales) and sediment transport potential *Q* (gold scales), averaged over times when they have negative values. In the two panels the mean difference (bias = case 1 - baseline) between the two simulations is shown plotted along with green dashed lines showing plus and minus half the baseline standard deviation (SDm) of total *Pls* (or *Q*).

The NIWA Coastal Stability Phase 2 Report, Executive Summary extract that fails to discuss the Manawapou result:

Extraction will not adversely affect physical drivers and processes that cause coastal change – Longshore transport: Longshore transport is the process by which waves arriving at an angle to the shore drive sediment along the shore and is a primary mechanism for supplying sand to beaches from alongshore sources. **Statistics derived from the 12-month model simulations were used to evaluate a criterion for "accepting" or "rejecting" a potential sand extraction site based on a range of one-half the standard deviation (+0.5s) about the mean (m) of the longshore transport potential.** The analysis showed that for the case 1 (worst case situation in terms of potential effects on the shore), the **differences in longshore wave energy flux and sediment transport potential as a consequence of the proposed extraction lie well within the envelope of one-half a standard deviation of the natural longshore transport potential.** That is to say, the extraction proposed by TTR for the case 1 situation meets the criterion for "accepting" a sand extraction site.

PIT dimension for modelling was 300 x 500m by 10m depth, which is a significant underestimation of the total pit sizes that cumulatively will reach 3-7 km! Section 6 of the EEZ Act requires the cumulative effect to be considered (s59 (2) (a) (i) and this has not been done.

The reason why it is so important to consider the full extent of the pits that will result from the Project, is that it has been demonstrated that smaller and wider pits tend to fill in, but **larger and elongated pits tend to erode and deepen a**t their centres. Calculations I have done to determine the cumulative pit width, indicates widths of 3-7km, rather than 300m!

The fact that the cumulative impact of pits has not yet been modelled, would indicate that the years taken to infill the pits will take significantly longer than those given below:

- Over 500 years @ 50m depth to infill the pit
- Over 100 years @ 35m depth to infill the pit- proposed to be mined/dredged first.
- Over 70 years @ 20m depth to infill the pit

The project total pit width is likely to extend to 7km in parts – which can trigger instability - Ross and Hulscher (2204) and Ross et al. (2208) **studied pits that are wide (order of kilometres) and shallow (pit to water depth) which showed morphodynamic instability being triggered**, which results in a deepening and deformation of the pit itself. This fact is noted in the discussion in 6.4.4 of the Coastal Stability Report, phase 2.

There is still a degree of uncertainty involved with determining pit dimensions: Section 1.2 of the Coastal Stability Report states '*exact pattern of cut and fill depends on the path that the operation takes'.*

BELOW IS A CALCULATION TO SHOW THE CUMULATIVE PIT CONFIGURATIONS:

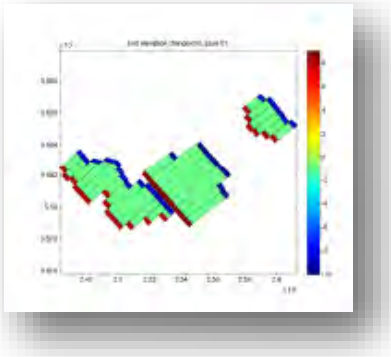
Cumulative CALCULATION OF PIT width AREA, worst case 01 – Figure 1-2

14 lanes @ 500m wide = **7km** (although the 'ends' don't line up)

9 lanes @ 500 m wide = **4.5km** (the 'ends' mostly line up)

6 lanes @ 500m wise = **3.0 km** (the 'ends' mostly line up)

Bathymetry case 01 Figure 1-2:



Recommendation: The underestimation of pit infilling, due to 90degrees used in modelling, needs to be investigated in terms of its appropriateness when the pit orientation to sediment transport direction is considered and in terms of the cumulative size of pits. Until this is done, the analysis is incomplete.

Recommendation: the pit width for modelling needs to be re-defined to calculate the cumulative effects of pits aligning themselves alongside other pits, and having an effective width footprint greater than 300m – extending 3km to 7km.

Recommendation: Plume modelling 'worst case' analysis needs to calculate the cumulative impact of having a **total of 14.5km's in pits**. Instability may be triggered.

The Executive Summary of the Coastal Stability Report regarding 'deposition of substances to the foreshore and seabed' does not reflect important commentary made further on in the Report

The Coastal Stability Report, 2.4 states "we consider an analysis of sediment budget is of little value in predicting the effects of sand extraction on the shoreline" and 'we do not know what proportion of the input from each of these rivers is beach grade material and therefore this is an unreliable estimate for the sediment budget."

Despite these two comments made within the Report, the Executive Summary includes the effect of **rivers.** A figure of 2M m^3 is used, which when compared to the River data below is misleading in so much as the rivers contributing sediment around the Project area, come nothing close to depositing 2M m^3.

> *There will be no adverse effects from deposition of substances to the foreshore and seabed:* Very fine sands and muds generated by sand extraction operations will not make the beaches muddy. While sediment plumes from extraction operations will reach the shore, **the absence of mud beach sediments despite that fact that river flood events deliver 2 M m3 of fine sediment and turbid water to the shoreline and adjacent to beaches, indicates that if deposited on the beaches fine sediment will be quickly winnowed from the beach sediment** by wave action and transported offshore not buildup on the beach.

Page 10, Executive Summary
http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp1-47.pdf

Page 31: http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp1-47.pdf

Table 2-2: Mean water flows and mean annual suspended sediment inputs from the rivers flowing into the study area. The data is sourced from NIWA's WRENZ model (http://wrenz.niwa.co.nz/webmodel/), and has been compiled in a manner described in Hicks et al. 2011). A factor of 2 has been used to convert sediment yield in tonnes/yr to cubic metres/yr.

River	Upstream area (km^2)	Mean flow (m/s)	Sediment yield (tonnes/yr)	Sediment yield (m^3/yr)
Waiaua River (Opunake)	46.4	3.6	4900	2450
Kaupokonui Stream	146.3	8.6	9700	4850
Waingongoro R (Ohawe)	233.1	7.8	9100	4550
Tangahoe River	285.1	4.2	43900	21950
Manawapou River	120.9	1.9	15000	7500
Patea River	1048.5	30.4	310600	155300
Whenuakura River	465.3	9.9	275900	137950
Waitotara River	1162.0	23.3	475400	237700
Kai Iwi Stream	191.0	1.8	16900	8450
Whanganui River	7113.8	229.0	4699800	2349900

Fine sediment quickly winnowed from the beach' is an important statement that has had minimal site substantive scientific research.

The section 2.2 which discusses beach sand storage shows in Figure 2-10 that pits dug in the sand show alternating layers of coarse and fine sand – coarse sediment comes from cliff collapse and in calm periods there is a build-up of finer material. The conclusion is made (7.1) that *because little fine sediment is shown in the pits dug,* that the fine sediment has been quickly winnowed from the beach. **This logic is flawed in terms of using the same logic for the Project impact,** in so much as three factors have been overlooked:

1. Fine sediment from the Project ejected into the sea, is in significantly greater proportions to the amounts provided by the Patea River – **4.2 tonnes per annum of fine sediment from the Project** verses **0.3 tonnes per annum from the Patea River.**
2. The Project provides a **constant source of sediment**, compared to intermittent river sediment events.
3. And most importantly, **particle size** has a great deal to do with how sediment arrives at the shore – in the case of the Project hydro-cyclone discharges, the sediment size will be much finer than the 'natural' onshore accumulation of sand in the past.

Further elaboration of Point 1 above:

RIVER TONNAGE OF FINE SEDIMENT: Table 2-2 of the Coastal Stability Report:
http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp1-47.pdf

- Manawapou river inputs sediment of **15,000 tonnes p.a**/7,500 m^3/yr
- Patea river inputs sediment of **310,000 tonnes p.a**./155,300 m^3/yr
- Wanganui river inputs sediment of **4,699,800 tonnes** p.a/ 2,349,000 m^3/year

PROJECT TONNAGE OF FINE SEDIMENT: Table 3-4 of the Plume Modelling Report:

http://www.epa.govt.nz/Publications/NIWA_sediment_plume_modelling_report.pdf

Shows suspended sediment source (<8 µm to 90 µm, the fine sediment) of 609 tonne/h for the suspended source, which equates to an annualised rate of **4.2 tonnes per year (**100 % uptime).

DATA PER TABLE 3-2 & 3-3 OF NIWA PLUME MODELLING REPORT

		Source Rate kg/s	Source Rate **tonne/hour**	Source Rate At 80% uptime **tonne/hour**	Source Rate per minute kg/s	Source Rate per hour kg/hour
Hydro-Cyclone	38-90	24.6	**88.7**	**70.96**	1476	88560
Hydro-Cyclone	16-38	25.7	**92.5**	**74**	1542	92520
Hydro-Cyclone	8-16	20.3	**73**	**58.4**	1218	73080
Hydro-Cyclone	<8	28.5	**102.6**	**82.08**	1710	102600
de-ored sand	38-90	35	**181.2**	**144.96**	2100	126000
de-ored sand	16-38	3.2	**11.5**	**9.2**	192	11520
de-ored sand	8-16	2.4	**8.5**	**6.8**	144	8640
de-ored sand	<8	3.3	**11.8**	**9.44**	198	11880
		143	**569.8**	**455.84**	8580	514800
0.70 * 181.20 = de-ored sand tonne/hr in suspension				126.1		569*24 =
					13,675	a day
Hydrocyclone total source rate tonne/hour:				*482.9*		
Tonnes per annum of fine sediment:					**4,991,448**	
					4.5m at 80% uptime	
Hydrocyclone tonnes per annum:				4,230,059		

		Source Rate kg/s	Source Rate @ 100% **tonne/hour**	Source Rate @80% **tonne/hour**	Source Rate per minute kg/s	Source Rate per hour kg/hour
Hydro-Cyclone	90-125	7.8	**28.2**	**22.56**	468	28080
Hydro-Cyclone	125-150	2.1	**7.6**	**6.08**	126	7560
Hydro-Cyclone	150-212	1.9	**6.7**	**5.36**	114	6840
Hydro-Cyclone	>212	0	**0**	**0**	0	0
de-ored sand	90-125	69.6	**250.7**	**200.56**	4176	250560
de-ored sand	125-150	93.6	**337**	**269.6**	5616	336960
de-ored sand	150-212	279.6	**1006.7**	**805.36**	16776	1006560
de-ored sand	212-250	296.4	**1067.1**	**853.68**	17784	1067040
de-ored sand	250-355	576	**2073.5**	**1658.8**	34560	2073600
de-ored sand	355-500	257.1	**925.5**	**740.4**	15426	925560
de-ored sand	500-710	91.6	**329.7**	**263.76**	5496	329760
de-ored sand	710-2000	87.3	**314.3**	**251.44**	5238	314280
de-ored sand	>2000	88.9	**320**	**256**	5334	320040
		1851.9	**6667**	**5333.6**	111114	6666840
Tonnes per day calculation:						
Therefore a day is: 6667 multiplied by 24 hours =					160,008	
Tonnes per annum of sand:				(160,008x365)	**58,402,920**	
GRAND TOTAL -TONNES - fine sediment plus sand					**63,394,368**	
GRAND TOTAL TONNES - At 80% uptime					**50,715,494**	

The Executive Summary of the Coastal stability Report fails to identify the significant change in sediment profile for the Project area, pre & post mining.

Shown below is the extract from the Coastal Stability Report, which states that the environmental setting and grain size will not be changed by the Project. This contradicts the Geological Desktop Survey which defines the sediment coloured orange in the extract below, as "gravelly sand, rich in shell material".

In contrast to this, 80% of the de-ored sand discharge falls within a particle sizing of 'fine to medium sand'. It will contain no 'rich shell material' after the beneficiation process (see Table 3-3 of the Plume Modelling Report).

There is a big distinction then between the sediment pre-mining compared to post-mining sediment deposited back into the 'patch' – which the NIWA Executive Summary does not address.

Extract from Executive Summary; Coastal Stability Report

The natural landforms and geomorphic character of the beaches is unlikely to change due to

sand extraction: Geomorphic character of the beaches is determined by environmental setting, tide range, grain size and wave climate. **Environmental setting, tide range and grain size will not be changed by sand extraction**. Wave climate will be modified as waves pass over the pits and mounds on the seabed but as our wave modelling has shown the extent of the modification will be minor and will not alter the existing geomorphic character which under natural conditions exhibits a large degree of temporal and spatial variation in wave characteristics.

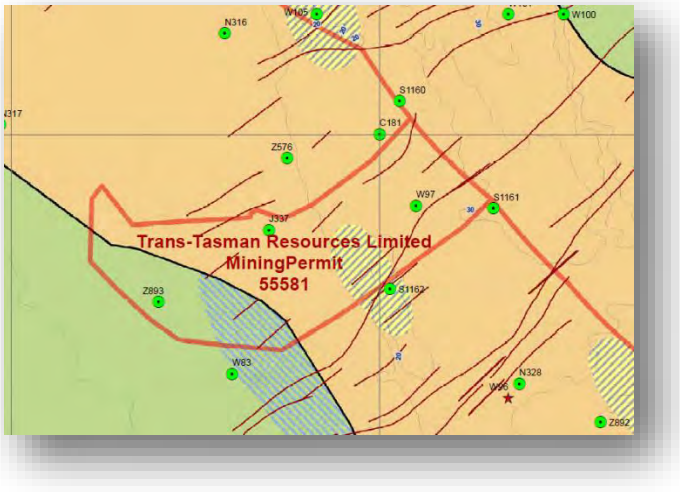
International scale [edit]

ISO 14688-1, establishes the basic principles for the identification an

ISO 14688-1[3]

name			size range
Very coarse soil		Large boulder, LBo	>630 mm
		Boulder, Bo	200 – 630 mm
		Cobble, Co	63 – 200 mm
Coarse soil	Gravel	Coarse gravel, CGr	20 – 63 mm
		Medium gravel, MGr	6.3 – 20 mm
		Fine gravel, FGr	2.0 - 6.3 mm
	Sand	Coarse sand, CSa	0.63 - 2.0 mm
		Medium sand, MSa	0.2 - 0.63 mm
		Fine sand, FSa	0.063 - 0.2 mm
Fine soil	Silt	Coarse silt, CSi	0.02 - 0.063 mm
		Medium silt, MSi	0.0063 - 0.02 mm
		Fine silt, FSi	0.002 - 0.0063 mm
	Clay, Cl		≤0.002 mm

Extract from Appendix B, Geological Desktop Survey



The NIWA Executive Summary for Coastal Stability has a statement on beach profiles that is supported in the body of the report for data only from Ototoka (near Kai Iwi) – see section 2.3.

Effects on the risk of accelerated coastal erosion and accretion along the region's coastline and modification to natural hazard processes will not be significant: Beach profile surveys and observations made at eight sites between Ohawe and Kai Iwi, spanning a stretch of about 70 km of coast show that the beaches are very active. The level of the **beach fluctuates up and down 1 – 2 m and the beach face shows excursions back and forth of about 10 – 40 m** over time scales of weeks and months in response to erosion during storm events and the calmer periods of beach building in between. These fluctuations occur under natural conditions (no extraction) as a consequence of this environmental setting. For a shoreline of this character, that experiences a wide variety of wave conditions and large variability in sediment transport rates and changes in sand storage on the beaches, **the level of acceptable impacts from sand extraction offshore should be relatively high,** compared for instance to a shore that experiences amore limited range of wave conditions.

The NIWA Executive Summary for Coastal Stability section 2.3 shows only data for Ototoka and it appears to be these results that are discussed in the NIWA Executive Summary for Coastal Stability Phase 2. It would have been informative to have been provided data for areas closer to the Project site, and for the Executive Summary comments to have indicated that the results discussed related to Ototoka.

It is perhaps also somewhat misleading to try and detail how much fluctuation there is in metres, as the 11 month beach profiles show that there is no pattern of erosion, just considerable change – which varies depending on which beach you consider – as shown below:

Table 2-1: Sand volume changes from beach profile data - June 2011 to April 2012.

Site	Length of beach spanned by profiles (m)	Net change in beach volume (m^3/km of shoreline)	Total amount of sand moving on and off the beach (m^3/km of shoreline)
Ohawe	500	+23,200	137,000
Hawera	530	-7,300	67,000
Manawapou	680	+25,700	247,000
Patea	360	-15,900	169,500
Waverley	400	+4,700	109,600
Waiinu	400	-10,100	100,500
Ototoka	630	-6,100	205,100
Kai Iwi	420	-5,300	203,300

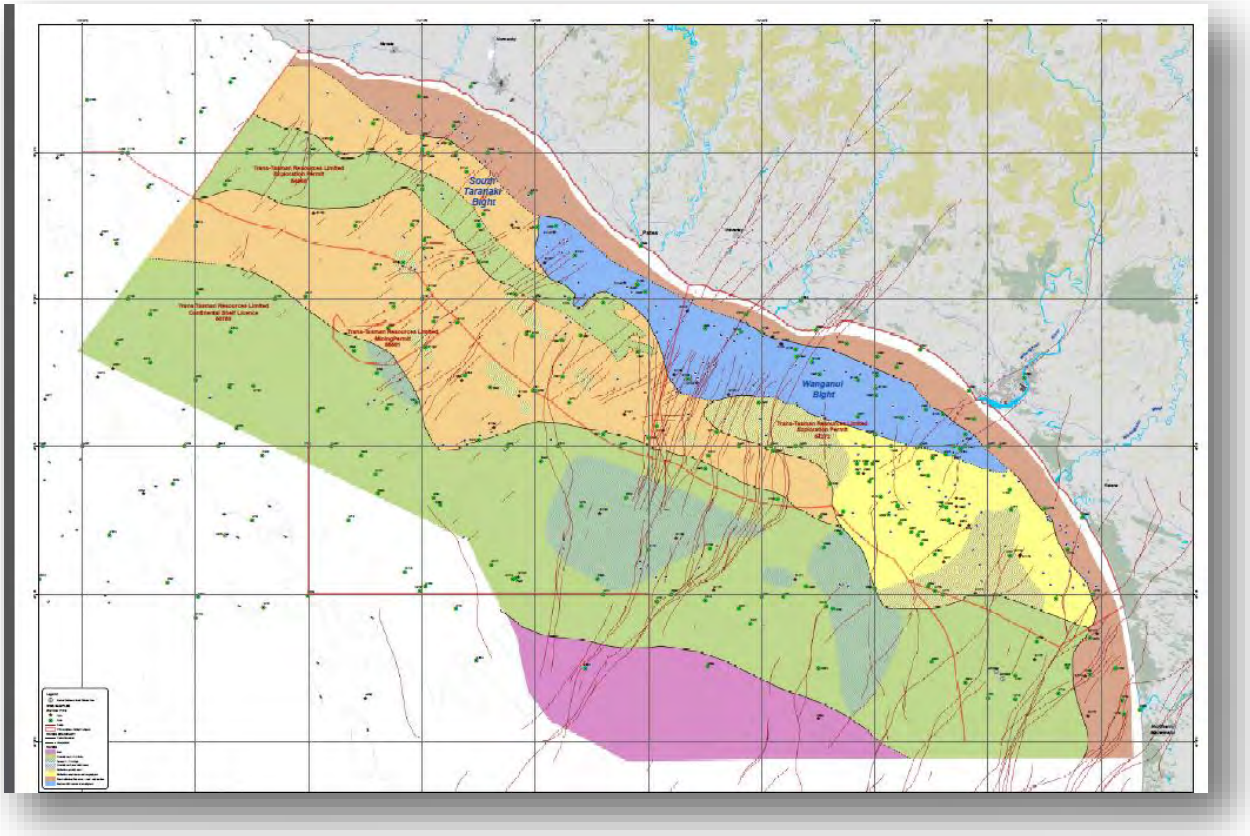
The 11 months of profile data show no spatial or temporal pattern of change in erosion and accretion along the shore, just considerable change. The total movements of sand on and off the beach over the year were of the order of at least 6-times to 39-times greater than the net change in sand storage. The beaches are continually changing as large volumes of sand enter and leave and are redistributed in the beach system.

http://www.epa.govt.nz/Publications/Coastal_stability_PHASE_2_report_FINAL_pp1-47.pdf

The NIWA Coastal Stability Report Executive Summary on 'currents' arising from the 9m high mounds left in the Project site - misses important information about particle sizes.

The Executive Summary rightly makes the comment that the 9m mounds in the extraction area will make features several kilometres long and 0.5km wide and comments that the mounds will be "of a size to naturally occurring ridges on the seabed." The important context that is missing, is the sediment composition of naturally occurring ridges and the mined mounds will be quite different and thus erode quite differently. Page 24 of the Geological Desktop Survey describe the dunes as 'condensed, coarse grained deposits that could well contain shell and gravel'. The mined 9m mounds will contain no shell and gravel, and will be medium to fine sand. In addition there are significant erosion factors that come into play (mentioned earlier on in this report).

Appendix C shown below, indicates the ridges as light green hatched areas.



Extraction will not adversely affect physical drivers and processes that cause coastal change – Currents: Bathymetric irregularities such as the pits (to 10 m deep) and mounds (to 9 m tall) at the extraction sites form features of the order of several kilometres long and 0.5 km wide and of a size to naturally occurring ridges on the seabed. While producing a localized effect on currents they are not expected to impact prevailing or ambient currents and flow characteristics. Weak cross shore currents and modelling of sediment dispersal of sands from the extraction area suggest that there is little connection between seabed sediments in the extraction area and the surf zone, and seabed sand in the area of the extraction operations some 22 to 35 km off the coast is not a significant source for sand on the beaches. Therefore, sand extraction will not have significant effects on sand supply to the beaches and will not promote beach erosion.

AIR EMISSIONS – S59 (5) (2) OF THE EEZ ACT REQUIRES THE EPA TO CONSIDER HEALTH EFFECTS. The TTR impact assessment fails to consider existing interests operating at sea who will be exposed to levels of emissions damaging to health. SKM does not identify emissions at sea as a key finding, or an issue needing further information/assessment.

Section 59 (2) (c) of the EEZ Act requires the EPA to take into account adverse effects on human health. Levels of Sulphur Dioxide and Nitrogen Dioxide on the ship and the sea surrounding the ship are at levels hazardous to health.

To assist the EPA with this aspect of the Act, below are the air contaminant levels, compared to Workplace Emission Standards and Ambient Air Quality Standards.

WORKPLACE EMISSION STANDARDS (WES)	TWA	STEL
1. Sulphur Dioxide WES	**5.2 mg/m³**	**13.0 mg/m³**
2. Nitrogen Dioxide WES	**5.6 mg/m³**	**9.4 mg/m³**

Gas turbine 11.9.2 Impact Assessment	24 hour	1 hour
1. Sulphur Dioxide on board FPSO	97 mg/m³	211 mg/m³
2. Nitrogen Dioxide on board FPSO	43 mg/m³	94 mg/m³

Reciprocating turbine: 11.9.3 Impact Assessmt	24 hour	1 hour
1. Sulphur Dioxide on board FPSO	231 mg/m³	453 mg/m³
2. Nitrogen Dioxide on board FPSO	160 mg/m³	313 mg/m³

Ambient Air Quality Standards	24 hour	1 hour
1. Sulphur Dioxide	120 mg/m³	350 mg/m³
2. Nitrogen Dioxide	100 mg/m³	200 mg/m³

The EPA requires independently commissioned reports to comment on areas “where further information might be necessary to inform an assessment of the impacts”. SKM in their review of the air emission report, did not raise the elevated levels of air emission contaminants as an aspect needing further information.

Section 59 (2) (c) of the EEZ Act requires the EPA to take into account adverse effects on human health.

Section 39 (4) of the EEZ Act requires issues of risk to be avoided, remedied or mitigated but only in regards to environmental and existing interests. Employees are neither of these too, and this will explain why the Impact Assessment does not discuss air emissions exceeding Workplace Emission Standards.

Section 14.4 of the TTR Impact Assessment 'human health' *fails to mention* anything about air contaminants exceeding *NZ standards & guidelines* and Workplace Emission Standards for **Sulphur Dioxide** on the FPSO ship.

Section 4.9.8 of the TTR Impact Assessment discussing personnel health does *not* mention air emission levels. The negative health effects for TTR workers exposed to high levels of Sulphur Dioxide and Nitrogen Dioxide are potent respiratory effects – see the Ministry for the Environment extract below for greater detail.

The **Health and Safety Act 1992 section 6** states an employer shall take all practicable steps to ensure the safety of employees while at work; and in particular shall take all practicable steps to provide and maintain for employees a safe working environment. It would appear that there is no body with enforcement jurisdiction for this Act on board the FPSO.

The Impact Assessment 4.10.4 on Health and Safety Management Section 4.9.1 states a 'safety case' approach is being developed with Maritime NZ and the High Hazards unit of the Department of Labour. **A 'safety case' is simply a plan** and whilst the **High Hazards unit would provide guidance, they have no legislative jurisdiction over the ship**.

Maritime NZ would only administer the H&S Act 1992 if the ship is **'NZ flagged'** and at this stage of the Project this is unknown.

Even if the FPSO was a 'NZ flagged ship', **Maritime NZ under NZ law does not recognise MARPOL Annex 6 which is to do with air emissions** – so they again have no jurisdiction over air emissions.

MARPOL 73/78 (the International Convention for the Prevention of Pollution from Ships has technical annexes regulating

- Annex 1 – pollution by oil
- Annex 2 – noxious liquid substances
- Annex 3 – harmful substances in packaged form
- Annex 4 - sewage from ships
- Annex 5 – pollution by garbage
- **Annex 6 – air pollution from ships**

Despite NZ not recognising in legislative fashion air pollution, internationally the environmental impacts of sulphur oxide and nitrogen oxide emissions have been recognised, with the sulphur content of fuel oil **restricted to 1.5% m/m** in the Baltic Sea and North Sea.

MARPOL Annex VI sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and includes **a global cap of 4.5% m/m on the sulphur content of fuel**. Annex VI contains provisions allowing for special SOx Emission Control Areas (SECAs) to be established **with more stringent controls on sulphur emissions. In these areas, the sulphur content of fuel oil used on board ships must not exceed 1.5% m/m.** Alternatively, ships must fit an **exhaust gas cleaning system or use any other technological method to limit SOx emissions**. The Baltic Sea Area and the North Sea was adopted as SOx Emission Control Areas. Annex VI entered into force on 19 May 2005 and a revised Annex VI with significant tighten emissions limits was adopted in October 2008 which entered into force on 1 July 2010

Recommendation: The conclusion in the T & T report on air contaminant levels states the location of the exposure on land is in 'an **unpopulated** coastline'. This comment needs evidential proof.

Recommendation: To ensure section 59 of the EEZ Act is appropriately addressed - an **Occupational Medical Specialist Report predicting the likely health effects** for workers due to modelled air emission levels on the FPSO, the FSO, the Tug and other visiting ship personnel needs commissioning.

Recommendation: There needs to be a process for regular **independent monitoring & documentation** of the results of air emission contaminant levels on board all TTR vessels. However this is difficult to suggest, as it would appear there is no LEGISLATIVE backing for this approach.

Recommendation: The 'Safety Case" approach needs to consider the health effects on workers exposed to higher levels than recommended in the 'Workplace Emission Standards'. Health checks of employees could occur – looking at changes in respiratory function or plasma S-sulfonate levels. But again with Maritime NZ and the Department of Labour having no legislative jurisdiction over the FPSO there is little enforcement power behind this suggestion.

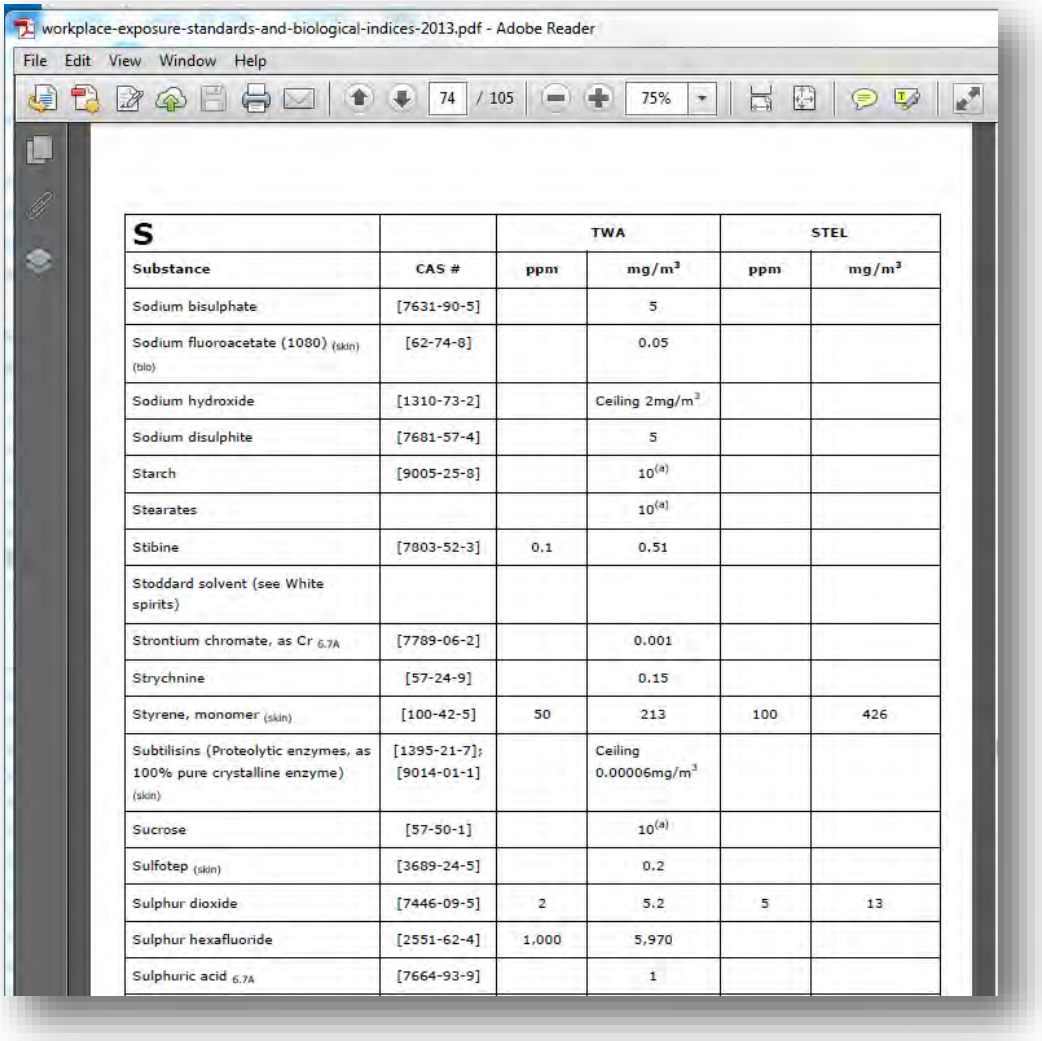
Recommendation: Consideration by the EPA needs to be made of the **international tightening** of regulations on the **sulphur content** of fuel.

Recommendation: If the 'reciprocating engine' option is taken, then a CONDITION needs to be that a selective catalytic reduction **(SCR) system and scrubbers** be fitted, to reduce emission levels. The effect of this condition needs to be shown in the Tonkin & Tonkin contour plots in Appendix B which need to be re-drawn and publicised.

Recommendation: Fishermen and divers, and the community need to know the **geographical points** at which the ambient air quality standard (for a time average of 1 hour) for Sulphur Dioxide falls from 453 µm to 350µm and where Nitrogen Dioxide falls from 313 µm to 200 µm - where the AAQS would be met. Fishermen are 'an existing interest' under the EEZ Act.

Recommendation: As the World Health Organisation (WHO) 24 hour air assessment criterion for Sulphur Dioxide is 20 µm, and as the modelled results are 31µm onshore – it would be appropriate for **communities exposed to the contaminants to be informed.** (Acknowledging that the WHO guidelines have no legislative backing in NZ).

*Below: Workplace Emission Standard for **Sulphur Dioxide** & **Nitrogen Dioxide** from Ministry of Business, Innovation & Employment (TWA = time weighted average STEL= short time exposure limit)*



S		TWA		STEL	
Substance	**CAS #**	**ppm**	**mg/m³**	**ppm**	**mg/m³**
Sodium bisulphate	[7631-90-5]		5		
Sodium fluoroacetate (1080) (skin) (bio)	[62-74-8]		0.05		
Sodium hydroxide	[1310-73-2]		Ceiling 2mg/m³		
Sodium disulphite	[7681-57-4]		5		
Starch	[9005-25-8]		10(a)		
Stearates			10(a)		
Stibine	[7803-52-3]	0.1	0.51		
Stoddard solvent (see White spirits)					
Strontium chromate, as Cr 6.7A	[7789-06-2]		0.001		
Strychnine	[57-24-9]		0.15		
Styrene, monomer (skin)	[100-42-5]	50	213	100	426
Subtilisins (Proteolytic enzymes, as 100% pure crystalline enzyme) (skin)	[1395-21-7]; [9014-01-1]		Ceiling 0.00006mg/m³		
Sucrose	[57-50-1]		10(a)		
Sulfotep (skin)	[3689-24-5]		0.2		
Sulphur dioxide	[7446-09-5]	2	5.2	5	13
Sulphur hexafluoride	[2551-62-4]	1,000	5,970		
Sulphuric acid 6.7A	[7664-93-9]		1		

N		TWA		STEL	
Substance	**CAS #**	**ppm**	**mg/m³**	**ppm**	**mg/m³**
Naled (skin)	[300-76-5]		3		
Naphthalene	[91-20-3]	10	52	15	79
Neon	[7440-01-9]	Simple asphyxiant			
Nickel metal (sen) Soluble compounds, as Ni (sen)	[7440-02-0]		1 0.1		
Nickel sulphide roasting, fume & dust, as Ni (sen) 6.7A			1		
Nicotine (skin)	[54-11-5]		0.5		
Nitric acid	[7697-37-2]	2	5.2	4	10
Nitric oxide	[10102-43-9]	25	31		
p-Nitroaniline (skin)	[100-01-6]		3		
Nitrobenzene (skin) 6.7B	[98-95-3]	1	5		
p-Nitrochlorobenzene (skin) 6.7B	[100-00-5]	0.1	0.64		
Nitrochloromethane (see Chloropicrin)					
Nitroethane	[79-24-3]	100	307		
Nitrogen	[7727-37-9]	Simple asphyxiant			
Nitrogen dioxide	[10102-44-0]	3	5.6	5	9.4

2.5 Sulphur dioxide

2.5.1 Guideline values

The guideline values for sulphur dioxide are 350 µg/m^3 (1-hour average) and 120 µg/m^3 (24-hour average).

These values are set to provide protection of lung function and prevent other respiratory symptoms of vulnerable sub-groups in the population, including asthmatics and those with chronic obstructive lung disease. They are in line with current international guideline values and standards. The annual guideline value for sulphur dioxide is now discussed in Chapter 4 on ecosystem-based guidelines. The short-term guideline value has been removed, as it is not appropriate for managing air quality in large air sheds, however, shorter-term criteria for sulphur dioxide may be appropriate for assessing industrial discharges.

2.5.2 Health effects

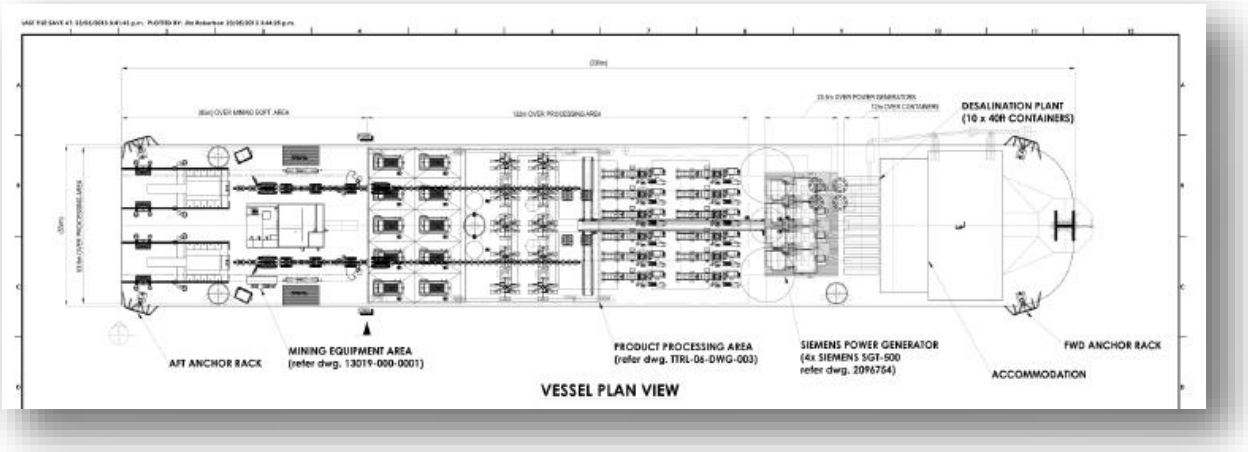
Sulphur dioxide (SO_2) is a potent respiratory irritant when inhaled. Asthmatics are particularly susceptible. SO_2 acts directly on the upper airways (nose, throat, trachea and major bronchi), producing rapid responses within minutes. It achieves maximum effect in 10 to 15 minutes, particularly in individuals with significant airway reactivity, such as asthmatics and those suffering similar bronchospastic conditions.

The symptoms of SO_2 inhalation may include wheezing, chest tightness, shortness of breath or coughing, which are related to reductions in ventilatory capacity (for example, reduction in forced expiratory volume in one second, or FEV_1), and increased specific airway resistance. If exposure occurs during exercise, the observed response may be accentuated because of an increased breathing rate associated with exercise. A wide range of sensitivity is evident in both healthy individuals and more susceptible people, such as asthmatics, the latter being the most sensitive to irritants.

Epidemiological studies have shown significant associations between daily average SO_2 levels and mortality from respiratory and cardiovascular causes. Increases in hospital admissions and emergency room visits for asthma, COPD and respiratory disease have also been associated with ambient SO_2 levels. These associations were observed with up to a two-day lag period. Long-term exposure to SO_2 and fine particle sulphates (SO_4^{2-}) has been associated with an increase in mortality from lung cancer and development of asthma and cardio-pulmonary obstructive

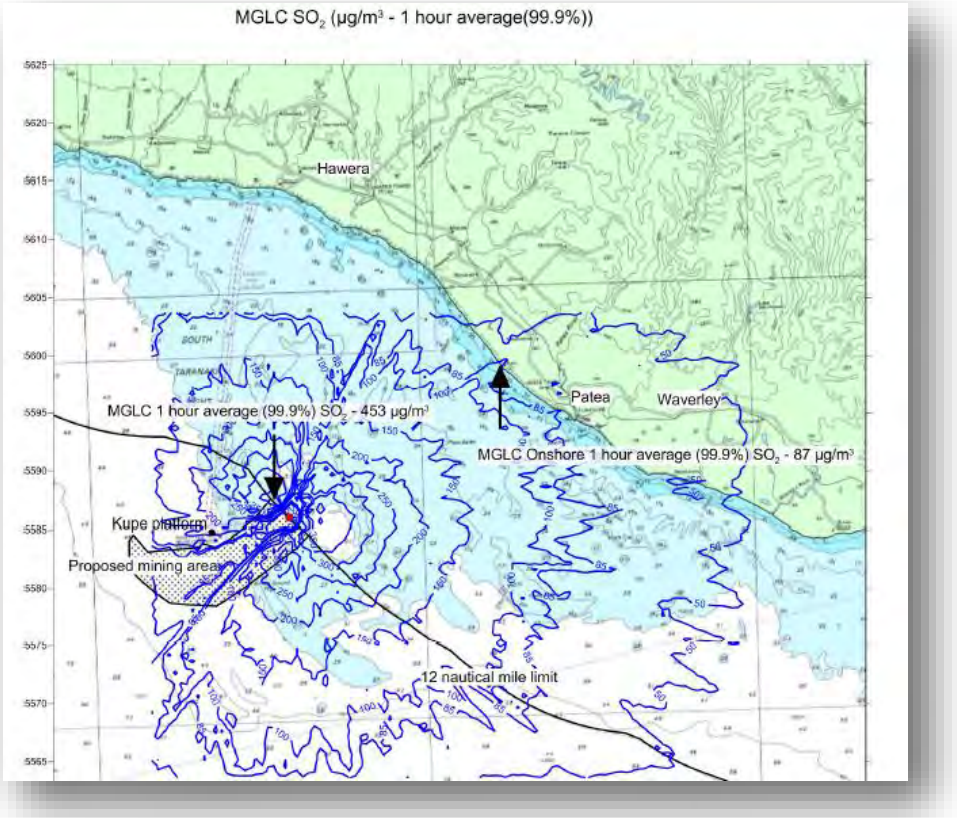
EXTRACT from the Ministry for the Environment detailing the health effects of sulphur dioxide:

Diagram below: showing the accomodation on ship in relation to the gas turbines and emissions.



2 diagrams showing Sulphur Dioxide and Nitrogen Dioxide emissions exceeding air quality standards from the reciprocating gas turbine option: 1 hour averages.

THE AAQS GUIDELINE for Sulphur Dioxide is 350 µM.
http://www.epa.govt.nz/Publications/29303_Air_Quality_Study_Reciprocating_Engines_%20FINAL.p



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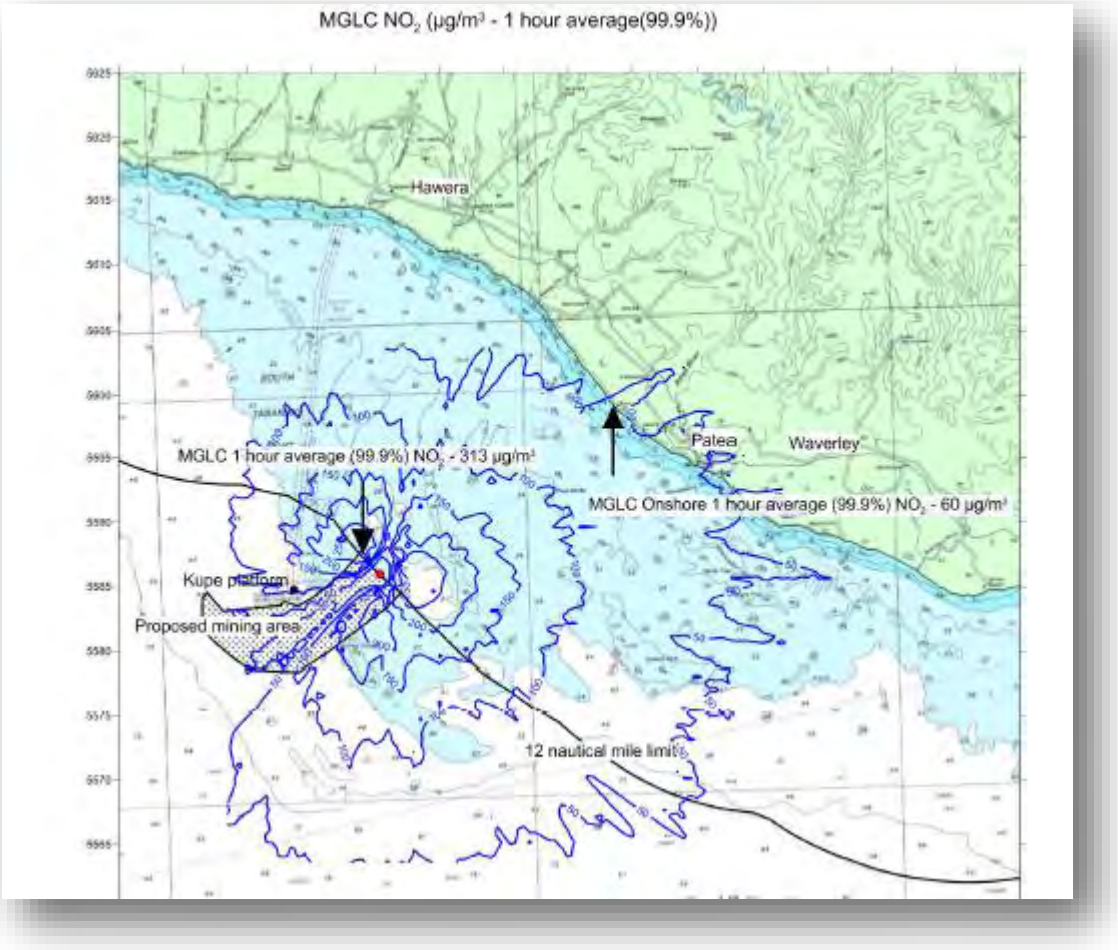


http://www.epa.govt.nz/Publications/29303_Air_Quality_Study_Reciprocating_Engines_%20FINAL.pdf Page 26 **THE AAQS GUIDELINE for Nitrogen Dioxide is 200.**

The Impact Assessment fails to address acidification of the ocean due to sulphur dioxide.

Extract below: from SKM report commissioned by the EPA *– Air Emissions*

> 21. Although the **effects of deposition of contaminants** from HFO combustion on the marine environment **is not discussed** in the reports, we do not consider the issue of dissolved emissions in the marine environment to be significant, as the level of deposition from the plumes into the seawater ***can be assumed*** to be minor. In the absence of precipitation, diffusion of contaminants from the air to the water is restricted to the air-sea interface and is limited by the rate of diffusion between the two phases. SO2 is likely to be the main concern, and will react with seawater to form sulphate, although in low quantities compared to existing sulphate concentrations in seawater

SKM 'assumptions' that sulphur dioxide deposition into the ocean is 'minor' has no place in a robust analysis of the environmental impacts of this Project. **Section 61 (1) of the EEZ Act** requires the EPA to base decisions on the best available information. A significant resource that the EPA could perhaps have utilised, is the information and contacts contained in the European Project on Ocean Acidification **(EPOCA)** website. EPOCA is a consortium of 27 partners, including more than 100 leading European scientists and their field and laboratory resources. EPOCA coordinates with international programmes. http://www.epoca-project.eu/index.php/what-do-we-do.html.

EPOCA outlines on its website the difficulties in determining impacts on the ocean due to sulphur dioxide. Nevertheless in order to determine the effect on the environment and impact of ocean life – some attempt at scientific analysis needs to be done, **rather than rely on an unsupported SKM 'assumption 'statement.**

Sulphur dioxide in air can be oxidized to sulphate by rain or the ocean thus forming "acid rain" - carbonic acid. The dissolution of carbon dioxide in sea water not only increases hydrogen ions and thus a decline in pH, but also a decrease in a the carbonate ion (CO32-).

There are *biological impacts* which need some independent commentary: numerous marine organisms such as corals, molluscs, crustaceans and sea urchins rely on carbonate ions to form their calcareous shells or skeletons. Physiological processes such as reproduction, growth and photosynthesis are susceptible possibly resulting in a loss in marine biodiversity. Some species, like sea grasses that uses CO2 for photosynthesis, may benefit positively.

The Ministry for the Environment does not regulate/monitor sulphur dioxide and the effects on the ocean

Advice I received 16 January, 2014 from the Ministry for the Environment, is that the Ministry does not regulate or monitor any potential effects of sulphur dioxide on the ocean as it is not considered an issue that warrants direct regulation. It is for the EPA to take into account effects on the environment.

Recommendation: SKM 'assumption' about deposition rates of sulphur dioxide into the ocean as 'minor' needs to be backed up by scientific calculations – keeping in mind the continuous nature of this project for at least ten years. As there is no monitoring requirement, or direct regulation of sulphur dioxide by the Ministry for the Environment – it is critical that some scientific work is conducted on this matter, so that the potential impacts on the ecology can be determined, a baseline determined and an appropriate monitoring regime identified.

Recommendation: the biological 'tipping point' for various organisms in the vicinity of the acidification needs to be determined. Vari'ous marine species and ecosystems might not have the time to adapt to changes in the ocean chemistry. 'Diatoms' for example (which form the base of aquatic food webs) are very particular about the water chemistry in which they live.

Recommendation: the spatial extent of pH changes needs to be determined.

Reference: Riebesell U., Fabry V. J., Hansson L. & Gattuso J.-P. (Eds.), 2010. Guide to best practices for ocean acidification research and data reporting, 260 p. Luxembourg: Publications Office of the European Union.

'Key findings' omissions for SKM review (noted in **red**.)

As there are no offshore receptors, which are likely to be affected by the air contaminants, the onshore effects were primarily considered. There are 'offshore receptors' - the ship (FPSO) workers/employees & fishermen and divers using areas within the contaminant plume. The reports provide a concise and generally comprehensive assessment of the effects of the air discharges although would benefit from addressing the following key points:

- Discussion of ambient air background concentrations onshore

- 1 hour & 24 hour offshore concentration of Sulphur Dioxide is 30% and 90% over AAQS standard respectively. 1 hour & 24 hour offshore concentration of Nitrogen Dioxide is 56% and 60% over the AAQS standard respectively. The WES (workplace emission standards have been exceeded well beyond the AAQS percentages)

- Confirmation that appropriate emission factors have been used for PM10 and CO

- Presentation of windroses for onshore meteorology used to develop the modelling dataset.

- Confirmation that the FPSO ship was included in the model for building downwash. There has been no downwash commentary on the impact of the FSO or Tug on contaminant dispersal.

- An assessment and discussion of potential effects of the discharges on personnel on the Kupe platform

Acidification of the ocean at the Project site (Point 21 of the SKM report) is missing as a Key Finding. SKM have *assumed* the impact to be minor – with no scientific data from SKM to back up this assumption. The international community do not see the effects of SO_2 as minor – with MARPOL considerably tightening sulphur dioxide emission levels in the Baltic and North Sea (reduction from 4.5% to 1.5%mm sulphur content in heavy fuel oil)

Annex 2 of the 1996 Protocol requires that parties to the Protocol develop national action lists for screening the constituents of wastes on the basis of their potential effects on human health and the marine environment. Priority substances for inclusion in these lists are toxic, persistent and bioaccumulative substances from anthropogenic sources.

SUBMISSION ON THE EXECUTIVE SUMMARY

SECTION 2: PROJECT DESCRIPTION & ECOLOGY

ECOLOGICALLY SUSTAINABLE DEVELOPMENT for this Project, requires that more work is done to address the SIGNIFICANT GAPS identified in ECOLOGICAL KNOWLEDGE and SEDIMENT MODELLING

Any economic or business venture will involve making compromises. Risks and benefits are weighed up. Ecologically sustainable development (ESD) principles mean that there can be some negative environmental effect - as long as the integrity of ecosystems is not threatened.

The community needs to be involved in deciding the level of acceptable protection, and they need a degree of certainty that the level of protection will be delivered.

The largest problem is that NZ's marine environment is still at an early stage and much of the diverse communities remains poorly researched. NIWA's **sampling has been biased away from the rocky areas which have the greatest diversity, and have principally focussed on the sand habitats. Further research, especially in the North & South Traps, and Graham's Bank needs to be done.**

1. We need to address the concerns about **concentrated metal discharge**, including obtaining a Report on the long term effects of discharging concentrated metals at sea.
2. We need to address the numerous **significant Plume modelling limitations**, to ensure the worst case scenario is understood and the cumulative effects are known.
3. The community and interested parties need to determine **suitable early warning indicators and Management targets.** The targets must have the potential for early detection of effects and measurement of biodiversity effects.
4. Ministry for the Environment guidelines to be used: incorporate the **precautionary principle;** allow calculation of different levels of protection to suit a particular situation; and use a **'transparent' methodology** so that the community can understand how a particular guideline value was derived.

Missing from the Executive Summary's comments on 'residual material' is the very fine sediment that gets discharged into the water column.

Not all residual material is returned to the seabed. Residual material from the hydro-cyclone overflow, which is deposited into the water column, is 399 tonnes/hour (*page 31 of the Impact Assessment).*

- is deposited ten metres above the bottom (page 29 Plume modelling report)
- 'discharged via a second pipe located on the de-ored sand deposition pipe, at a nominal height of 2m above the outlet'

- This material goes straight into the water column – and forms the basis for the NIWA plume modelling.
- These 'fines' are (mass flux) **399 tonnes/hour.**
- There are concentrated levels of copper, within the hydro-cyclone discharge

This is the extract from the Impact Assessment – have a look at the second sentence.

Executive Summary, page (ii) of the Impact Assessment
*The TTR Project involves the excavation of up to 50 million tonnes per year (up to 27 million cubic metres per year) of seabed material containing iron sand, for processing on a Floating Processing Storage and Offloading Vessel ("**FPSO**"). Around 10% of the extracted material will be processed into iron ore concentrate for export, with residual material (approximately 45 million tonnes per year) returned to the seabed as de-ored sediment via a controlled discharge at depth below the FPSO.*

THE CRITICAL IMPORTANCE for HABITATS, of PARTICLE SIZE has been overlooked in the Impact Assessment – section 6 of the EEZ regarding 'effects' will not be met unless much more focus is made of this factor.

Whether a creature or plant can live in an environment has a great deal to do with the size of particles on the floor bed.

The photographs below were taken from a dredge of the proposed extraction site. The 'shell-hash' is important – as it is something organisms can attach to. When the extracted sand 'is put back', it will not contain these larger items.

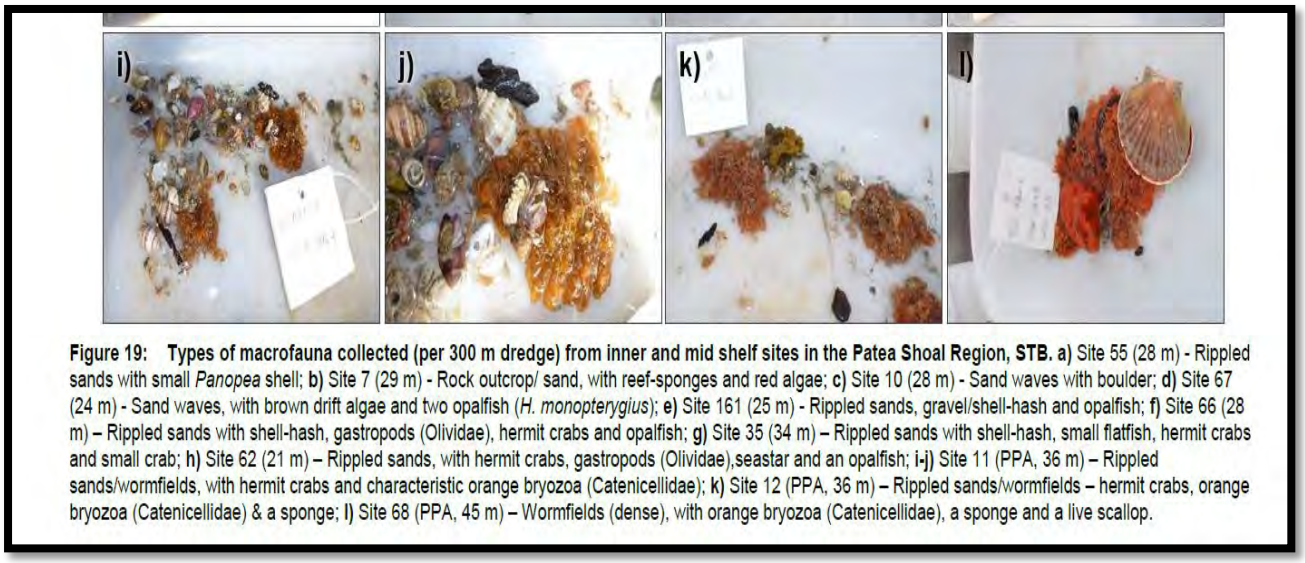


Figure 19: Types of macrofauna collected (per 300 m dredge) from inner and mid shelf sites in the Patea Shoal Region, STB. a) Site 55 (28 m) - Rippled sands with small *Panopea* shell; **b)** Site 7 (29 m) - Rock outcrop/ sand, with reef-sponges and red algae; **c)** Site 10 (28 m) - Sand waves with boulder; **d)** Site 67 (24 m) - Sand waves, with brown drift algae and two opalfish (*H. monopterygius*); **e)** Site 161 (25 m) - Rippled sands, gravel/shell-hash and opalfish; **f)** Site 66 (28 m) – Rippled sands with shell-hash, gastropods (Olividae), hermit crabs and opalfish; **g)** Site 35 (34 m) – Rippled sands with shell-hash, small flatfish, hermit crabs and small crab; **h)** Site 62 (21 m) – Rippled sands, with hermit crabs, gastropods (Olividae),seastar and an opalfish; **i-j)** Site 11 (PPA, 36 m) – Rippled sands/wormfields, with hermit crabs and characteristic orange bryozoa (Catenicellidae); **k)** Site 12 (PPA, 36 m) – Rippled sands/wormfields – hermit crabs, orange bryozoa (Catenicellidae) & a sponge; **l)** Site 68 (PPA, 45 m) – Wormfields (dense), with orange bryozoa (Catenicellidae), a sponge and a live scallop.

Below is page 127 of the NIWA 'Benthic Flora & Fauna of the Patea Shoals' Report. If you go down the first column you see 'PPA' (Proposed Project Area). Looking across to the 'seabed description' on the right, you can see that there is a lot of 'shell hash' – a very important component for larvae, and other organisms to attach to.

Even the research done by NIWA showed a brachiopod having a strong negative association for silt. (DISTLM in PERMANOVA+ for PRIMER which tests how much variation in community structure is

explained by each environmental variable.) Page 37 of 'Benthic flora & fauna of the Patea Shoals' Report)

Seabed samples collected during the benthic shelf survey on and adjacent to Patea Shoals, in the STB. Survey_station numbers (e.g. IKA1101_189) reflect the survey (IKA1101) and station (189) order in which samples were collected. Core Reps = Number of replicate cores collected per site. PPA= Proposed project area; Inner shelf=inner shelf zone.

Area	Site	Coastcam	Agassiz Dredge	KC-Denmark HAPS corer	Core Reps	Seabed Description
PPA	1	IKA1101_361	IKA1101_189	IKA1101_1-3	3	**Rippled sands:** iron-rich sands with coquina and shell-hash; trails, sml burrow, no visible biota
PPA	2	IKA1101_384	IKA1101_190	IKA1101_4-6	3	**Rippled sands:** iron-rich sands with coquina and shell-hash in troughs, no visible biota
Inner shelf	3	IKA1101_186	TQI1201_41	IKA1101_25-27	3	**Rippled sands:** iron-rich sands with heavy coquina and shell-hash in troughs, large trails, opalfish x1
Inner shelf	4	IKA1101_194	IKA1101_183	IKA1101_16-18	3	**Sand waves:** coarse iron-rich sands
Inner shelf	5	IKA1101_543	KAH1206_90	IKA1101_159-161	3	**Rocky outcrop/rippled sands:** low-relief outcrop with bryozoans and macroalgae, adjacent to rippled iron-rich sands (catenary-shaped), sml burrows
PPA	6	IKA1101_526	IKA1101_345	IKA1101_52-54	3	**Rippled sands:** iron-rich sands, catenary-shaped ripples with shell-hash/gravel/pebbles (mod) in troughs, hermit crab, opalfish x1
Inner shelf	7	IKA1101_440	TQI1201_73	IKA1101_137-138, KAH1206_87, XX	3	**Rocky outcrop/rippled sands:** low-relief bedrock, boulders, cobbles and pebbles partial covered in iron-rich sands with shell-hash; filamentous and turfing red algae, sponges (encrusting, massive, ball), sponges, blue cod x10, spotties x1, cardinalfish x1, fanworms sp1, seastar x1
Inner shelf	9	IKA1101_542	KAH1206_91	IKA1101_156-158	3	**Rippled sands:** iro-rich sands with silt in troughs, orange bryozoan (Catenicellidae) x1, opalfish x1
Inner shelf	10	IKA1101_444	TQI1201_65	IKA1101_119-121	3	**Sand waves:** coarse sand, with shell-hash and gravel in troughs, 1x cobble, no visible biota (except loose massive sponge, piece of drift kelp), school of baitfish
PPA	11	IKA1101_369	IKA1101_343	IKA1101_61-63	3	**Rippled sands/wormfields:** iron-rich sands (horse-shoe divets); *Euchone* tubeworms (mod/dense), some coquina, sml burrows, gastropods, live scallop x2, seastar (*Coscinasterias*), flatfish, baitfish
PPA	12	IKA1101_401	IKA1101_344	IKA1101_106-108	3	**Rippled sands/wormfields:** iron-rich sands; *Euchone* tubeworms (dense/patchy), burrows, gastropod shells, trails, salp, opalfish x3, live scallop, orange bryozoan (Catenicellidae) x1.
Mid-shelf	14	IKA1101_371	TQI1201_44	IKA1101_64-68	5	**Rippled sands/wormfields:** iron-rich sands (horse-shoe divets); *Euchone* tubeworms (dense), some coquina, gastropods, orange bryozoan (Catenicellidae) x3, trails.
Inner shelf	15	IKA1101_437	KAH1206_89	IKA1101_153-155, KAH1206_83-84	5	**Sand waves:** iron-rich sands with shell debris in troughs; crabs
Inner shelf	17	IKA1101_541	KAH1206_92	IKA1101_77-79	3	**Rippled sands/wormfields:** iron-rich sands with heavy coquina and shell-hash in troughs, *Euchone* tubeworms (sparse-mod), trails, opalfish x1, faecal casts.
Mid-shelf	18	IKA1101_395	IKA1101_346	IKA1101_49-51	3	**Rippled sands:** iron-rich sands, shell-hash and gravel in troughs; sml crustacean, opalfish x1
Inner shelf	20	IKA1101_396	IKA1101_347	IKA1101_46-48, KAH1206_78-79	5	**Rocky outcrop/rippled sands:** low-relief outcrop partially buried by rippled sands, shell debris and gravel/pebbles in troughs, mudstone cobble; opalfish x5, sml fish x1.
Inner shelf	21	IKA1101_537	IKA1101_353	IKA1101_147-149	3	**Rippled sands:** iron-rich sands, coquina, some pebble/gravel in troughs, opalfish x1
Inner shelf	22	IKA1101_365	TQI1201_67	IKA1101_162-164	3	**Rippled sands:** iron-rich sands with coarse shell-hash and pebble/gravel; no visible biota
Inner shelf	23	IKA1101_379	TQI1201_68	IKA1101_143-146	4	**Rippled sands** iron-rich sands with coarse shell-hash and pebble/gravel, opalfish x1
Inner shelf	24	IKA1101_532	IKA1101_348	IKA1101_43-45	3	**Rippled sands** with shell hash;
Inner shelf	25	IKA1101_378	TQI1201_66	IKA1101_129-133	5	**Sand waves:** iron-rich coarse sands heavily laiden with coquina/shell-hash and gravel/pebbles, opalfish x1

What is the sediment type on the ocean floor around the Graham Bank? What are the creatures you would find on the ocean floor here? (Graham bank is a very important diving & fishing spot, where a huge diversity of organisms live).

The answer to these questions is 'we don't know'. NO SAMPLING was done of the Graham Bank benthic flora and fauna (plants & animals living on the sea floor.

NIWA PATEA SHOALS REPORT: If you look at the numbers along the top of Figure 2 (the latitude scale) it stops at 174º 25E. The Graham Bank is at 174º40.

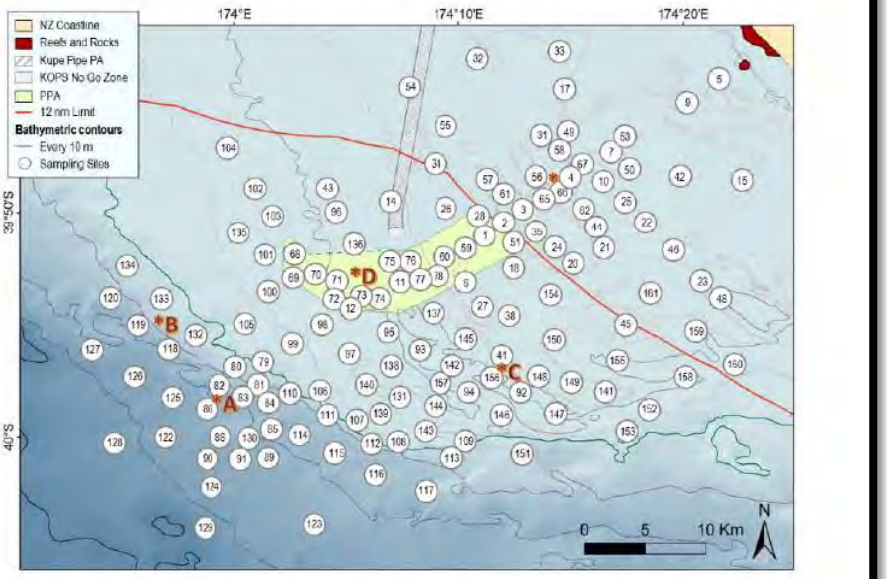


Figure 2: Location of sampling sites across Patea Shoals **within the South Taranaki Bight (STB).** PPA= Proposed Extraction Area; Kupe Pipe PA = Kupe Pipe protected area; KOPS no go zone = Kupe Oil Platform Safety no go zone. Depth contours are in 10 m intervals. *A-*C indicate TTR's preliminary deposition-assessment areas, *D indicates TTR's proposed extraction/deposition area/PPA. '*' depicts the inner shelf area prior to contraction of the PPA area.

NIWA REPORT ON: "BENTHIC HABITATS, MACROBENTHOS AND SURFICIAL SEDIMENTS OF THE NEAR-SHORE SOUTH TARANAKI BIGHT"

If you look at the sample sites in the diagram below - you can see that the Graham Bank was NOT SAMPLED – as it is not a 'near-shore' rock area. This biologically important area, of importance to the fishing & diving community, is in the 'yellow part' of the sediment plume. This means the area is going to get a high level of sediment in the top and bottom part of the sea.

I have looked at the sediment plume calculations, and I believe they significantly under-estimate the levels of sediment that are likely to enter the water. This is really important to know because in red areas the sediment levels are so high – hardly any light will reach the bottom. A report done on the ability to see to the bottom of the ocean at the mining site, shows visibility dropping from 10 metres – down to 1metre! *(NIWA Report on Optical effects, pg. 58: "Secchi map")*

The important rocky areas have been under-sampled. Sample 7 is the only sample area on a rocky outcrop.

Figure 17: showing rocky outcrops and sampling areas (but missing the rocky outcrop out at sea further, called the Graham Bank).

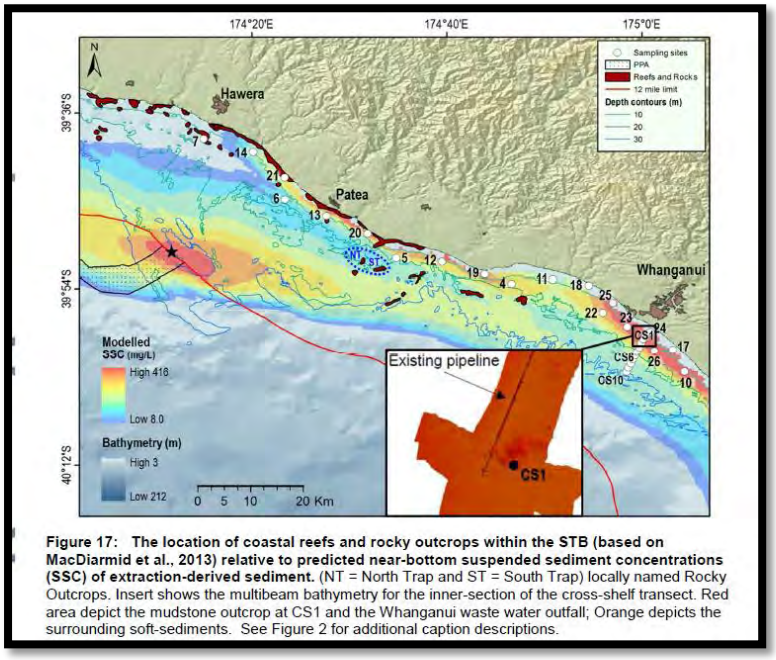


Figure 17: The location of coastal reefs and rocky outcrops within the STB (based on MacDiarmid et al., 2013) relative to predicted near-bottom suspended sediment concentrations (SSC) of extraction-derived sediment. (NT = North Trap and ST = South Trap) locally named Rocky Outcrops. Insert shows the multibeam bathymetry for the inner-section of the cross-shelf transect. Red area depict the mudstone outcrop at CS1 and the Whanganui waste water outfall; Orange depicts the surrounding soft-sediments. See Figure 2 for additional caption descriptions.

2

How much area do the rocky areas cover – so we can understand the amount of life that may be living there? When you look at the sizes below, you can begin to appreciate their significance (note Graham Bank is not included in these figures).

4 coastal reefs	between 0.2km² to 8.5 km² in size range
13 rocky outcrops	between 0.34km² to 2.5km² in size range

The most extensive ones are 4.3km² to 5.1km² around Patea and Hawera. There is a small reef north of the Wanganui river mouth of 0.2 km²

The ecological impact of fine sediment and the importance of robust and comprehensive plume modelling

Very fine particles have two effects in the ocean. The first effect is when they are in the sea water – either the top or bottom part of the sea water. The second effect is when those very fine particles settle on the sea floor.

IN SUSPENSION: The fine particles reduce the ability of light to pass through the water and so reduces the ability of marine plants to be able conduct photosynthesis. The majority of marine plant production (primary production) is by the very small single celled plants called phytoplankton. The bigger marine plants are the kelp and seaweed.

The gills of fish do not respond well to the rough nature of the sediment particles.

WHEN THE PARTICLES SETTLE: The fine particles can smother benthic (sea floor living) organisms and their habitats. The extreme fineness of the particles can mean larvae have a hard time finding something to bind onto. This will not help with re-colonisation.

The Impact Statement diagrams miss out the 'pits (10 meters) & mounds (9m) from dredging.

The Executive Summary does not mention them. The diagrams on pages 15 & 16 of the Impact Assessment, do not contain details of the pits and mounds.

There is to be a 10m pit and 9m mound at the end of each lane, or at the end of each excavation 'block.' These pits and mounds are significant – because the Wave Modelling uses them when determining their impact on the waves.

The 'pit and mound detail' is the basis for 8 modelling scenarios – to determine the impact on wave climate. I have attached them below (*page 20, Near-shore Wave Modelling).*

The area mined will have . . .

- a pit (300 x 500m) 9 – 10 metres depth at the SW end of the lane
- a depression of 1 metre deep in the backfilled lanes
- a mound (300 x 500m) 8m or 9m tall at the NE end of the lane.

SEDIMENTS AND/ OR TAILINGS FROM MINERAL OPERATIONS ARE NOT CURRENTLY REGULATED BY MARITIME NZ RULES, OR THE EEZ ACT. THIS IS WHY TRANSPARENCY OVER THE PROCESS TO DETERMINE APPROPRIATE MONITORING OF CONCENTRATED LEVELS OF METALS DISPERSED INTO THE WATER PLUME, IS IMPORTANT.

Whilst keeping in mind the political and regulatory regimes – the matter of metal concentrations is one that needs to be dealt with in a suitably robust and transparent manner – the Project site is located next to a coast line containing numerous rocky outcrops containing a large diversity and number of organisms – that have not had the benefit of being sampled in an in-depth manner.

The following circular contains an extremely robust process for determining appropriate levels of sample sizes for elutriate testing, biological testing etc. http://www.maritimenz.govt.nz/Rules/Rule-documents/Part180-Advisory-circular-1999.pdf

SKM's suggested approach for reducing uncertainty over metal concentrations is not comprehensive enough

The SKM Report (on Oceanographic Processes and the Physical Environment), point 28 fails to give a comprehensive enough approach for addressing the uncertainties surrounding the elevated concentrations of metals, especially copper, nickel and mercury. The Maritime Guideline covers sample sizes, depth of sample sizes, lab testing protocol, bio-testing etc. and so offer a far more robust approach. A CONDITION applied to the Marine Permit, should be that the protocols outlined in the Maritime document be followed.

Recommendation: The processes outlined in the maritime advisory circular 1999 should be followed as a means of addressing the uncertainties surrounding metal concentrations

The ability to regulate the discharge of sediments and/ or tailings from mineral operations is proposed to be introduced to the EEZ Act.

The Ministry for the Environment is proposing a package of measures to ensure that New Zealand continues to meet its international obligations related to discharges and dumping. It also seeks to reflect the existing balance between environmental protection, economic activity and cost to the extent this is consistent and appropriate within the EEZ Act. Standard conditions for permitted activities and greater regulatory alignment between the EEZ, MBIE and Maritime NZ, provides increased investment certainty for operators and improves the attractiveness of NZ as an investment opportunity. For the EPA to process a non-notified discretionary marine consent the cost is approximately $100,000 to $500,000, compared to $250,000 to $1,500,000 for a discretionary marine consent, plus monitoring and reporting costs. The implementation of the ML Bill and ***transfer of regulatory responsibility for discharges and dumping to the EPA as regulator*** *is expected to improve the efficiency of the process.*

http://www.mfe.govt.nz/publications/oceans/managing-our-oceans/activity-classification-under-the-eez-act.pdf

Ministry for the Environment. 2013. ***Activity classifications under the EEZ Act:*** *A discussion document on the regulation of exploratory drilling, discharges of harmful substances and dumping of waste in the Exclusive Economic Zone and continental shelf.* Wellington: Ministry for the Environment

SKM's review notes as a key finding the omission of mercury as a potentially significant gap in the report on metal concentrations commissioned by TTR

Due to the significance of this metal to the fishing, diving and general public it is important that there is transparency over this issue.

'Vanadium-Titanomagnetite iron sands' contain VANADIUM, yet there is no reference to this in the metal concentrations report or in the SKM review

It would be beneficial to the community to understand if this metal will enter the environment along with other metals identified. Vanadium can be found in the environment in algae, plants, invertebrates, fishes and many other species. In **mussels and crabs vanadium strongly bioaccumulates,** which can lead to concentrations of about 10^5 to 10^6 times greater than the concentrations that are found in seawater. Vanadium causes the inhibition of certain enzymes with animals, which has several neurological effects. Next to the neurological effects vanadium can cause breathing disorders, paralyses and negative effects on the liver and kidneys. Laboratory tests with test animals have shown, that vanadium can cause harm to the reproductive system of male animals, and that it accumulates in the female placenta. Vanadium can cause DNA alteration in some cases, but it cannot cause cancer with animals.

The Impact Assessment Executive Summary fails to note the discharge of concentrated metals into the sea water

The 'Processing' section of the Executive Summary (ii) states: *Processing on the very slow moving FPSO involves separation of the ore from the seabed material using screening and magnetic processes, and does not involve the discharge of any chemicals.*

Missing from the 'Processing' paragraph above was the discharge of concentrated levels of metals (significantly copper) into the water column.

There are a number of concerns about the concentrated metal discharges into the water plume which need addressing if **section 59(2) (c) of the EEZ Act** is to be met

1. Copper exceeds guideline levels for protection of 80% of species. *(Results from AUT testing – commissioned by TTR)*

2. The Report on the metals, contains an 'assumption' on dilution. There are no scientific reports deciding whether these assumptions are valid (dilution is important as it can decrease the concentration of the metals to acceptable levels.)

3. Aquatic life can be attracted to the hull of the ship, which is where the concentrated levels of metals get discharged.

4. There is an interaction of metal concentrations and the sediment in the plume – but there have been no reports on this.

5. TTR have not communicated the copper concentration issue to a number of interested parties, as at the time of their public notification.

6. EPA Public Notification does not mention discharges contain metals.

7. TTR provided the sediment samples for chemical analysis. As the analysis of this sediment is fundamental to the plume modelling, there would be a greater degree of objectivity – if NIWA had obtained the samples.

COPPER:

The following results are as stated on page 4 AUT Client Report 'Iron sand extraction in South Taranaki Bight: effects on seawater trace metal concentrations

COPPER

- *Concentrations in elutriates of medium and fine sand (second and third grind)* ***exceeded the ANZECC & ARMCANZ trigger values for the protection of 80% of the species).***

- *Concentrations of as-received and coarse (first grind) iron sand* ***exceeded the ANZECC & ARMCANZ trigger values for the protection of 99% and 95% of the species.***

ZINC

- *Concentrations in elutriates exceeded the ANZECC & ARMCANZ trigger values for the protection of 99% of the species, in 3 of 20 samples (page 4 of AUT Report)*

NICKEL

- *Concentrations in elutriates did not exceed water quality trigger concentrations for the protection of 95% of the species.*

Important points of note:

1. AUT recommends a precautionary approach is taken to routinely monitor seawater concentrations of copper and other trace metals in the vicinity of the beneficiation plants to ensure compliance with ANZECC & ARMCANZ guidelines.

2. "The proposed mining operation involves two activities that may result in the release of contaminants into the water column" *(page 5 AUT Client Report 'Iron sand extraction in South Taranaki Bight: effects on seawater trace metal concentrations)*

3. "magnetic separation and milling not only increases the acid extractable concentrations of copper and zinc but also the concentrations of these metals in seawater suspensions of the resulting iron sand concentrate" (*Page 26 AUT Client Report)*

4. This Project's processing results in "two orders of magnitude higher concentrations of zinc and copper than the extracts of unprocessed sediment." (*Page 26 AUT Client Report)*

5. Copper is highly toxic to most aquatic species, the main cause is through rapid binding of copper to the gill membranes, which causes damage and interferes with osmoregulatory processes. *(US Environmental Protection Agency, Copper facts, June 2008)*

6. Copper is very toxic to algae. *(US Environmental Protection Agency, Copper facts, June 2008)*

Robust scientific analysis needs to be done to calculate the spatial distribution of metal concentrations, especially copper and nickel. The potential for a permanent zone of elevated copper around the FPSO needs determining and the ecological outfall from this also needs some determination.

The SKM Report, 'Oceanographic Processes and the Physical Environment' noted in the 'discussion' section point 27 and point 28 the trace metal concentrations and the possibility for benthic organisms near the mine site to undergo long term exposures to copper concentrations above ANZECC/ARMCANZ trigger values.

Recommendation: That the comprehensive methodology in the Maritime document noted below should be followed

http://www.maritimenz.govt.nz/Rules/Rule-documents/Part180-Advisory-circular-1999.pdf

Important extracts from this document to indicate issues:

The characterisation of waste and its constituents must include:
- *origin, total amount, form, and average composition*
- *properties: physical, chemical, biochemical and biological*
- *toxicity*
- *persistence: physical, chemical, and biological*
- *potential for accumulation and biotransformation in biological materials or sediments.*

This requirement for characterisation of the waste is contained in:
- *paragraphs 7 and 8 of the WAF Annex (refer to Annex 2 in Part 3); and*
- *clause 2 of Part 1 of Schedule 3 to the Resource Management (Marine Pollution) Regulations 1998.*

1. *This section outlines a four level procedure for waste characterisation. This procedure is consistent with international best practice.*

A level 2 investigation requires a comprehensive physical and chemical characterisation based on samples of the waste concerned. The aim of such an investigation is to identify any contaminants of concern if data from the level 1 investigation are insufficient.

2. *The susceptibility of the waste to physical, chemical and biochemical changes, and to interaction with other dissolved organic and inorganic materials in the marine environment should also be considered in a level 2 investigation.*

Table 5 in Part 2 of these guidelines lists chemical parameters for which (interim) sediment toxicity data exist. This action list specifies an upper and a lower level. The upper (ER-M) level is set to avoid both acute and chronic effects on sensitive marine organisms representative of the marine ecosystem. The lower (ER-L) level represents a minimal effects range, a range intended to estimate conditions in which effects would be rarely observed. The theory behind the use of the action list is outlined in section 5.0 of these guidelines (below).

3. *Generally, if the mean concentrations for all substances detected in waste are found at levels below the ER-L in Table 5, then the material is determined to be suitable for unconfined ocean dumping and does not require further testing. However, if there is significant variability between samples and at least one is above ER-M, additional sampling and testing may be required in order to establish whether there are significant "hot spots."*

The elutriate test simulates the release of contaminants from a waste during and after disposal. Release can occur by physical processes (e.g. directly from sediment pore water) or by a variety of chemical changes (e.g. the oxidation of metal sulphides and the release of contaminants adsorbed to particles or organic matter).
It is essential that fully representative samples are used for elutriate testing. For dredged material, at least one sample should be collected from each area within a dredging project and where there are significant separate dredging units ("chunks" of sediment with broadly similar physical and chemical characteristics), individual tests should be carried out on each. Sample collection and handling requirements are presented in Table 3 in Part 2 of these guidelines.

4. *The results of elutriate testing are to be compared to the ANZECC marine water quality criteria (or other appropriate criteria such as USEPA or as specified in a regional coastal plan) after the application of an appropriate dilution factor to be determined using the methods noted in Part 2 of these guidelines. If the elutriate test results exceed the relevant criteria after initial dilution, the material should be further tested (toxicity to water and benthic organisms) or an appropriate mixing zone agreed with the issuing authority.*

The AUT Report (page 28) states "Assuming that STB seawater contains 0.25ppb copper a **160-fold** dilution would decrease the highest average copper concentration measured to below the concentration for the protection of 99% of the species".

The TTR Open Day poster states an **85-fold** dilution would decrease the highest measured average copper concentration to below the **ANZEC 99% guideline** of **0.3ppb**.

The Open Day details states a copper concentration of up to 8.1ppb was determined in elutriate from processed ore. In practice the 1:1 mixing with process water prior to discharge, results in a **discharge concentration of 4ppb.**

There have been no independent scientific reports on the biological impact of concentrated levels of copper

The Impact Assessment states: There have been no studies on the 'rapid initial mixing'. The impact of the sediment plume, on metal distribution also needs consideration. The congregation of marine line under the hull of the boats, and in close proximity to the 'de-watering' process, which occurs approximately 2 metres under the hull of the boat also needs review.

The TTR Impact Assessment states that the ships will provide a potentially significant aggregation habitat for pelagic fish. The combination of the navigational safety buffer zone and the presence of the hull may act as a de-facto marine reserve.

The TTR commissioned Report from NIWA *on the 'Effects of ships lights on fish, squid and seabirds' states in the Executive Summary, page 5, "For fish and squid, any effects of the iron sand extraction vessel as a source of artificial nocturnal light are* ***likely to be very localised and centred on the vessel*** *itself: some species of both groups could* ***potentially aggregate in the water column close to the vessel"***

There does not appear to have been much transparency with the community or interested parties, about the concentrated levels of copper exceeding guidelines.

Stakeholder Engagement/Interested Parties – lack of transparency
TRC: I rang the Taranaki Regional Council (TRC) and talked with the Environmental Manager, Gary Bedford. I asked if the TRC were going to be putting in a submission, despite the fact that the EEZ is outside the jurisdiction of the TRC. He did not know whether they were or not.

I asked Mr Bedford if he was aware of the copper issue and he said he wasn't, but that he would raise the matter immediately with his marine biologist.

Ministry of Fisheries: I rang the Ministry of Fisheries, who said they were unlikely to put in a submission, but I was referred to Nelson Fisheries as they are the ones affected by the proposed Project.

Nelson Fisheries: When I talked with Nelson Fisheries they were unaware of the copper issue.

Patea Fishing Club members: The members I talked to were unaware of the Copper issue.

The impact of the highly elevated levels of SSC with concentrated metals, needs evaluating

Suspended Particulate Matter - SPM is also ***important for transporting many contaminants (e.g. heavy metals, nutrients, toxic organic compounds) through aquatic systems; these contaminants are strongly associated with the suspended particulate*** *and colloidal matter (Hart et al. 1997).*

The fishing community have identified independent monitoring as being of importance

One of the **areas of concern raised in TTR discussions with Recreational Fishermen** was monitoring. A **CONDITION** attached to any permit, must be some independent audit of concentrated metal emissions. The audit must be frequent and have clear reporting responsibilities to interested parties.

Impact Assessment Executive Summary extract, page (iv) **Other discharges**
TTR will monitor dissolved concentrations of copper and other trace metals in the beneficiation plant discharge to verify compliance with ANZECC & ARMCANZ guidelines.

EPA public notification does not mention expressly that the discharges contain concentrated metals.

I believe in terms of public interest the Public Notification needed to have expressly mentioned the metals. Instead the third paragraph of the consent states 'other discharges including, *but not limited to*, brine, fine sediment and freshwater associated with the proposal with also be considered as part of the marine consent application.'

I e-mailed this concern to the EPA on 21 November and also on the 4 December 2013. The EPA response on 6th December acknowledged my comment and suggested I include my thoughts in a submission to the EPA

If the consent goes ahead, one condition would be the use of suitable indicators and guidelines for monitoring purposes. The Impact Assessment, Draft Environmental Monitoring Plan would not meet many of the guidelines listed below.

Any assessment of actual or potential environmental degradation will only be as effective as the indicators chosen to assess it (Cairns et al. 1993).

The indicators need to be:
1 anticipatory: should occur at levels of organisation, either biological or physical, that provide an indication of degradation, or some form of adverse effect, before important 'serious' environmental harm has occurred;

2 sensitive: in detecting potential important impacts prior to them occurring, an early warning indicator should be sensitive to low levels, or early stages of exposure to the stressor;

3 diagnostic: should be sufficiently specific to a stressor, or group of stressors, to increase confidence in identifying the cause of an effect;

4 broadly applicable: alternatively, an early warning indicator should predict potential impacts from a broad range of stressors;

5 correlated to actual environmental effects: knowledge that continued exposure to the stressor, and hence continued manifestation of the response, would eventually lead to important environmental effects is important;

6 timely and cost-effective: should provide information quickly enough to initiate effective management action prior to important environmental impacts occurring, and be inexpensive to measure while providing the maximum amount of information per unit effort;

7 regionally and socially relevant: should be relevant to the ecosystem being assessed, and of obvious value to, and observable by stakeholders, or predictive of a measure that is;

8 easy to measure: should be able to be measured using a standard procedure with known reliability and low measurement error;

9 constant in space and time: should be capable of detecting small changes, and clearly distinguishing that a response is caused by some anthropogenic source, not by natural factors as part of the natural background (i.e. high signal : noise ratio);

10 non-destructive: measurement of the indicator should be non-destructive to the ecosystem being assessed.

Some challenges whilst trying to determine relevant indicators are:

- Biological indicators are not as well advanced for marine as for freshwater. This is primarily because **ecological understanding of the processes and the structure of marine and estuarine ecosystems is not as well advanced.**

- **In marine ecosystems, there are no species or groups of species that can be universally identified as the central ecosystem component (the 'keystone' species) and so there is no simple way of choosing a representative taxon to use as a bio indicator.**

- Biomarkers have been equally applied worldwide in both freshwater and marine ecosystems.
  Molecular biomarkers are characteristic signatures of pollution expressed in enzymes, cell constituents, or metabolism products within organs of animals and plants. Organisms respond to stress by invoking molecular responses, and these can be then expressed as physiological or other changes. The molecular responses to pollution stress are likely to be the earliest form of organism response, and potentially should be capable of being used as an early warning indicator of changes induced by pollution. **Of course, changes at the molecular level in an organism may not necessarily reduce its ecological fitness.**

Interpretation of ANZECC & ARMCANZ guidelines.

The guideline values derived for toxicants are not the simple pass/fail levels provided in the previous guidelines for use across Australia or New Zealand.

Instead they are regarded as **trigger values which, if exceeded, may initiate the decision-tree** process that can allow a guideline value to be assessed and tailored for the environmental conditions of a specific locality or region.

Contaminants such as toxicants and salinity are not assimilated by aquatic ecosystems, but may be tolerated if they are below certain concentrations (ANZECC 1992). **Protection of aquatic ecosystems from toxic substances, which act according to their bioavailable concentration in solution, is therefore best achieved by adapting water quality guidelines based on aquatic toxicological studies (trigger values) to local conditions.**

Bioaccumulation:
In terms of the NZ ANZECC & ARMCANZ guidelines - **The 99% protection level is recommended for those chemicals that have a tendency to bio accumulate (Section 8.3.3.4) and in a few cases where important species were not protected at the 95% level (Section 8.3.4.4).**

Bioaccumulation of metals

- *For many organisms the key determinants that influence metal accumulation are the relative amounts of metal present in the environment, together with their chemical form. Metal accumulation in biota can occur either by direct uptake from the surroundings across the body wall or respiratory surfaces, or via food. In aquatic organisms, it has generally been assumed that the predominant route of uptake of metals is via passive diffusion across the body surface, gills or lungs or by active transport via calcium pumps. The bio concentration factor (BCF), i.e. the degree of enhancement of metal in the organism relative to its environment, is defined as: µg/g trace metal in water*

- *The BCF is calculated for whole animals or individual tissues on a dry or wet weight basis. For trace metals, this model has been applied to **suspension-feeding bivalves, particularly mussels and oysters, together with phytoplankton, zooplankton and crustaceans.***

- *Application of BCFs assumes that the metal concentrations in the organisms are at steady rate with concentrations in the environment and that **uptake of the metal is proportional to its concentration in water.** However, numerous factors affect BCFs, including water chemistry (salinity, dissolved organic matter), biological factors (organism size, reproductive stage) and the ability of organisms to regulate metal levels.*

- *Teleosts in the sea maintain their water balance by drinking seawater and excreting Na+ and Cl- across the gills. This **represents a source of dissolved toxicants additional to food and absorption across the gills**.*

- *Most of our information on heavy metal concentrations in aquatic organisms comes from studies with **fish, molluscs and crustaceans, particularly edible species due to concerns about metal transfer to humans through ingestion of seafood (Furness & Rainbow 1990)**. However, data on bioaccumulation of metals in polychaete worms, coelenterates, echinoderms and algae have also been published (Hellawell 1986, Depledge et al. 1993).*

- ***Overview of major research — New Zealand***
  The National Institute for Water and Atmospheric Research (NIWA) in Hamilton, New Zealand, has developed a suite of standardised toxicity testing procedures on behalf of the Ministry for the Environment (Hall & Golding 1998). While the previously discussed benefits of standardised DTA procedures were a major factor in New Zealand opting for the development of such protocols, the country's relatively small geographical size also lends itself to the use of standardised, rather than site-specific procedures (M Nipper pers. comm.).

  It is likely that fewer habitat types will be represented than, for example, in Australia, and that standard test organisms can be identified which will occupy a significant proportion of aquatic habitats throughout the country.
  The NIWA program has developed standardised toxicity test methods for a freshwater alga (Selenastrum capricornutum; short term, chronic growth inhibition), a freshwater amphipod (Paracalliope fluviatilis; acute lethality), a freshwater cladoceran (Ceriodaphnia dubia), a freshwater fish (Gobiomorphus cotidianus; acute lethality), a marine alga (Dunaliella tertiolecta; short term, chronic growth inhibition) a marine echinoid, or sand dollar (Fellaster zelandiae; short term, chronic embryo development), and a marine fish Rhombosolea plebeia; acute lethality) (Hall & Golding 1998).

Copper

Copper is found at low concentrations in most marine, estuarine and fresh waters (table 8.3.2). Copper is an essential trace element required by most aquatic organisms but toxic concentrations are not much higher than those that allow optimum growth of algae.

Cairns et al. (1978) noted that copper stimulated growth of Scenedesmus quadricauda and Chlamydomonas sp. at near lethal concentration. It is generally assumed that the free hydrated copper ion (Cu2+) together with copper hydroxy species are the most toxic inorganic species to aquatic organisms.

*Copper is readily accumulated by plants and animals; bio concentration factors ranging from **100 to 26 000** have been recorded for various species of phytoplankton, zooplankton, macrophytes, macroinvertebrates and fish (Spear & Pierce 1979). Toxic effects of metals occur when the rate of uptake exceeds the rates of physiological or biochemical detoxification and excretion (Rainbow 1996). This is more important than absolute body burden. Jarvinen and Ankley (1999) report data on tissue residues and effects for copper for 14 freshwater species and 9 marine species. It is not possible to summarise the data here but readers are referred to that publication for more information. Ahsanullah and Williams (1991) reported that the marine amphipod Allorchestes compressa exposed to 10 µg/L of copper for 28 days accumulated 100 mg/kg of copper and experienced reduced growth.*

Marine guideline
Screened data consisted of 70 data points from 5 taxonomic groups, as follows (expressed as geometric means of NOEC equivalents; pH data were not recorded):

Fish: 6 spp, 30 □g/L (2 spp, from 12–14 d EC50, hatch & mortality) to 260 □g/L (Menidia menidia, 11-d EC50, hatch)

Crustaceans: 3 spp, 1.7 µg/L (Callianassa australiensis, from 10–14 d EC50 of 8.5 □g/L) to 42 □g/L (Mysidiopsis bahia, from 29–51 d MATC, reproduction)

Molluscs: 7 spp, 0.4 □g/L (Mytilus edulis, from 30-d EC50, reproduction of 2 □g/L) to 20 000 □g/L (Ostrea edulis, 5-d LC50)

Annelids: 3 spp, 17 □g/L to 68 □g/L (from 14–28 d LC50)

Algae: 6 spp, 2 □g/L (Enteromorpha sp, from 5-d LC50) to 1000 □g/L; 5 species had some end-points with means <25 □g/L

A marine high reliability trigger value for copper of 1.3 µg/L was derived using the statistical distribution method with 95% protection. This figure is above the converted NOEC for Mytilus edulis but below the experimental EC50 (2 □g/L) and is considered appropriate for slightly-moderately disturbed systems.

SUBMISSION ON BENTHIC ECOLOGY 6.10, 12

LIST OF LIMITATIONS CONTAINED WITHIN THE IMPACT ASSESS

Based on my review of the Reports and the limitations contained within them, I do not believe the TTR Risk Assessment is valid. Further research needs to be taken, before any kind of accurate risk assessment can be made. This viewpoint is supported by SKM's reviews of the benthic reports.

WE KNOW LITTLE ABOUT THE EUCHONE WORM

NIWA states little is known about the Euchone Worm larval connectivity

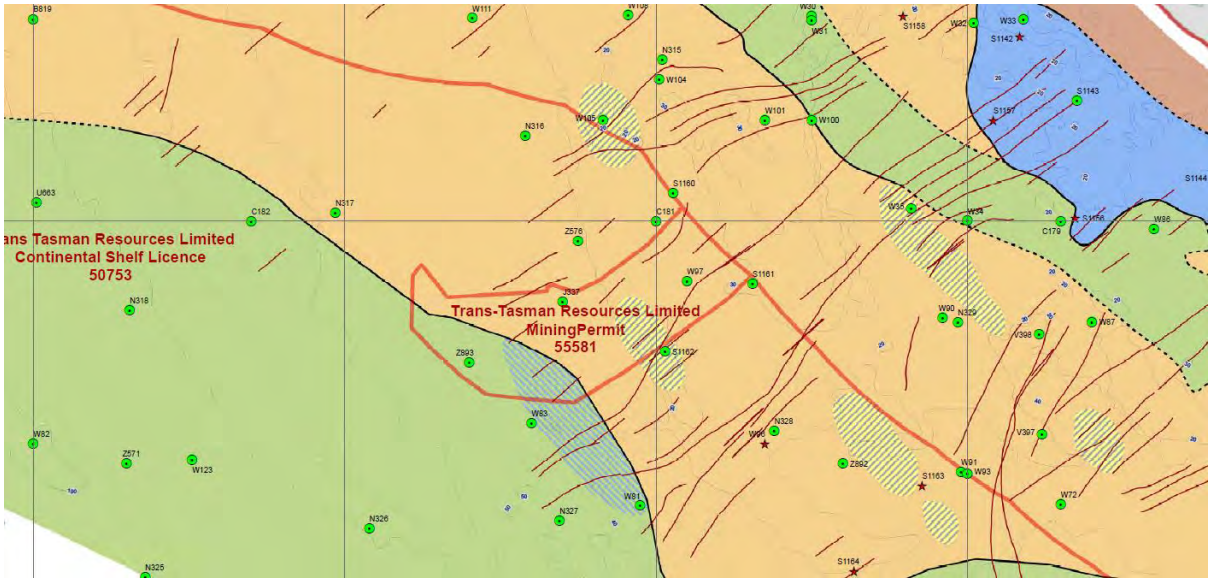
The NIWA Risk Assessment for the Ministry of the Environment states: " **So little is known about larval connectivity in these populations that the optimal size or placement of these mining patterns is unknown."**

Unstable sediments may result in the Euchone worm unable to reach maturity

A recent study in 2005 suggests that if there are unstable sediments in a dredged site, animals may be unable to reach maturity. In this study, even after six years the species were not able to meet maturity. Certainly the TTR project site could be regarded as unstable as there will be a seabed which has slumped by a metre, with approximately 9 metre high piles and 10 metre pits, and a severe level of sediment plume consistently in the area.
Boyd, S. E., Limpenny, D. S., Rees, H. L., and Cooper, K. M. 2005. *ICES Journal of Marine Science, 62: 145e162.*

One really important point made in this research is to do with **particle size, and its critical role in providing a suitable habitat for species. Sites with sediments containing a higher gravel content typically support a richer assemblage than sandy substrata.** Returned sand from dredging will not have the broken shells that are currently found on the seafloor at the site. Page 127 of the Benthic Patea Shoals Report gives the **Project site seabed description as containing shell-hash, coquina, gastropod shells, and gravels/pebbles.**
Page 21 of the Geological Desktop Summary describes the inner and mid-shelf shoals as **predominantly gravel sands, rich in shell material**, with the Rolling Ground and Patea Bank comprising >50% carbonate. Graham Bank is a coarser grained, carbonate-rich (>50%) sandy gravel.

The orange area in the extract below is '**reflective gravelly sand rich in shell material**.
The green area is gravelly mud 1-3m high.
The green striped areas are dunes 3-12m high



Extract from Geological Desktop Survey, Appendix C
http://www.epa.govt.nz/Publications/TTR_Geological_Summary_Appendix_C.pdf

The existing patch sediment type has been described by NIWA's Report (page 14) 'Benthic flora and fauna of the Patea Shoals as "dynamic high energy benthic environments dominated by sand rippled and mega-rippled iron rich bedforms, comprising **coarse grained sands that are largely devoid of mud**. The sediment from the plume, is largely of mud origin – due to the depths of mining.

The TTR comment that there will be ongoing opportunity for recovery is unlikely to hold true when the factors such as turbulence, lack of light & changed particle size is considered

As the elevated levels of sediment will be continuously in the mined area, I do not know that the following comment by TTR holds: *TTR's anticipated excavation rate means that the extraction and deposition impact at each site will be of very short duration, meaning that there will be ongoing opportunity for recovery on a continuous basis throughout the year.*

The TTR comment that the operation will affect a small area of the seabed at any one time is misleading – fine sediment impacts and changes to particle sizing on the seabed cover many kilometres of area

The comment contained within the Impact Assessment is misleading, as a mining area of 6.05 km² has been used for sediment plume modelling purposes (page 33 Sediment Plume Modelling Report) which equates to an 11 life project life. *"TTR's operations will affect a relatively small area of the seabed within the STB at any one time. On an annual basis TTR's extraction operations will disturb around 5% of the extraction area or 3.3 km2 (assuming a 20 year project life). This equates to less than 0.1% of the area of the STB."*

SKM noted in their review of reports on the Benthic Ecology that there is an inability for TTR to make an ecological risk assessment as the benthic studies fail to address how the changes in the environment will impact on the sensitivities/thresholds of benthic organisms.

The statement made in the Impact Assessment has no validity without much further research. *"The TTR operation is not considered to present any issues in respect of protection of biological diversity in*

the broader STB area notwithstanding localised effects in the extraction and immediate deposition areas."

THE **'RE-COLONISATION EXPERIMENT'** FAILED TO TEST FOR ONE OF THE MOST IMPORTANT ASPECTS – PARTICLE SIZE

I do not believe the experiment tested the important factors that determine the ability of the Euchone worm to re-colonise.

Particle size is one of the most important factors for ensuring colonisation of the Euchone. This was not tested in the re-colonisation study. The significance of particle size was however discovered in the research done.

*"Small differences in **sediment properties** had a **larger influence** on community structure than iron concentration".*

There was a limitation to the study, as due to exposure of the PPA and likelihood of storm disruption (which would replace the experimental sand) the re-colonisation experiment was done at two places within Wellington Harbour (Mahanga Bay & Evans Bay). Each core was analysed for benthic community, particle size, and concentration of iron. An important finding from the experiment, that was not followed up by further research was: "Small differences in **sediment properties** had a **larger influence** on community structure than iron concentration".

The results of the re-colonisation study were obtained after seven months – whether this captures important life cycles of the worm is unknown.

The results from the experiment were after seven months.

Oxygen availability to the worms are likely to be reduced in the Project site due to slumping of the site and other changes to the seabed

There has been no scientific analysis done on the impact of the 'slump' of one meter in the extracted site. It has been mentioned that the water patterns will change as a result of pits, piles and the slump and this could affect oxygen availability

Light at the Project site reduces from 20-25m to 5m due to sediment in the water – photosynthetic organisms will not receive sufficient light

No research has been done on the extremely limited light, due to elevated sediment plumes, and the effect that will have on re-colonisation. Page 55 of the Optical Effects Report:
*In contrast, around the mining site, **zeu is substantially reduced to about 5 m, from about 20-25 m (Figure 3-12).** Under natural conditions there appears to be sufficient light reaching the benthic environment to support photosynthetic organisms, **which would not receive sufficient light during mining operations.** Primary production in the water column in this region is likely to be impacted by mining activity increasing SSC in the upper water column and hence **reducing light availability**.*

LIMITATIONS WITH THE BENTHIC ANALYSIS THAT WAS PERFORMED BY NIWA

VIDEO FOOTAGE – COASTCAM 144 sites.
HAPS-CORING SAMPLES 103 sites (331 samples)
DREDGE SAMPLES 116 sites 27,714 specimens, 457 species

1. Sand movement covers trail activity, so 'life' can be under-represented

   Lebensspuren activity (trails, burrows, mounds) were recorded as presence. However page 27 Patea Shoals Report, says mobile sediments are likely to cover animals activities such as trails and burrows very quickly e.g. scallop lebensspuren divots, were only observed in the stable sediments within the wormfields.

2. DISTLM analysis to find key driver, placed emphasis on iron – which as research conducted by NIWA showed – is not an important ecological driver

   DISTLM analyses was used to identify key drivers in community structure *particularly with respect to the influence of iron.* The model runs sequentially and **so the order in which the variables are tested is important.** Order was: depth, silt, clay, distance from shore, fine gravel, medium sand, iron, coarse sand, medium gravel/shell, time, fine sand, very fine sand.

3. The 'multi-variate' analysis only considered sandy sites, despite the most diverse ecology linked to rocky environments.

   Only sandy sites, within similar depth ranges of the PPA for which environmental data was available (from sediment core data) were included in the multivariate analysis.

4. There was a seasonal bias for the core sampling – towards spring

   22 September to 2 December.

5. Sampling was difficult in hard ground habitats – which tend to be ecologically important

   6 sites failed to return any samples due to hard ground habitats e.g. bryozoan and bivalve habitats) – so relied on video (these were further out sites). 14 core samples returned only a partial sample (< 5cm), where there was bedrock, gravel,

6. The 'macro-fauna' only went to a taxonomic specialist and only the top 5cm had meio-fauna sorted.

   Patea Shoals Report, pages 21 and 22, show that meiofauna (<0.5mm in size) was only sampled from the top 5cm. **Macrofauna (>500 µm)** are amphipods, copepods, polychaetes, bryozoans, molluscs, algae etc. and the **Meiofuana (63-500 µm)** are the nemotodes, copepods, ostracods, small polychaetes, and other annelid worms, cumaceans etc.

7. The 'life' less than 63µm was discarded.

8. There was an emphasis on the top 5cm of the core. Which means 14% of the sample was analysed to a lesser degree.
   88% of organisms were recorded in the top 5cm of sediment and so this was analysed to a greater extent than deeper core sections.

'SENSITIVE' SPECIES that might be in **Project Area**

The Ministry for the Environment has identified the following as **'sensitive'** and will need conditions to manage the environmental effects of permitted activities in the EEZ that occur is such sensitive marine benthic habitats. Some of them are:

- **beds of large bivalve molluscs**
- **brachiopod beds**
- **bryozoan beds**
- **calcareous tube worm thickets**
- **chaetopteridae worm fields**
- **macro-algal beds**
- **maerl beds**
- **sponge gardens**
- **sissile protozoan bed**s

Project area is not insignificant in terms of biodiversity compared to other areas sampled by NIWA

The results below are a subset of data I have obtained from the NIWA report, selected by 'sensitive species' **to show the bio-diversity in the project area, in comparison to other areas,** such as the inner shelf, or mid-north area. The Project Area is certainly not insignificant in terms of its biodiversity compared to other areas.

To understand the significance of the organism and the role it plays within the ecology, I have attached some background information.

Significant gap in NIWA sampling of rocky area so 'sensitive organisms' in those habitats unknown

A significant gap in knowledge, is the fact that the Graham Bank, North & South Bank and other rocky outcrops in the coastline by the Project, have **NOT BEEN SAMPLED so we do not know the bio-diversity in those areas and more importantly the degree to which they contain 'sensitive organisms'.**

Baseline Environmental Report highlights interesting bryozoan and algal groups

The 'Baseline Environmental Report' mentions the lack of data, but also mention that these areas are **biologically significant due to the provison of habitat for encrusting and sessile fauna.** The Baseline Report highlights some potentially **interesting community compositions within the bryozoan and algal taxonomic groups**.

Again this **highlights the importance of SAMPLING these rocky areas.**

Background to Bivalve mollusc beds –

- They create **biogenic structure** in what may otherwise be a featureless habitat. Their shelves, live and dead, provide a substrate for settlement by organisms such as sponges and bryozoans and shelter for invertebrates and fishes. Bivalves (those that live in, and those that live out of sand) add complexity to soft sediment habitats by altering flow conditions and providing hard surfaces on which other flora and fauna can grow. For example a 2012 study showed infaunal beds of the dog cockle had taxon richness and abundance 25% higher than in adjacent gravel beds without them.

CORE RESULTS MOLLUSCA

Page 148 & 149 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'

Mean densities per 1m²

Type	Abund	Species	Inner shelf	mid north	**PPA**	midsouth
Bivalvia	18	Paphies australis	3.52	1.19	**10.55**	2.78
Bivalvia	57	Psammobiidae spp	7.05	10.74	**17.15**	15.32
Bivalvia	143	Glycymeris modesta	39.94	23.87	**18.47**	46.64
Bivalvia	355	Scalpomactra scalpellum	45.82	319.85	**26.38**	16.71
Bivalvia	5	Juvenille bivalve sp1	1.17	0	**2.64**	1.39
Bivalvia	3	Diplondonta	1.17	0	**1.32**	0.70
Bivalvia	2	Irus sp*	0	0	**2.64**	0
Bivalvia	2	Limidae sp2	0	1.19	**1.32**	0

*the only other bivalvia irus sp found in the core samples.

Core result comment: The project site has 2 species of bivalves found in greater numbers than other areas and juvenile bivalve numbers greater than other areas. The Bivalve Irus sp was only found in the Project area for core results.

DREDGE RESULTS MOLLUSCA

Page 146 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'

Mean densities per 250m²

Type	Abund	Species	Inner shelf	mid north	**PPA**	midsouth
Bivalvia	1625	Glycymeris modesta	**70.669**	2.789	0.737	6.059
Bivalvia	58	Pecten novaezelandiae	0.053	0.263	**0.211**	0.735

LIMITATION: To determine if there is a 'bed of bi-valves' one can consider page 13 of 'Sensitive marine benthic habitats defined' NIWA Report. A bed of bi-valves to be described as contributing 30% or more by weight or volume to the catch ion a single grab sample or dredge tow. I do not believe this kind of analysis has been done.

Note: The emphasis in the NIWA Report tends to be on dredge results, rather than core samples.
Scalpomactra = abundance of 355
Glycymeris = abundance of 1625 (dog cockle)

Background to Brachiopods (lamp shells) beds.

- They look like clams, but their anatomy is very different and they are not like a mollusc. Brachiopods are small (5-50mm) symmetrical filter feeders. They are generally anchored to a hard substrate such as rock, gravel, or shell debris by a muscular stalk. The dead shells contribute to habitat complexity. They are usually found in areas **free of fine sediment**.

- Page 37 of NIWA Report 'Benthic Flora and Fauna of the Patea Shoals Region STB' Table 4 This table shows that **Brachiopods have a negative correlation with silt and coarse sand.**

- *Reference: 'Sensitive marine benthic habitats defined' NIWA Report April 2013 – prepared for the Ministry for the Environment.*
- **Page 16: Unlikely to be successfully sampled using cores or grabs**. A bed can be considered to be present if one or more species occur in successive samples using point sampling gear. Rock dredges form areas of hard bottom will generally retain brachiopods. If the catch equals or exceeds 1 live brachiopod per m^2, then a bed can be considered to be present.

- **Sea imaging should not be used**, to determine their occurrence/absence, because they may be difficult to distinguish because of their small size and overgrowth of other organisms.

- Other indicators of localities are hard bottom areas, **free of fine sediment.**

Lack of data sampling of the habitats for Brachiopods means a significant lack of understanding as to population that could be affected by elevated SSC.

More research needs to be conducted for brachiopods in the rocky sites, especially when it is known they are susceptible to SSC.

Background to Bryozoans

The Dredge recorded: 14,680 live bryozoan colonies & 161 species

- **Bryozoas are suspension feeding organisms,** which may live as a few, or in groups of millions, and can live on the seabed or on algae, sea grass and animals. The sub-millimetre sized individuals that comprise a colony are called zooids. They are known as 'frame builders' and can provide habitat for other organisms such as sponges, bivalve molluscs, and mobile organisms. The bryozoan habitat is fragile and vulnerable to disturbance.

- The habitat complexity of bryozoans range from micro-organisms to mega-fauna.

- The surface area bryozoans provide can be very large, so the surface area of the habitat increases. So bryozoan habitat is thought to be important for generating and maintaining the biodiversity of an area.

- LIMITATIONS: Towed gear such as a dredge, makes it difficult to obtain robust estimates of colony density you need multiple cores taken over the study area to determine the extent of any thicket.

- There are two marine classes of bryozoan – the Stenolaemata and the Gymnolaemata.
- The Stenolaemata is a stationary suspension feeder, with strongly calcified walls. The Stenolamata has tube like zooecia. The Gymnolaemata is the most varied class and has box-shaped zooecia.
- Most colonies are attached to hard material such as rocks, shells or sediment grains. They can adhere to seaweeds and algal fronds. The majority of bryozoan habitats are found in areas of low sedimentation.

- Page 43: Patea Shoals Report: The mollusc fraction is important in providing islands of hard substrata upon which the larvae of the large habitat-forming bryozoan and many encrusting species can settle. The area to the east of the study contains large numbers of bryozoan, as well as the deeper sites.
- Due to the susceptibility of this species to sediment – it is important that the plume modelling is 'accurate'. Page 43: Patea Shoals Report - Bryozoa rely on a constant supply of water passing across their feeding appendages to feed, grow and reproduce.

- The Baseline Environmental Report mentions that bryozoa species richness is higher than average between Hawera and Wanganui (page 116)

(A) *DREDGE RESULTS BRYOZOAS, 'Page 137 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'* **Mean densities per 250m²**

Type	Species	Inner shelf	mid north	**PPA**	midsouth	Offshore
Stenolaemata	Tubulipora sp epizpoic	0.158	41.362	**22.368**	4.706	1.192
Stenolaemata	Disporella novaeholland	0.158	4.947	**3.368**	0.676	0.519
Gymnolaemata	Galeopsis porcellanicus	0.053	0.158	**0.263**	0	4.102
Gymnolaemata	Fenestrulina incompta *	0	0	**0.105**	0	0
Gymnolaemata	Aetea australis	0	0	**0.105**	0	0.077

*Proposed Project Area is the only area sampled to have this species

Dredge result comment: the Project Area had the only dredge sample of a *Gymnolaemata Fenestrulina incompta* and significant numbers of stenolaemata tubulipora, along with the midnorth, compared to other regions

(B) *CORE RESULTS, BRYOZOAS: 'Page 142 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'* **mean density per 1m²**

Type	Species	Inner shelf	mid north	**PPA**	midsouth	Offshore
Gymnolaemata	otionellina	9.40	20.29	**18.47**	3.47	0

Core result comment: The Project Area has, along with the midnorth, has significantly more *Gymnolaemata otionellina* than other areas. The species is vulnerable to sedimentation.

Background: Calcareous tube worm thickets or mounds

- NZ has a number of tube worm species (in family Serpulidae) that secrete tubes of calcium carbonate. They are common in coastal waters. Settlement and growth of tubes allows mounds or patch reefs to grow. Densities range from scattered individuals to three dimensional mounds.

- The range is from the Taranaki coast down to Stewart Island.

- They usually require some **hard structure on which to initially establish, including dead shell in the case of soft sediment systems** (page 21 'Sensitive Marine benthic habitats defined' NIWA)

- "Calcareous tube worm mounds are likely to be rare in NZ's EEZ'. A mound can be considered to be present is a core or grab shows two or more intertwined specimens of a species. (Dredges are likely to break apart individual tubes). If 10% of the catch comprise tube worm species it can be considered to be a thicket.

- Worm mounds will be readily apparent as raised reef like structure in seabed imaging (<0.5m)

- Overseas work have shown that even 'low relief' tube-worm beds can be correlated with increases in fish densities (Stoner 2005).

- In NZ **virtually nothing is known about the potential role of tube-worms** in forming biogenic habitat for other species (page 23 NIWA Report on 'Sensitive marine benthic habitats').

- On the Continental Shelf off Oamuru worm fields were associated with a **muddy-sand and broken bryozoan bottom. Samples collected suggested sponges may be growing over the worm tubes**, which may act as surfaces upon which sponges may grow.

- Page 25 NIWA Report on 'Sensitive marine benthic habitats'- this page photographically shows the high diversity associated with a small patch.

Euchone sp A was identified as a new species and the Project site had the largest density

NEW RECORDS Page 43: Patea Shoals Report:

Cinctipora elegans (Wanganui was the northernmost range before)	found in offshore region
Schizomavella aoteroa (first record outside of the Milford Sound)	found in offshore region
Parasmittina livingstonei(first record outside of Three Kings locality)	found in innershelf region
Buffonellodes globosa	found in midsouth region

NEW SPECIES Page 43: Patea Shoals Report:

Smittoidea n. sp.	Found in offshore region

HIGH NUMBER of dog cockle at innershelf

High numbers of small dog cockle: Glycymeris modesta 1625 specimens	found in the innershelf

FIRST 'NOTE-WORTHY SPECIES' noted in Patea Shoals report: Lacydonia sp A – a new family record for NZ.

The specimens are large, living on or very near the sediment surface, or on shell debris are collected by dredges. The samples were collected offshore in dredges (10 specimens from 4 sites).

SECOND 'NOTE-WORTHY SPECIES' noted in Patea Shoals report: Euchone sp A – 4 specimens from 2 sites "a small undescribed euchone-like tubeworm".

Commentary is made "Due to the fact that the shallow benthic environments on the west coast of New Zealand have been very poorly studied, **it is unknown if newly recorded taxa from this study are unique to the Patea Shoals or STB region, or** occur over much larger areas along the west coast of New Zealand."

Of the Dredge data, 98% were Polychaeta (segmented worms)

(A) CORE RESULTS ANNELIDA & OTHER WORM SPECIES

Page 152-155 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'
Mean densities per 1m²

Type	Abd	Species	Inner shelf	mid north	**PPA**	midsouth
Polychaeta	1,438	Euchone sp A*	37.59	572.86	**1184.50**	18.80
Polychaeta	293	para sylid nd*	142.15	77.57	**46.17**	50.13
Polychaeta	230	Aricidea nd	18.80	101.44	**104.21**	20.89
Polychaeta	135	Pisiona oerstedii	21.15	25.06	**18.47**	52.91
Polychaeta	9	Maldanids	0	0	**7.91**	2.09
Polychaeta	4	Aglaophamus nd	1.17	0	**2.64**	0.70
Polychaeta	1	Armandia maculate**	0	0	**1.32**	0

* NEW SPECIES **ONLY FOUND IN THE PROJECT SITE

*The **Project area had two new species of Polychaeta found there, the Euchone sp A and the para sylid nd.** The Project area also had a **polychaeta armandia maculate**, which was not a new species, but **only found in the project area**.*

DREDGE RESULTS ANNELIDA

Page 151 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight Report'
Mean densities per 250m²

Type	Abd	Species	Inner shelf	mid north	**PPA**	midsouth
Nemertea	31	nemertea nd	0.105	0.684	**0.316**	0.088

(A) DREDGE RESULTS ECHINODERM **SPECIES densities per 250m²**

Page 161 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'

Type	Abd	Species	Inner shelf	mid north	**PPA**	**Mean** midsouth
Asteroid	6	Astropecten	0	0.105	0.053	0.088
Asteroid	2	Coscinasterias	0	0	0.105	0

The Project site was the only area to find the *Asteroid Coscinasterias* species of Echinoderm in the dredge samples, although the abundance was very slight.

(B) CORE RESULTS ECHINODERM ***SPECIES*** **Mean densities per 1m²**

Page 152 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight Report'

Type	Abd	Species	Inner shelf	mid north	**PPA**	midsouth
Ophiuroidea	3	Amphiura herladica	1.17	0	1.32	0
Ophiuroidea	2	Amphiura psilopora	0	0	1.32	0.70

The project site was the only area to find the *Ophiuroidea Amphiura herladica* and Ophiuroidea *Amphiura psilopora* Echinoderm species out of all the core results

Findings on Algae – particularly red algae

- Red and green macroalgae have been sampled from reefs to 100m in the EEZ, but they are not all yet formally identified and described, and to date **this flora has been poorly sampled**.

- To illustrate this I have compared the listing of red and green algae identified in NZ water over 30m and up to 200m (page 37 of 'Sensitive Marine Benthic habitats' NIWA Report) to Table M1 (page 167 & 168) of the NIWA Report on Benthic Flora and Fauna of the Patea Shoals region.

- Many of the species found in the dredge samples **were not listed** on the 'sensitive marine benthic habitats' report Table 3-1 NIWA Report (unpublished data) – which adds further weight to the fact that this flora is poorly sampled.

- It is important to note that detection of **a single occurrence of any species of red, green or brown macro-algae** is sufficient to indicate that this **rare habitat has been encountered** (page 38 of 'Sensitive Marine Benthic habitats' NIWA Report).

Type	Family	Species	Inner	Mid-north	**PPA**	Mid-South
Red Algae	Ceramiaceae	Ceramium sp	6	4	**3**	1
Red Algae	RhodomelaceaeAphanocladia		7	1	**1**	0
Red Algae	Rhodomelaceae	Polysiphonia sp	4	0	**1**	0
Red Algae	RhodymeniaceaeRhodymeniasp		1	2	**1**	0

As per the 'sensitive marine benthic habitats' report, the detection of a single occurrence of red, green or brown macro-algae is sufficient to indicate this rare habitat has been encountered. The Project area had three different species of red algae identified.

Due to the significance of finding red algae, it adds further support to the common theme throughout this report – of the necessity to get the rocky areas sampled.

Background: Rhodolith (maerl) beds

- Definition: 'free living calcified red algae, Phylum Rhodophyta) that occur worldwide, forming structurally and functionally complex habitats (maerl). They are fragile and slow growing (0.02-2mm/yr.) and are at risk from dredging, anchoring, reduction in water quality (e.g. Riul et al 2208) Internationally Rhodolith beds have been identified as **critically important biodiversity hotspots**. They have been identified as important nursery areas for commercial species, such as scallops, crabs and fish and brood stock bivalves.

- Distribution: very little information exists about the location, extend or ecosystem functioning of rhodolith beds in NZ. It is likely they exist in the EEZ at localities characterised by strong currents to depths of 200m, depending on water clarity, particularly around the margins of reefs or elevated banks.

- Like other calcified macroalgae, acidification of the oceans may impact, and it is thought that sensitive reef-building species such as coralline algae, **may be pushed beyond their thresholds for growth and survival** with the next few decades (Anthony et al. 2008).

- To understand the impact of dredging and sediment plumes on coralline algae we need good baseline data and an ability to monitor communities. An important first step is to document and describe calcified algae.

Research and sampling of the rocky habitats impacted by the Project needs to be done, due to the significance of coralline algae and molluscs to young **rock lobsters & Paua**

A study in Western Australia (Jernakoff et al. 1993) found that the two major components in the diet of very young Western rock lobsters (juveniles within their first year after settlement) were coralline algae and molluscs. While the proportions of coralline algae and molluscs differed depending on the moult stage (premoult, intermoult, or postmoult), as much as 80% of the food in the foregut of postmoult lobsters was coralline algae.

Corallines act as settlement inducers for paua, corals and kina. For example Paua larvae have cilia that enable them to swim through the water column. Seven days after fertilisation they must find a suitable substrate to settle on, before they can metamorphose. This metamorphosis is controlled by a chemical associated with the surface of non-geniculate coralline red algae.
(NIWA Information Series No. 57: Coralline algae of central NZ)

More effective sampling methods need to be used, to determine the Paua populations that could be affected by the Project Area – Paua shell debris was sighted S/E of the Project area

See page 31 of the Patea Shoals Report – which shows VIDEO sightings of Paua shell debris S/E of the PPA.

The rocky areas missed from NIWA's sampling sites, need to be assessed for sponge life.

Definition: sedentary, filter-feeding metazoans that direct a water current through their bodies for the purposes of feeding and excretion. There are about 700 known sponge species in New Zealand, but the real number may be twice this. Most (around 95%) are endemic – found only in New Zealand waters. (NZ Encyclopedia)

Red rock lobsters **breed in the South Taranaki Bight and contribute substantially to populations around NZ** – the east and west coasts of the Northland peninsula is particularly dependent on larvae from the South Taranaki Bight

Background on CRAYFISH The red rock lobster, also known as koura, crayfish, *Jasus edwardsii*, Crayfish hatch in the water from eggs, as tiny larvae. For one or two years the larvae float on the currents, where they eat and moult. When they are about 2.5 centimeters long they swim back to the coast. Adult crayfish live among rocks and eat kina (sea urchins), crabs and shellfish.

The Ministry for Primary Industries:

Statistics	
Recreational significance	High
Customary significance	High
Environmental importance	High

The study by Chiswell & Booth (2008) indicated that **red rock lobsters breeding in the CRA 9 area (this includes the STB as well as much of the west coasts of North Island and South Island) contribute substantially to populations around the rest of New Zealand.**

CRA 1 (the east and west coasts of the Northland peninsular) is particularly dependent on larvae originating from CRA 9 with 80% originating from this region. Importantly, only about 17% of larvae originating from within CRA 9 actually settle as juveniles somewhere in the same region

About **75% of lobster larvae settling in the CRA 9 area, including reefs in the STB, originate from CRA 8, which includes Fiordland, the Southland coast and Stewart Island.**

MOLLUSCS

4,512 specimens
74 species

(A) *DREDGE RESULTS MOLLUSCS*, *'Page 146 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight' Mollusca* **Mean densities per 250m²**

Type	Ab.	Species	Inner shelf	mid north	**PPA**	midsouth
Gastropoda	96	Amalda Baryspira	2.105	0.947	**0.526**	0.794
Gastropoda	61	Tanea zelandica	0.842	0.789	**0.316**	0.676
Gastropoda	48	Austrofusus glans	0.526	0.211	**0.316**	0.824
Gastropoda	2	Semicassis pyrum	0.053	0	0.053	0

(B) CORE RESULTS MOLLUSCS**:** *'Page 148 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight' Molllusca* **Mean densities per 1m²**

Type	Abund	Species	Inner shelf	mid north	**PPA**	midsouth
Bivalvia	143	Glycymeris modesta	39.94	23.87	**18.47**	46.64
Bivalvia	355	Scalpomactra scalpellum	45.82	319.85	**26.38**	16.71
Bivalvia	57	Psammobiiida spp	7.05	10.74	**17.15**	15.32
Bivalvia	18	Paphies australis	3.52	1.19	**10.55**	2.78

DECAPODS

Specimens 3,194
Species 22

Hermit crabs were the most common (lophopagarus and areopaguristes).

Lophopagarus
Two mid-shelf (close proximity to PPA) had markedly higher abundances of these hermit crabs.
Site 98 had 200 specimens (by the West side adjacent to the PPA – see page 17 Patea Shoal Report)
Site 93 had 200 specimens (by the South side adjacent to the PPA – see page 17 Patea Shoal Report)

Areopaguristes setosus
Site 54 had 179 specimens (by the Kupe Pipe North of the PPA – see page 17 Patea Shoal Report)

DREDGE RESULTS DECAPOD

Page 156 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'
Mean densities per 250m²

Type	Ab.	Species	Inner shelf	mid north	**PPA**	midsouth
Decapod	1,568	Lophopagarus	6.632	12.053	**11.00**	25.206
Decapod	1,005	Areopaguristes setosus	12.474	19.053	**9.158**	5.324
Decapod	97	Diacanthurus spinulima	0.737	1.105	**0.737**	0.941
Decapoda	1	Notomithrax meg larva*	0	0	0.053	0

*The PPA was the only sample site to record this species

The Project area was the only area to record the decapoda notomithrax meg larva in dredge results, although the number was small

CORE RESULTS DECAPOD

Page 157 of the 'Benthic flora and fauna of the Patea Shoals region, ST Bight'
Mean densities per 1m²

Type	Ab.	Species	Inner shelf	mid north	**PPA**	midsouth
Decapoda	2	shrimp juvenile*	0	0	2.64	0
Decapoda	1	Heterosquilla laevis*	0	0	1.32	0
Decapoda	1	Palaemonidae sp1*	0	0	1.32	0

*The Proposed Project Area, was the only *cored* sample site to record these species

The Project area was the only area in the coring samples to record the decapoda heterosquilla laevis and decapoda palaemonidae

NIWA **EXPERT RISK ASSESSMENT OF ACTIVITIES** IN THE NZ EXCLUSIVE ECONOMIC ZONE AND EXTENDED CONTINENTAL SHELF: Prepared for the Ministry for the Environment. Published May 2012 Extract from page 53

Mining iron sands in the EEZ may affect stocks of fished species in two ways. There may be some direct effects on fish during extraction of the ore-bearing sand, and ***redeposited sands may take several years before they provide the full range of prey species*** *to benthic foraging fish. Additionally* ***fish may move away from the area of active mining and plume influence.***

We *assessed there to be low (5) risks to key fish stocks and* ***moderate (10) risks to ecosystem functioning from direct effects on fish stocks,*** *and low risk (5) from displaced fishing to key fish stocks and ecosystem functioning (Table 4-4).*

NIWA EXPERT RISK ASSESSMENT page 54 on risk for IRON SAND MINING fails to consider concentrated metals such as copper in their risk analysis

Due to the significance of this aspect for human health as well as the ecology – this risk factor should have been noted.

The possibility for **MULTIPLE MINING** in the area – and the cumulative effect for ecology is an issue raised by the expert risk assessment

"Regulators need to be mindful, however, of the possibility for multiple mining operations to occur in a single region and direct and indirect effects on fish stocks to proportionally increase within a QMA."

The TTR Impact Assessment and supporting reports fail to consider the 'worst case scenario' for modelling purposes of the whole area having been dredged. The effect is compounded if further areas are mined under other marine permits.

NZ Biodiversity Report 2012 notes the understudied marine soft-sediment assemblages

The lack of data available on marine soft-sediment assemblages points to the risks involved with assuming recolonisation of the mined area will occur. The TTR commissioned study on the Euchone did not research biogenic substrates. The structural complexity of the various rocky areas within the STBight has had no research.

A Review of the Marine Soft-Sediment Assemblages of New Zealand - New Zealand Aquatic Environment and Biodiversity Report No 96 June 2012

*(1) provide a range and replication of **large-scale environmental factors** thought to influence assemblage composition (e.g. sedimentation rates, overlying primary productivity)*
*(2) comprise of **biogenic substrates (live and dead) that provide habitat complexity** at a range of spatial scales*

 *Conduct experimental studies that will determine the **mechanisms involved in the promotion and maintenance of biodiversity by habitat of structural complexity (e.g. bryozoan thickets/beds/reefs). Included in these studies should be assessments of the impact of physical disturbance (at different spatial and temporal scales**) on such habitat by fishing, specifically evaluations should allow for an appreciation of amount of ecological redundancy inherent in such habitats and the recovery time post-disturbance.*

 ***Support taxonomic study of New Zealand's relatively understudied soft-sediment fauna, in particular the Polychaeta, with a view to providing practical information and tools that will allow for the identification of soft-sediment polychaetes by non-expert biologists** (parataxonomists).*

To review existing published and unpublished sources of information on soft-sediment marine assemblages around New Zealand.
 *Using the results of the first specific objective, identify **gaps in the knowledge, hotspots of biodiversity, areas of particular vulnerability, a**nd make recommendations on areas or assemblages that could be the subject of directed research in future years.*

*Examination of **trophic interactions** across different habitat types within the same ecosystem with consideration to the contribution of benthic assemblages to overall ecosystem productivity.*

*One such research area deemed **worthy of specific attention is the study of marine soft sediment communities (Ministry of Fisheries, Draft Medium Term Research Plan).** New Zealand has a variety of soft sediment habitats in coastal (estuaries, embayments, mangroves, seagrass beds) and offshore waters (shelf, slope, deep-sea) for which there is **a perceived lack of biodiversity and ecosystemfunction information.***

*In addition, the **New Zealand Biodiversity Strategy (2000),** conceived to halt the decline of indigenous biodiversity, requires the documentation of marine species, their taxonomy, distribution and the mapping of habitats and ecosystems.*

SUBMISSION ON ECONOMIC BENEFITS: SECTION EIGHT

The economic implications involve far more than just looking at the Trans-Tasman application. The economic consequences are numerous:

- NZ's relations with China – as one of our major trading partners
- China's need for raw materials for steel production – VTM consumption 30-40 million tonnes
- Government policy – thousands of km of west coast sea has been permitted to offshore companies
- The purpose of the EEZ Act, being the sustainable management of natural resources
- Balance of payments
- Royalty and Tax flows
- Significant resource of ironsands
- Low cost of extraction when mined and processed at sea
- Global demand significant – China's consumption of VTM iron ore 30-40million tonnes
- TTR have a JORC compliant recoverable resource of over 4.6 billion tonnes

High level economic analysis has already been done

The Ministry of Business Innovation and Employment as far back as 2011 engaged a consulting firm specialising in the mining and metals industry to review the future outlook for the titanomagnetite market. http://www.med.govt.nz/sectors-industries/natural-resources/oil-and-gas/review-of-the-crown-minerals-act-regime/consultation-on-proposed-changes/consultation-royalty-regime-minerals/discussion-paper.pdf

As such any economic analysis provided by TTR is hardly significant in terms of economic evaluation as far more comprehensive analyses will already have been conducted at a much higher governmental level.

Inadequacies of the NZIER commissioned Economic Report identified by COVEC

At the point of the first submission process I was unaware of the 'bigger picture' and so analysed TTR's economic report. I have included the analysis again in this second submission – if only to point out the substantial inadequacies that were contained within it.

Covec's review commissioned by the EPA of the Economic Report also highlighted the inadequacies of the report

"we are asked to take on trust that the model provides robust results, but this report provides no basis for drawing such a conclusion – it is a black box"

"we have been unable to check the assumptions with respect to electricity and costs, or other costs"

Comprehensive financial analysis missing for the TTR Project

An economic analysis would have benefited from providing an indication of the spending on-shore verses off-shore, so the indicative cashflow injection to the local economy could have been assessed. The presentation would have benefited from a tabulated form. Mineral Regulations and NZ Tax law

could have been applied to budgeted financial projections, to determine a more realistic royalty and tax take.

Section 34 of the EEZ Act and necessity to base decisions on the best available information – will necessitate obtaining other economic analysis than the 'black box' provided by the NZIER.

The **NZIER public discussion paper on 'valuing natural assets' notes that in New Zealand, decisions are often made without proper economic valuation.** "*Yet it is common for economists and legal teams to confine themselves to tangible matters that can be easily measured – jobs, wages, and tax payments. This leaves those presiding over hearings to weigh up the balance between economic gain and environmental harm, relying on implicit rather than explicit valuations."*

The economic report prepared by NZIER for TTR confined itself to focussing on contribution to GDP, and fails to place a value on potential species loss and loss on consumer welfare from negative environmental effects. On a localised scale, should the environmental impacts fail to be managed, there is the fishing community spend on capital equipment (boats, cars) and the positive multiplier effect in the local community. There is considerable value to commercial fisherman in the fishing stocks contained within the South Taranaki Bight. There has been no economic valuation of these two aspects.

One particularly confusing aspect of the NZIER report is the indication of a Government Spend of $71million verses Government Income of $53million.

My calculation $US28.75m verses TTR $US11.6m

1. Accounting depreciation based on capital expenditure of $US575m – using a straight line 5% - equates to an accounting depreciation claim of $US28.75 RATHER THAN $US11.6m used in the NZIER economic analysis (8.3.3). THIS HAS A FUNDAMENTAL IMPACT on the TAXATION payable by TTR.

My calculation $US34m p.a. verses TTR $US4.6m

2. Interest costs based on $US 425m borrowings @ 8% is $US34m annually NOT $US4.6m as recorded in the NZIER economic impact report (8.3.3). THIS HAS A FUNDAMENTAL IMPACT on the TAXATION payable by TTR.

3. Tax depreciation has been calculated by me at an average rate of 11%, thus producing a further tax deduction of $US34.5m.

My calculation of tax & royalties $US 27.6m verses TTR $US 42.9m

4. Overall taxation including royalties, when taking into account the above impacts, reduces taxation and royalties payable from $US42.9m to $US27.6m. This is a reduction of 35.6% on the original projections.

NEGATIVE IMPACT OF $NZ 36.4 million on Government coffers.

5. The costs of policing this Project are projected to be $NZ 71 million (page 177 of the Economic Report). This Project has a NEGATIVE IMPACT on Government revenues to the tune of $NZ 36.4

ROYALTY CALCULATIONS DONE AT 5%

6. Page 177 (8.3.4) of the Impact Assessment correctly states 'Accounting Profit Royalties' as being at 10%. The NZIER calculations appear to have been calculated at 5%. However I believe that the matter of royalty calculations is not as simplistic as this. Any future economic analysis needs to discuss this more fully.

FUTURE REPLACEMENT CAPITAL

7. The NZIER Economic Report discusses a further $US11.5m per year from the 6th year on in replacement capital. This detail does not appear to have made it through to the Impact Assessment.

ECONOMIC BENEFITS' - ANALYSIS OF THE IMPACT ASSESSMENT REPORT, PAGE 175-177

		$US	$NZ					
					Exchange Rate:		0.80	
		$US	$NZ	note 1	Revenue Calculation:	As per Page 175, 8.3.1		$US
Total Revenue	*note 1*	**359,920,000**	**449,900,000**			Tonnes	$Price	
						4,400,000.00	81.80	359,920,000
Operational Exp (pg 176 IA)		184,000,000	230,000,000					
Accounting Depreciation	*note 2*	28,750,000	35,937,500	*note 2*	Accounting Depreciation at 5%		28,750,000	(NZIER report page 5, 5% of USD$575 Mil Capital Investment Baseline)
								(Note that the additional capital spend from year 6 is not included and
Interest	*note 3*	34,000,000	42,500,000					would inflate the Accounting depreciation)
Total Expenditure		**246,750,000**	**308,437,500**		*Tax Depreciation Rates @11%*		*63,250,000*	
					Variance for additional tax deducti		34,500,000	
ACCOUNTING PROFIT		113,170,000	141,462,500					
				note 3	Capital NZIER calculalation:		$US	
Tax Deductions - Depn variance		34,500,000	43,125,000		Capital investment		575,000,000	(page 176, 8.3.3 $US575m capital investment)
					Less Equity Raising Per NBR Article		150,000,000	NBR Article 28th November 2013
					Debt Funding Portion		425,000,000	Amount of Debt Raising
					Financing @ 8%		8%	(page 176, 8.3.3 financing rate at 8%)
Tax assessable income		78,670,000	98,337,500		Annual Interest Cost		34,000,000	Not 4.6mil as included in report
				note 4	Royalities		$US	
TAX (at 28%) per 8.3.4		22,027,600	27,534,500		113,170,000		Accounting Profit	
Royalties @ 5%	*note 4*	5,658,500	7,073,125		5,658,500		5% of accounting profit	(page 177, 8.3.4 $US8m per annum)
Total Income Tax & royalties		**27,686,100**	**34,607,625**					
				NZIER	*Life time of Project 20 years*		$US	
Deductions:	$US	$NZ		Report for	*annual interest:*		1,700,000	*20 years not used by NZIER*
Acctg. Profit	159,720,000	199,650,000		*interest Calc*	**Life time of Project 10 years**			
Tax Assessable	125,000,000	156,250,000		0.80%	annual interest:		**3,400,000**	(page 176, 8.3.3 $US4.6m per annum)
Difference:	34,720,000	43,400,000						

Confusion as to calculation of Royalty payments

It would appear the NZIER Report has provided a royalty figure based on a calculation of 5%, rather than the required 10%.

I have placed into a spreadsheet below, all the figures given in pages 175 to 177 of the Impact Assessment

The Impact Assessment on 8.3.4 states $US8 million in Royalties. I can see how this is calculated in the first column below. You obtain the accounting profit (US$159m) **and multiply by 5%** to get $US8m.

The Crown Minerals Regulations 2013 state **10% should be used.**

If you take $US 35m tax and add the royalties of $US8m (rounded figure) you get a total in $US of $43m – which equates to $NZ54m. The $54m is used in the 'National Economic Analysis' (Impact Assessment 8.4.)

		$US	$NZ	note 1
Total Revenue	*note 1*	**359,920,000**	**449,900,000**	
Operational Exp		184,000,000	230,000,000	
Depreciation	*note 2*	11,600,000	14,500,000	
Interest	*note 3*	4,600,000	5,750,000	*note 4*
Total Expenditure		**200,200,000**	**250,250,000**	
ACCOUNTING PROFIT		159,720,000	199,650,000	

Revenue Calculation:	As per Page 175, 8.3.1	$US
Tonnes	$Price	
4,400,000.00	81.80	359,920,000

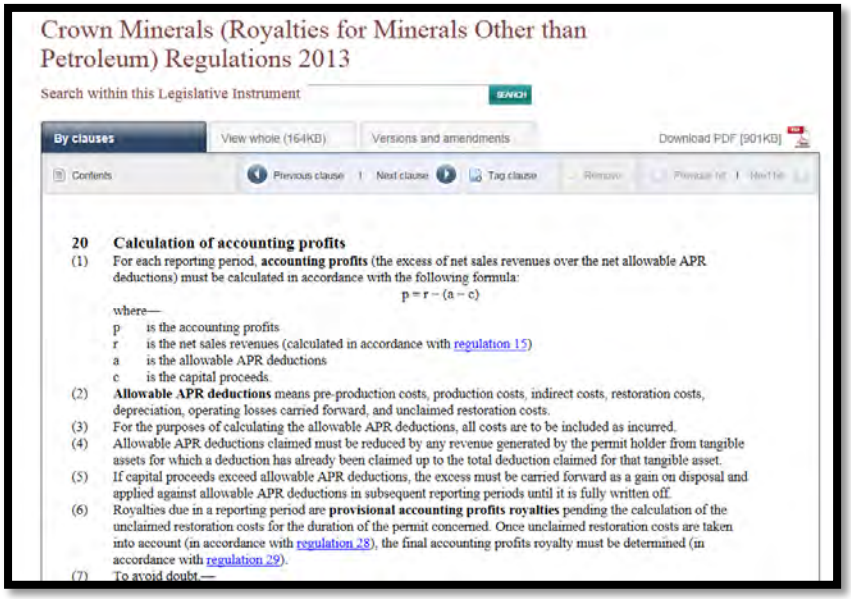
Royalities	$US	
159,720,000	Accounting Profit	
7,986,000	5% of accounting profit	(page 177, 8.3.4 $US8m per annum)

		$US	$NZ
TAX (at 28%) per 8.3.4		35,000,000	43,750,000
Royalties @ 5% *	*note 4*	7,986,000	9,982,500
Total Income Tax & royalties		**42,986,000**	**53,732,500**

ROYALTIES ARE DETERMINED AFTER 'ALLOWABLE DEDUCTIONS' AS PER THE CROWN MINERAL REGULATIONS.

As can be seen below – to determine 'accounting profits' for the purposes of the Crown Minerals Regulations 2013, there are a number of 'allowable deductions'. These include pre-production costs. Information on page 2 of the TTR Overview document state $50 million has been spent on pre-production costs.

I do not believe a 'Crown Minerals Accounting Profit' was determined in the NZIER analysis for royalty payments. Instead a different 'Accounting Profit' was used for the calculation of Royalties.



Crown Minerals (Royalties for Minerals Other than Petroleum) Regulations 2013

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By clauses | View whole (164KB) | Versions and amendments | Download PDF [901KB]

Contents | Previous clause | Next clause | Tag clause

20 Calculation of accounting profits

(1) For each reporting period, **accounting profits** (the excess of net sales revenues over the net allowable APR deductions) must be calculated in accordance with the following formula:

$$p = r - (a - c)$$

where—

p is the accounting profits
r is the net sales revenues (calculated in accordance with regulation 15)
a is the allowable APR deductions
c is the capital proceeds.

(2) **Allowable APR deductions** means pre-production costs, production costs, indirect costs, restoration costs, depreciation, operating losses carried forward, and unclaimed restoration costs.

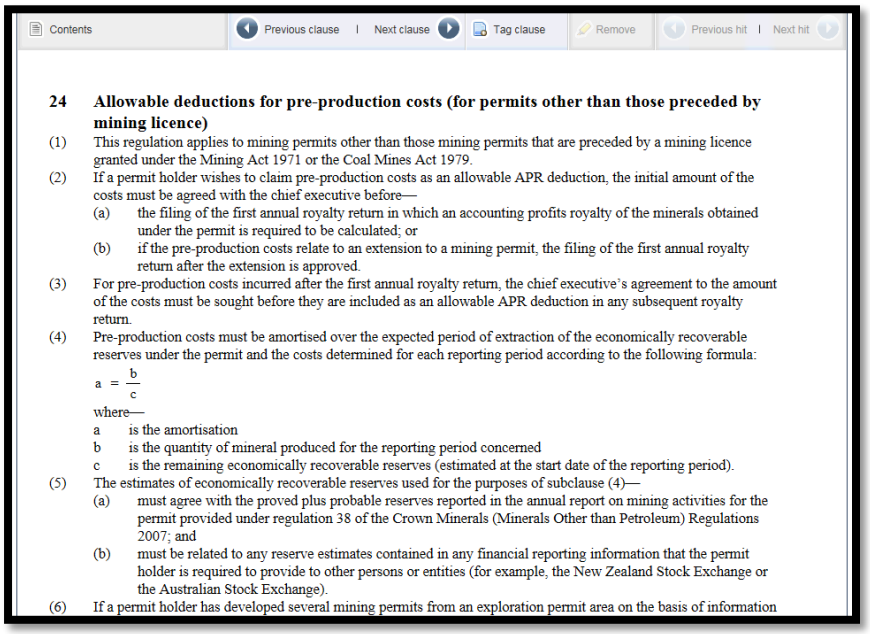
(3) For the purposes of calculating the allowable APR deductions, all costs are to be included as incurred.

(4) Allowable APR deductions claimed must be reduced by any revenue generated by the permit holder from tangible assets for which a deduction has already been claimed up to the total deduction claimed for that tangible asset.

(5) If capital proceeds exceed allowable APR deductions, the excess must be carried forward as a gain on disposal and applied against allowable APR deductions in subsequent reporting periods until it is fully written off.

(6) Royalties due in a reporting period are **provisional accounting profits royalties** pending the calculation of the unclaimed restoration costs for the duration of the permit concerned. Once unclaimed restoration costs are taken into account (in accordance with regulation 28), the final accounting profits royalty must be determined (in accordance with regulation 29).

(7) To avoid doubt—



Contents | Previous clause | Next clause | Tag clause | Remove | Previous hit | Next hit

24 Allowable deductions for pre-production costs (for permits other than those preceded by mining licence)

(1) This regulation applies to mining permits other than those mining permits that are preceded by a mining licence granted under the Mining Act 1971 or the Coal Mines Act 1979.

(2) If a permit holder wishes to claim pre-production costs as an allowable APR deduction, the initial amount of the costs must be agreed with the chief executive before—

(a) the filing of the first annual royalty return in which an accounting profits royalty of the minerals obtained under the permit is required to be calculated; or

(b) if the pre-production costs relate to an extension to a mining permit, the filing of the first annual royalty return after the extension is approved.

(3) For pre-production costs incurred after the first annual royalty return, the chief executive's agreement to the amount of the costs must be sought before they are included as an allowable APR deduction in any subsequent royalty return.

(4) Pre-production costs must be amortised over the expected period of extraction of the economically recoverable reserves under the permit and the costs determined for each reporting period according to the following formula:

$$a = \frac{b}{c}$$

where—

a is the amortisation
b is the quantity of mineral produced for the reporting period concerned
c is the remaining economically recoverable reserves (estimated at the start date of the reporting period).

(5) The estimates of economically recoverable reserves used for the purposes of subclause (4)—

(a) must agree with the proved plus probable reserves reported in the annual report on mining activities for the permit provided under regulation 38 of the Crown Minerals (Minerals Other than Petroleum) Regulations 2007; and

(b) must be related to any reserve estimates contained in any financial reporting information that the permit holder is required to provide to other persons or entities (for example, the New Zealand Stock Exchange or the Australian Stock Exchange).

(6) If a permit holder has developed several mining permits from an exploration permit area on the basis of information

TTR's production occurs all offshore, barely using any NZ resources – yet the production is counted for GDP purposes

To understand the impact of this Project, it is critical that the term GDP is understood.

1. Basically GDP (Gross Domestic Product) refers to goods & services **produced within the borders of NZ.**
2. By comparison GNP (Gross National Product) is goods and services **produced by the residents of NZ.**

The cashflow impact for NZ is largely confined to Royalties and Taxes

1. Trans-Tasman's shareholders (owners) are OVER 90% OVERSEAS INVESTORS.
2. The Company itself is 'registered' in NZ, which makes it a NZ Company.
3. PROFITS FROM THIS COMPANY WILL FLOW TO THE OVERSEAS INVESTORS and a small amount to any NZ investors.
4. ALL PRODUCTION OCCURS OFFSHORE. The processing doesn't occur on NZ land.
5. By far the majority of the Company's EXPENSES ARE SPENT OVERSEAS which results in a negligible cash flow for the region, or nationally.
    a. POWER is self-generated – so there is no benefit to NZ Power Companies Heavy Fuel Oil will fuel the generators (pg. 28 Impact Assessment)
    b. The HEAVY FUEL OIL will be by ship-to-ship transfer at sea – no benefit to our domestic ports or NZ fuel Companies.
    c. Singapore is the largest large scale source for the heavy fuel oil. (pg. 38 & 39 Impact Assessment) – so again no spend in NZ.
    d. INSURANCE will likely be obtained with an offshore Company
    e. The transfer of the iron-ore concentrate will be done at sea – so no use of NZ ports. FREIGHT will be to an Export Bulk Carrier vessel, chartered by TTR or their customers (China). This will not be a NZ vessel. (pg. 36 Impact Assessment).
    f. The LABOUR workforce of 250 (offshore & onshore) will require 'specialised skill levels' – so whether these are sourced in NZ or overseas, is difficult to determine without closer analysis. It is mentioned on page 285 of the Impact Assessment, that the workforce 'could live anywhere' in NZ or further afield, and fly in and fly out.
    g. If the labour force is flown in and out – to an overseas destination, there will be very little spend of wages within NZ shores.

Commentary on the 'INDEPENDENT REPORT' & expectations that labour 'would be sourced locally'

When a newspaper quotes a Report as being 'independent' – it gives a degree of **credibility** to figures. In this case $NZ 54m in taxes & royalties was quoted.

Should a comprehensive financial analysis and projected cash flows be done, the tax and royalty figure **may be significantly less.**

Had the newspaper article stated 'a commissioned report by TTR' – readers may have been more **cautious** in their acceptance of the figures quoted.

Public tend to be more **accepting of the environmental trade off, if the economic benefits are significant.** But as has been pointed, the domestic impact could well be minimal.

Furthermore, whilst the domestic labour force may be hopeful of employment – the air emissions modelled to occur around the ship far **exceed workplace emission standards –** which somewhat downgrades the value of any employment opportunity.

Section 13.2.2 of the Impact Assessment states "It is **unlikely that the new jobs created will significantly reduce the relatively high levels of unemployment i**n the 'local area' and 'wider area' because of the specialised skill levels that will be required for most of the positions"

No support has been provided for labour figures either – the numbers could be overstated. Fully **automated** filter presses and dewatering equipment result in labour savings, with technology becoming more sophisticated to assist with process optimisation.

4 TARANAKI DAILY NEWS Saturday, November 23, 2013

NEWS

Public get say on irons

Consent sought to mine ore

Public submissions have opened on a proposal for what is believed would be the biggest seabed iron-sand mining project in the world.

Trans-Tasman Resources is seeking a marine consent from the Environmental Protection Authority to mine up to 50 million tonnes of seabed material a year off the coast of Patea.

The South Taranaki Bight project, which would cost $607 million to set up, would cover an area of 65.75 square kilometres.

If permitted, the mining project could gross an estimated revenue of $450m to $500m annually for 20 years. The proposal is one of the first to be considered under new economic zone and continental shelf legislation.

Trans-Tasman says overseas evidence indicates the seabed would recover within two years and the project would have minimal to no impact on commercial fishing.

But one of the project's chief opponents, Kiwis Against Seabed Mining (KASM), says seabed mining is such a new industry, little is known about its environmental effects.

"The life of the ocean and how that life interacts ... is so complex and so little is known about it, particularly along the west coast, how can we predict the effects if we don't have a strong baseline to start with?" KASM chairman Phil McCabe said.

However, Trans-Tasman chief executive Tim Crossley said that while seabed mining was new for iron ore, it was not new for other commodities such as tin, diamonds and phosphate.

"Dredging as an industry has been going on for hundreds of years ... so the knowledge around how quickly the environment rehabilitates post-dredging is well understood.

"We're really no different to a large-scale dredging operation," he said.

If both marine and mining consents are granted, the company hopes to have operations up and running in the first half of 2016.

It expects to extract up to 5 million tonnes of iron ore annually.

Independent analysis carried out by the New Zealand Institute of Economic Research suggests the project would increase exports by $147m a year and contribute $54m in taxes and royalties a year.

It would increase Taranaki's gross domestic product by 3 per cent or $240m, the institute said.

After setup costs, the business is expected to have continuing costs of about $219m a year, mostly in freight and labour.

About 200 staff would be needed to man the offshore vessel and another 50 in engineering and support roles.

Mr Crossley expected that most of the staff would be sourced locally.

A decision on a separate mining application with New Zealand Petroleum and Minerals is due in a couple of months. Fairfax NZ

It was hard to determine from the Impact Statement how the figures for exports and household consumption were arrived at. I found I had to do the following spreadsheet to try and obtain the figures.

ECONOMIC BENEFITS' - ANALYSIS OF THE IMPACT ASSESSMENT REPORT, PAGE 175-177

					$NZ	
					page 177 8.4	
				Exports:	147,000,000	
		$US	$NZ	**GDP:**	302,000,000	(includes taxes & royalties of $54m)
Total Revenue	*note 1*	**359,920,000**	**449,900,000**		**449,000,000**	*page 177 8.4*
Operational Exp		184,000,000	230,000,000			
Depreciation	*note 2*	11,600,000	14,500,000			
Interest	*note 3*	4,600,000	5,750,000	**Household consumption:**	104,000,000	(due to increased economic activity*)
Total Expenditure		**200,200,000**	**250,250,000**			*page 177 8.4*
ACCOUNTING PROFIT		159,720,000	199,650,000			*my calculations indicate $NZ 16m is a feasible figue instead*
Tax Deductions		34,720,000	43,400,000			
	note 5					
Tax assessable income		125,000,000	156,250,000			
TAX (at 28%) per 8.3.4		35,000,000	43,750,000			
Royalties @ 5%	*note 4*	7,986,000	9,982,500		Government Spending	
Total Income Tax & royalties		**42,986,000**	**53,732,500**		71,000,000	*(page 177, 8.4 $NZ 71million)*

Below is a *very crude attempt* ('crude' due to the 20 working day time pressure from receipt of all the reports to preparing this submission!) to see the impact of domestic verses international spend. The spreadsheet does not profess to show a realistic scenario – **just prompt discussion on needing to do a similar kind of analysis, but with greater access to information in order to do so.**

Note: the figures were from NZIER provided amounts, rather than the more realistic figures I have earlier suggested should be used.

The spreadsheet also showed me how the 'household consumption' figure was arrived at. When you consider it has been calculated by adding 'domestic intermediates' and 'labour' – I would suggest that the household consumption is inflated in value. For example 'power' makes up a bulk of the amount, and we know that it is being generated on board the ship. We also know that insurance is likely to be offshore.

Operational Expenditure Cost Structure - Impact Assessment page 176

Analysis to determine likely domestic spend & household consumption

Exchange Rate 0.8

Table26; Page 176 of Impact Assessment

Operational Expenditure Cost Structure	US$ m	%
Domestic Intermediates (dominated by power & professional services, like insurance)	*91*	*50%*
Imported Intermediates (leasing storage and processing vessels)	*34*	*19%*
Labour (page 285 Imact Assessment 13.2.2 "it is unlikely that the new jobs will reduce employment in the local and wider area"	*14*	*8%*
Freight (bulk carrier export vessels, chartered by TTR or China/customers) (page 36 Impact Assessment 2.15.1)	*44*	*24%*
	183	*100%*

My Table showing split into Domestic & International expenditure

	A	B	C	D	E	F
	Domestic US$m	International US$m	**Total $Usm**	**Domestic $NZm**	**International $NZm**	**Total $NZm**
Domestic Intermediates (dominated by power & professional services, like insurance)	10	81	**91**	12.5	101.25	**113.75**
Imported Intermediates (leasing storage and processing vessels)		34	**34**		42.5	**42.5**
Labour (page 285 Imact Assessment 13.2.2 "it is unlikely that the new jobs will reduce employment in the local and wider area"	3	11	**14**	3.75	13.75	**17.5**
Freight (bulk carrier export vessels, chartered by TTR or China/customers) (page 36 Impact Assessment 2.15.1)		44	**44**		55	**55**
	13	170	**183**	16.25	212.5	**228.75**
	7%	93%	**100%**	7%	93%	**100%**

Household Consumption *NZIER* *My table*

(page 177, 8.4 of Impact Assessment)

	US$millions	Domestic $NZm
Domestic Intermediates	*91*	12.5
Labour	*14*	3.75
As per Table 27 ($US104m)	***105***	**16.25**

(Table 27 incorrectly says it is in NZ$, it is infact $US)

My Table showing split into Domestic & International expenditure

	G	H	I	J	K	L
	Domestic US$m	International US$m	**Total $Usm**	**Domestic $NZm**	**International $NZm**	**Total $NZm**
Domestic Intermediates	10	81	**91**	12.5	101.25	**113.75**
Labour	3	11	**14**	3.75	13.75	**17.5**
As per Table 27 ($US104m)	**13**	92	**105**	**16.25**	115	**131.25**
	12%	88%	**100%**	12%	88%	**100%**

Conclusion:

It is feasible that operational expenditure spent domestically would be $NZ 16 m rather than $NZ 229m (compare D to F)

($US 13m verses $US 183m) (compare A to G)

It is feasible that Household consumption would be $NZ16 million rather than $NZ 131 million. (compare J to L)

($US 13m verses $US 105m) (compare G to I)

SUBMISSION on RECREATION, OPTICAL QUALITIES & SEDIMENT PLUME

6.18, 11.5, 11.6, 13.3, 12.4, 12.5, 13.4.5.3, 14.2.6, 15.4.4, 15.4.5

LIMITATION ONE: Missing from the Executive Summary on Recreation are the ecologically diverse (and hence fishing and diving important) areas of the North & South Traps and Graham Bank.

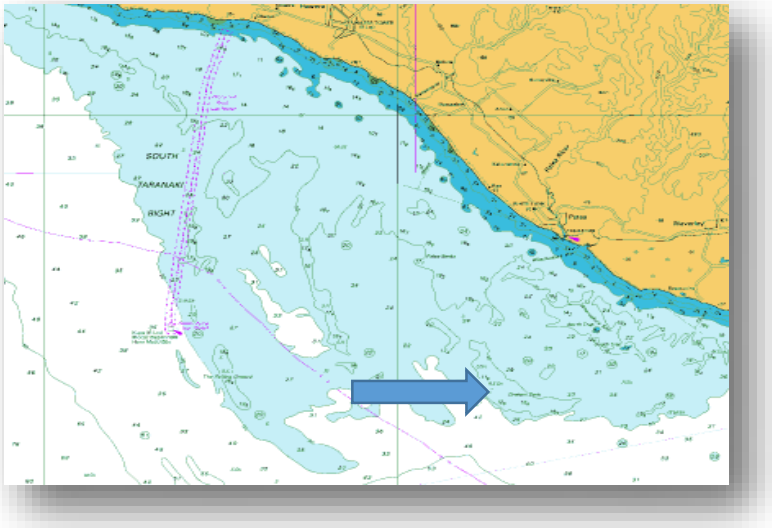
Local divers describe the areas as being the 'Poor Knights' of Taranaki. DOC (2006) suggest the North and South Traps appear to be biologically significant for the South Taranaki coat.

Graham Bank is further out at sea, and within some of the higher levels of sediment plume, makes it a significant omission. The Impact Assessment 6.3 'Physical Oceanography' clearly shows this area.

It is easy to miss the significance of this area in the Impact Assessment, as pictures used in the sections for 'offshore benthic ecology' in 6.10, discussions about crayfish in 6.10.4 and marine fish in 6.10.7 – all fail to emphasis in discussion or pictorially – the Graham Bank. Maps in section 11.7 (visibility of plume) likewise fail to record the Graham Bank, although the North and South traps are noted.

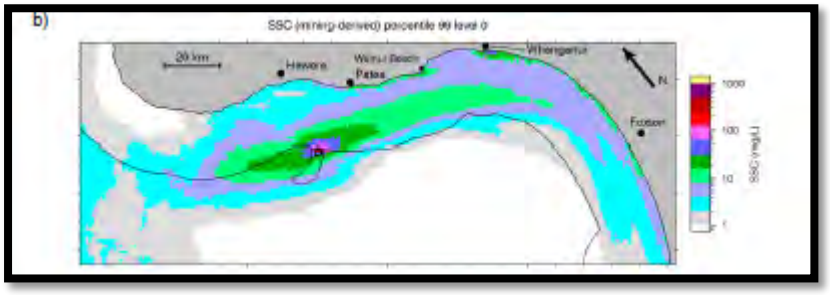
The 'vertical visibility' at the Graham Bank is modelled as falling from 8-10 metres to 1-5 meters (see figure 3-13 of the Optical Report). This is a significant reduction.

A map from the Plume Modelling Report – with an arrow pointing to Graham Bank



The attached GPS picture is an excellent way to appreciate the significance of this outer-shore area to the fishing and diving community.

The Impact Assessment on page 212, (Figure 80) shows a 'bottom' concentration of mining derived sediment – in the Graham Bank area of 20 SSC mg/L



LIMITATION TWO: Recreation: The Executive Summary restricts itself to discussing the very limited fishing in 'the immediate vicinity of the Project'.

Due to the significance of recreational fishing to the local economy and to the local community – one would at least expect a comment on the extensive recreational fishing and diving activity that occurs within the 'near vicinity' of the Project and its plume effects.

LIMITATION THREE: A diverse ecosystem, the Graham Banks has not been sampled/reported on by NIWA.

The two reports prepared by NIWA were:

*Benthic habitats, macrobenthos and surficial sediments of the **near-shore** South Taranaki Bight NIWA June 2013.* Page 11 of this Report shows the location of sampling sites – no samples were taken in the Graham Bank, as the samples ran along the shore for every 6km, until reaching Wanganui where a cross shelf transect was done.

Benthic flora and fauna of the Patea Shoals region South Taranaki Bight NIWA October 2013. This NIWA Report restricted itself to a Longitude of **174 25E** – the Graham Bank has a Longitude of **174 41E.** See page 132 of the Impact Assessment.

LIMITATION FOUR: Recreation: A useful dataset was not used in the Greenway Report – the Coast Guard records of calls.

While there are obvious limitations with the data, such as possible duplicate calls (overstatement) from the same boat, or boats that do not radio in to the Coast Guard (understatement), plus variability in volunteers methods of recording – it would at least provides some context to claims on recreational activity levels. For the month of November 2013 the Coast Guard responsible for Patea and Ohawe logged (un-officially) 177 vessels.

LIMITATION FIVE: The Executive Summary for the Greenway Report fails to list two important concerns raised at a community meeting with recreation groups on 13 August 2013.

These are 'risk of accidents with ships and subsequent marine pollution' and 'how effects will be monitored' (page 8 Greenway).

LIMITATION SIX: The Greenway report assessment has a number of limitations

The Greenway report reviews technical reports and then comments on:

a) Water clarity and its effects on recreational activities – fishing, diving etc.
b) Adverse effects to marine ecology.

I shall address both of these:

(a) Water clarity and diving

The Greenway Report states the effect is *minor in the important diving setting of the Traps due to a persistent but small scale change in water clarity, which will be most apparent only when the mining activity is occurring in the eastern part of the mining area (that is, not for the full period of mining activity" (Page 4)*

The Greenway Report states the effect is a *"potentially moderate, adverse effect for diving at the traps due to water clarity during the rare periods of extreme water clarity (>10 m horizontal visibility on the bottom for four days per year), which are likely to coincide with ideal settled diving conditions and are therefore likely to be experienced by divers seeking a scenic experience, and when water clarity is marginal (< 5 m) for divers hunting crayfish (page 4). Similar effects are also likely at the less important diving setting on the Graham Bank.*

The Greenway Report states the effect is *potentially minor, adverse effect for offshore fishing, sailing and boating because of*

- *the large scale of the offshore setting,*
- *the relatively low level of activity in the plume area*
- *the transient characteristic of the experience.*

There are three important aspects in this statement that need addressing.

- Firstly, there are other important diving settings other than the Traps and water clarity needs to be discussed in terms of all diving settings.
- Secondly there are significant limitations to the Plume modelling which means the 'worst case' scenario has not been modelled.
- The comments of '**small scale changes in water clarity**' is so un-specific, as to provide little context to the reader.

LIMITATION 6(1) sediment & water clarity

If you look at the following **offshore** results which are obtained 8km from the source location 'A' - the levels of increase could not be deemed 'minor'.

Source location 'A' is at the eastern side of the Proposed Project area and is in the path of the mining plume

- The median has *increased f*rom 0.8 mg/L to 3.8 mg/L
- The 95th percentile has *increased* from 3.7mg/L to 11.7mg/L
- The 99th percentile has *increased* from 8.2 mg/L to 15.8 mg/L
- The maximum has increased from 17.3 mg/L to 23.6 mg/L
- *(See page 45 of the NIWA Plume modelling Report October 2013)*

LIMITATION 6 (2) the modelled 'patch' is for a very small area and the depth mean is limited.

The following questions need to be addressed:

- If the patch is increased in area from the small 3 x 2km patch used for this modelling, to an area of slightly under 65km², what level of increase in mg/l will there be?
- If the mean modelling depth of 6m is increased twofold – what is the impact on sediment particle size and the consequent impact on mg/l and hence sediment deposits?

LIMITATION 6 (3) Sediment Characteristics used for modelling

The mining depth for dredging is important – as the particle size changes depending how deep you dredge. This has obvious flow on effects for sediment plume modelling. You can see in the extract below that a 'mean mined depth' of 5 metres is used, and states "there are various sources of uncertainty in this number but the largest is the mean mined depth, which could differ from the assumed value by a factor of two".

WE NEED TO HAVE SOME RE-MODELLING DONE, WHICH GOES TO A DEPTH OF 11 METRES – AND HAS THE CONSEQUENT HIGH SEDIMENTATION THAT GOES WITH DREDGING TO THAT DEPTH. The results of the modelling might mean consent restrictions might have to be made about the depth of mining allowable.

3.2.3 Patch source

To model the fate of de-ored sand buried at the mining site we consider a rectangular patch representing one year's worth of ironsand extraction and populate this patch with material that reflects the composition of the combined hydro-cyclone and de-ored sand discharge streams, minus all the material that was released in the suspended source (Section 3.2.1).

The area of this source is calculated as follows: Assuming a volume extraction rate of 1.195 m^3/s at full operation (mass extraction rate 8000 tonne/h with a bulk density of 1860 kg/m^3) and an up-time of 80%, the annual volume extracted is 30.15×10^6 m^3. At a mean mined depth of 5 m, this implies that an area of 6.05 km^2 would be mined in one year. (There are various sources of uncertainty in this number but the largest is the mean mined depth, which could differ from the assumed value by a factor of two.) This area is represented in the model as a 3 × 2 km rectangular patch centred on the mining site, which is taken to be mining site A.

The sediment classes for the patch source are listed in Table 3-6. There is no < 38 µm class because all this material is assumed to have been released in the suspended source. The fractions in the right-hand column sum to 100% and are in proportion to the deposition rates.

Table 3-6: Sediment classes and composition for the deposited patch source.

Source	Size range (µm)	Grain size (µm)	Deposition rate (kg/s)	Fraction
Patch	500–1000	710	268	14.3%
Patch	125–500	256	1507	80.7%
Patch	90–125	107	78	4.2%
Patch	38–90	58	15	0.8%

SEDIMENT CORE RESULTS: To understand why the dredging to deeper levels impacts on the levels of sediment plume – it is useful to look at how the sediment is structured.

TTR provided samples from STH010RC (33m water depth) and STH012RC (29m water depth).

Sediment sample characteristics from STH010RC

- At the top 6m the **mean grain size** is 271-452um
- At the muddy levels the **mean grain size** drops to 35um.
- At below 10m the **mud content increased** to **37-43%** (from <4%)
- At 11-12m the mud content increased to **84%.**

Sediment sample characteristics fromSTH012RC

- Below 6m the mud content increased to 58% (from <3%)
- At 7-8m the mud content increased to 82%

There appears to be no discussion of the impact of the first and second grind on particle size distribution – this is a critical factor that has been overlooked – the second grind goes to 75µm
It is the SEDIMENT SIZE OF PARTICLES that can be critical to different organisms. You can see the impact on particle size that occurs as a consequence of the beneficiation process. The first stage grind: (page 23 impact assessment) 130um second stage grind 75um.

LIMITATION SEVEN: OPTICAL RESULTS: There is a significant variation in results obtained from the modelling verses survey results (page 55 Optical effects Report)

This difference was explained as being due to the survey being conducted in a relatively calm period, whereas the Modelling covers long term conditions. NIWA considers the visibility depth (zeu) predictions, reasonable and adequate. Modelling has a visibility median depth of **up to three metres.** Surveys have a measured visibility depth of **up to 10 metres.** In light of these significant variations – further modelling and testing could be performed in 'non-calm' conditions – to ensure modelling predictions are reasonable.

LIMITATION EIGHT: The Executive Summary fails to mention the mining site visibility drops from 25m to 5m due to the SSC

OPTICAL EFFECTS – **Mining site** visibility

Around the mining site visibility (zeu) is substantially reduced from 20-25m to about 5m. This reduction to 5m would result in photosynthetic organisms not receiving sufficient light.
This aspect has not been alluded to in the Executive Summary, indeed quite a different picture has been presented "***Sensitivity of aquatic ecosystems*** *and human observers and recreationalists* ***to optical*** *and visual* ***impacts on coastal and near-shore*** *STB waters* ***are expected to be low "***

LIMITATION NINE: The significant impacts for optical effects are not reflected in the Executive Summary - vertical visibility reduces 38m-25m & 25m-8m & at the release site from 10m to 1m. Graham Bank falls from 10m to 1m

-OPTICAL EFFECTS – **Vertical visibility (Secchi depth)** more than 5km offshore

The Optical Effects Report (page 58) states that *more than 5km offshore*, there are a number of times you may be able to see the bottom (pre-mining)

Looking at Figure 3-14 (page 59) you can clearly see the change in visibility due to the sediment plume following the main axes of South to North and West to East. For example, West-East has a Secchi depth of 38m (5^{th} to 95^{th} percentile) which reduces to 25m. Another South-North example is a Secchi depth of 25m reducing to 8m.

The 'vertical visibility' at the release site (at the far eastern side of the proposed Project area) is modelled as falling from 10m to 1m and the ability to see the bottom will be rare if at all (page 58 Optical Report). The 'vertical visibility' at the Graham Bank is modelled as falling from 8-10 metres to 1-5 meters (see figure 3-13 page 58).

More than 5 km offshore, there are a number of occasions that an observer may be able to see the bottom (Figure 3-14, South-North and West-East). Model simulations suggest that mining reduces z_{SD} considerably at the release site from about 10 m to 1 m, and the ability to see the bottom within the plume affected zone will be rare if at all.

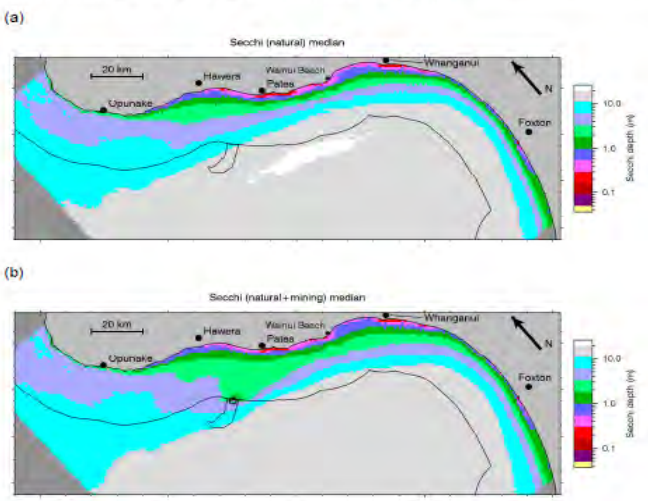


Figure 3-13: Modelled median vertical visibility depth (Secchi) surface maps under natural and mining conditions.

Optical effects of an iron-sand mining sediment plume in the South Taranaki Bight region 58

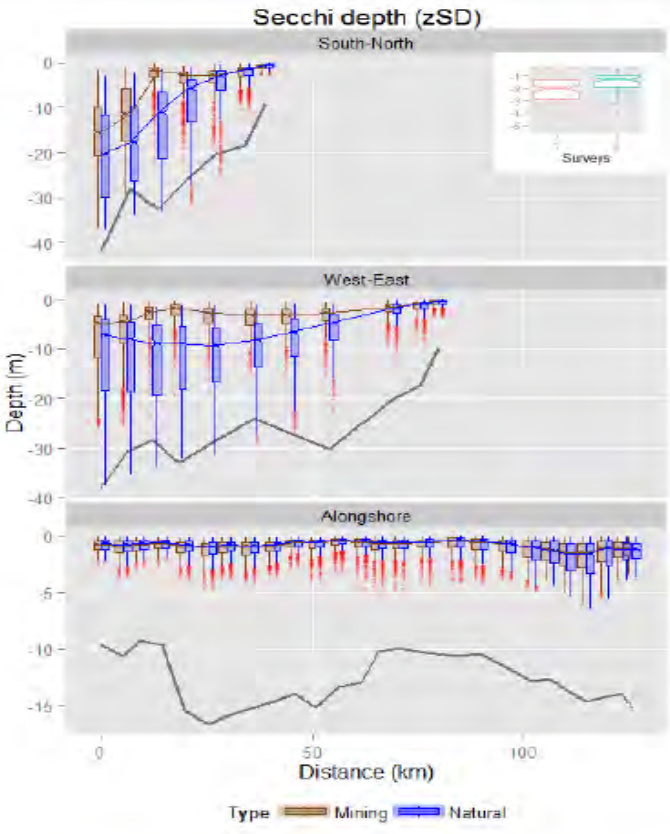


Figure 3-14: Modelled vertical visibility depth (Secchi) transects under natural and mining conditions, following the main axes of where a mining sediment plume would occur (South to North (Hawera) and West to East (Wanganui)), and in the nearshore environment (within about 2 km) alongshore (Hawera-Foxton). Boxplots enclose 50 % of the data around a median (25th to 75th percentile), with bars extending to 90 % (5th to 95th percentile). All points outside this range are highlighted red. The sea-floor is indicated by the black line.

OPTICAL EFFECTS – Horizontal visibility (black disk distance) Page 60 (NIWA Optical effects Report, October 2013) the reduced visibility might be of concern in regards to reactive distance of fish, marine mammals and aquatic life.

An independent risk assessment needs to be done for this. No research was commissioned by TTR to evaluate the effect of these elevated levels of sediment on fish, marine and aquatic life.

The Executive Summary of the Impact Assessment fails to address the horizontal optical risk - "***Sensitivity of aquatic ecosystems*** *and human observers and recreationalists* ***to optical*** *and visual* ***impacts on coastal and near-shore*** *STB waters* ***are expected to be low.***"

Please note: Figure 5-4 is ***based on dredging at 'point/source A'*** *– which is at the inner end of the mining area – see details below in Table 3-5. The 'point/source A' is known as 'measurement site 7' also, see Figure 1-2 below.*

Table 3-5 with 'Source A' that I refer to in my submission

Two source locations are considered, as specified in Table 3-5.

Table 3-5: Source locations.

Label	Location		Water depth (m)	Description
	Longitude	Latitude		
A	174.194°E	39.850°S	30.8	Inner end of mining area, at measurement site 7
B	174.070°E	39.888°S	42.0	Outer end of mining area, at measurement site 10

Figure showing 'Point 7', or 'Point source A' – that I allude to in my submission.

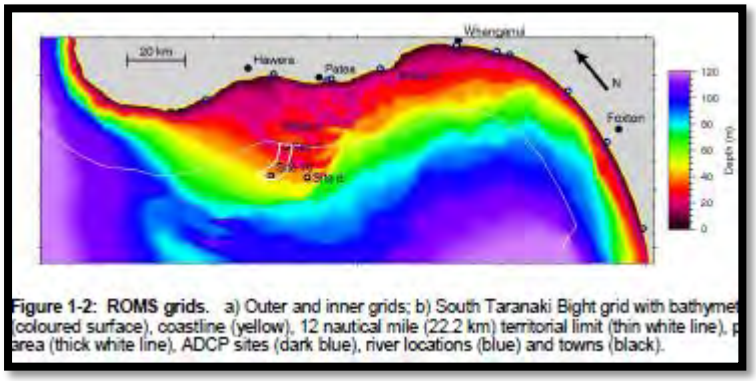


Figure 1-2: ROMS grids. a) Outer and inner grids; b) South Taranaki Bight grid with bathymet (coloured surface), coastline (yellow), 12 nautical mile (22.2 km) territorial limit (thin white line), p area (thick white line), ADCP sites (dark blue), river locations (blue) and towns (black).

The modelling is based on 'Point A' 'patch source' of 6.05km² (a 3 x 2 rectangular patch) with the *assumption* of the area around this patch to be un-mined (page 33 of NIWA plume modelling Report).

Suggest modelling is done for a 'patch source' area equivalent to 'Dianne'.

Suggest modelling is done for a patch size equivalent to just under 65.76 km², which represents the maximum potential area that could be mined

Until these patches are modelled there can be no effective risk assessment for this proposed project.

MARINE ECOLOGY and the Impact from proposed dredging

Importantly in SKM's report is the comment "it is not possible to independently assess whether the conclusions of the impact assessment are justifiable and robust"
SKM note the lack of information regarding the sensitivities of benthic communities to changes in SSC, light availability and sediment deposition in point 11 of their report.

The comments below contained with the Greenway Report – are unable to be stated with any degree of assurance due to the following points.

- No research conducted into predicted sediment levels and the species specific effects
- No research conducted into sediment particle size and its impact on biological communities
- Plume modelling that has not considered the 'worst case analysis'
- Plume modelling that 'struggles' with predictions for rocky environments
- Limited knowledge and research conducted on benthic communities in the South Taranaki Bight
- No NIWA sampling in the important ecological area of the Graham Bank
- Severe limitations contained within the auditory report – so that the impact of sound on mammals frequenting the area needs much more extensive research.
- No research conducted into the impact of concentrated copper levels, the dilution of those, and potential impacts on different species.
- Limitations in the Wave modelling – which means the spread of the plume could vary – and hence its impact on biological communities
- It appears there has been no research conducted on the response of Tourists to a dredging operation occurring in a potentially significant marine habitat, and in an environment that contains diverse biological communities within the reef structures along the coast.
- There has been no site research into fish species in the area. Instead 'predictive models were used, based on old survey information, and 'a set of environmental predictor variables'.

- NIWA is undertaking a range of bio geophysical studies in the STB for TTR to meet the likely requirements of consenting procedures under the new EEZ environmental effects legislation. But any findings from this, have not been included in the EPA submission supporting documents. In light of sediment plume findings for the off shore environment, this report will of importance to read.

The Greenway Report states the effect is:
Potentially minor, adverse effect OUTSIDE THE MINING AREA due to changes to marine ecology on recreation and tourism:
Minor for recreation and tourism activities outside the mining area due to the low scale of adverse effects on marine ecosystems.

The Impact Assessment (section 12) has an assessment of the environmental effects by Dr McClary. It is this assessment that forms the basis for the conclusion by Greenway that there 'is a low scale of adverse effects' on the marine ecology from the proposed Project.

SKM in their report on 'Benthic Ecology' fail to raise in their key findings some important limitations of the Benthic reports that they raise further on in their analysis & discussion sections

1. Point 8 of the SKM report mentions that the Patea Shoals report did not discuss the potential impacts of the **mining particle size** distribution in areas adjacent to the mine.
2. Point 8 of the SKM report mentions that the Patea Shoals report does not identify a potentially significant mode of impact – the **interference of recruitment** of macroalgae onto rocky substrates – by relatively small amounts of sediment deposition
3. The focus on **'recovery time'** verses 'thresholds' **obscures** the fact that the impact persists over the life of the mining operation.
4. The optical report does not have a transect for the **North & South traps**
5. Reductions in light predictions are based in the Optical report on two year median, but this misses the impact of **seasonal changes to light,** which from an ecological view are meaningful
6. The reports reviewed provides **no strong differentiation** between the impacts of the plume and the direct impact of deposition of sand from the plume.

LIMITATION ONE: Dr McClary's Report fails to comment on Project suspended sediment concentration and particle size

Page 265 and 256 of Dr McCLary's Report in the Impact Assessment – fails to comment on the Project's levels of fine sediment deposition and associated particle sizes from the sediment plume – instead much of the discussion is on the deposited sand, which is of a larger particle size.

LIMITATION 'BETWEEN ONE AND TWO': There has been no discussion or reports commissioned to determine sustainable loads of SSC

There have been no reports commissioned that give suitable SPM performance indicators to ensure the risk to biological life is minimised. www.environment.gov.au gives some examples about establishing sustainable loads of suspended particulate matter. For example: sedimentation guidelines of 2mm/annum to protect benthic macro invertebrates, with a key performance indicator of SPM loading ?g.m2.

LIMITATION TWO: The 'patch source' is likely to move further away than the 10km predicted

***Plume Modelling Limitation Two*:** (page 8 Sediment Plume Modelling) Analysis was conducted on a recovery simulation, and it was found that the 'Patch source' would likely move away up to 10km in two years, but the model simulation may *underestimate* the extent to which patch material is eroded and transported

LIMITATION THREE: NIWA doubles deposition rate compared to MTI

Plume Modelling Limitation Three*: (*page 31 Sediment Plume Modelling)

The assumption in the modelling has been to *double the deposition* rate by comparison to MTI. This is an important assumption, as if the deposition rate of MTI had been used, there would be a greater quantity of sediment carried 100m downstream – hence the impact on areas surrounding the mined site will be greater.

- MTI model for 38-90µm: of the 50.3 kg/s de-ored sand discharge between 32-43kg/s would still be in suspension 100m downstream and **7.3**kg/s deposited.
- NIWA model for 38-90µm has used the *assumption*: 35.0kg/s and a deposition of **15.3** kg/s

LIMITATION FOUR: 80% uptime used for modelling – not verified independently

(Page 32 Sediment Plume Modelling Report)
The modelling used **an 80% uptime,** based on advice from the Client – so in other words, the model had the source 'turned off for 4 days in every 20.
This assumption has a significant impact on the modelling – so it would be prudent to reassess this assumption.

This conflicts with information contained on page 44 of the Impact Assessment which states seabed extraction and processing are planned to be undertaken continuously 24 hours per day!

LIMITATION FIVE: Plume modelling is based on a project life of 11 years – this factor is not clearly spelt out throughout the Impact Assessment

(Page 33 Sediment Plume Modelling Report).
The application period of 20 years, does not indicate a Project period of 20 years. I do not believe the Impact Assessment reflects this distinction as clearly as it could have.

The Impact Assessment states an Application Area of 65.76 km².
The 'patch source' calculations for the plume model gives an extraction area of 6.05km² a year (modelled with an 80% uptime, and a ***mean depth of 5m).*** *6.05km² multiplied by 11 years gives 66.55km². The marine consent is for a period of 20 years.*

Once the distinction between 'application life' and 'project life' has been determined – there are some pertinent issues to be aware of, and to seek answers to.

1. After 11 years – the iron ore for the area consented for has been extracted. As a period of 20 years has been applied for, it could mean TTR plan to mine further areas at the completion of dredging the 65.76m².
2. If extraction occurs with a **mean depth** of 11 metres, would the modelling of sediment need to change, due to the change in particle size composition at that depth? There appears to be no discussion on this point in the Plume Modelling report.
3. Presumably if extraction takes place at the deeper levels, a time period more like 20 years will eventuate.
4. If you look at the diagram below, and the comment in the Impact Statement that Diane will be worked for three years, a Project life of 10 years seems likely.

LIMITATION SIX: Not included in plume modelling was the effects of re-anchoring 4 Stevpris-type anchors every ten days

The anchor removal and its impact on sediment pluming has not been mentioned/evaluated in the Plume Modelling Report (see page 16 Impact Assessment for anchor details)

LIMITATION SEVEN: The 'assumption' used for modelling the 'patch' of unmined sound, will not apply if a greater area of mined patch than one year is used.

An assumption is used, that underestimates the impact of having many mined patches – which is what will occur after a year of dredging.

Page 33: A 'patch' represents one year of extraction. The area is represented in the model as a 3 x 2 km rectangular patch.

Page 33 second to last paragraph states: "the material in the seabed around the patch *is assumed* to be unmined sand". This assumption **only holds for part of the first year of operation.** Future years will have a strip of re-deposited sand alongside them.

IF THE PATCH IS INCREASED IN AREA FROM THE SMALL 3 X 2KM PATCH USED FOR THIS MODELLING:

- HOW FAR WILL THE SEDIMENT PLUME STRETCH?
- HOW THICK WILL THE SEDIMENT FALL?

LIMITATION EIGHT: The 'patch calculations' do not consider the 9m mounds and the 9-10m pits.

NIWA Report: page 67 - *It is probable that this simulation is **underestimating** the rate at which the patch sediment is eroded and transported, because the model's formulation of active layer thickness does not take account of the complex bed forms in the area (Section 1.6) and we believe that the model underestimates the rate at which sand is suspended at this site.*

LIMITATION NINE: The first project area to be mined has not been modelled

According to the Impact Assessment Dianne will be worked for the first three years of operation and then X2. Yet the 'source locations' used for Plume Modelling were the inner end of the mining area and the outer end of the mining area.

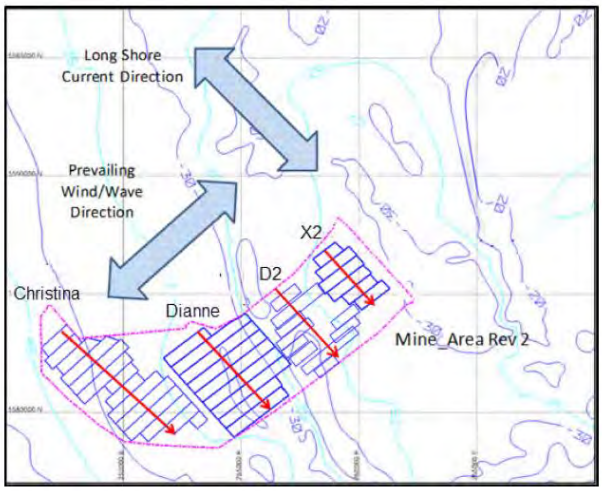


Figure 3: Mine Plan - alignment of extraction "strips"

LIMITATION TEN: Modelling results differs to observation results

(Page 39) There was a difference in 'Near-bottom SSC results' produced by the Model verses samples taken. The model did not reproduce the large difference in observed SSC between site 7 (X2 area, see the map page 11) where observed SSC reaches 500mg/L on occasion and is generally under-predicted by the model.

The conclusion by NIWA from the comparison is that the sediment model does NOT reproduce the wide range of variation in susceptibility to sand re-suspension between different locations on the Patea Shoals, and furthermore could not do so without a lot of tuning to local conditions.

Figure – showing the difference in modelling verses survey results

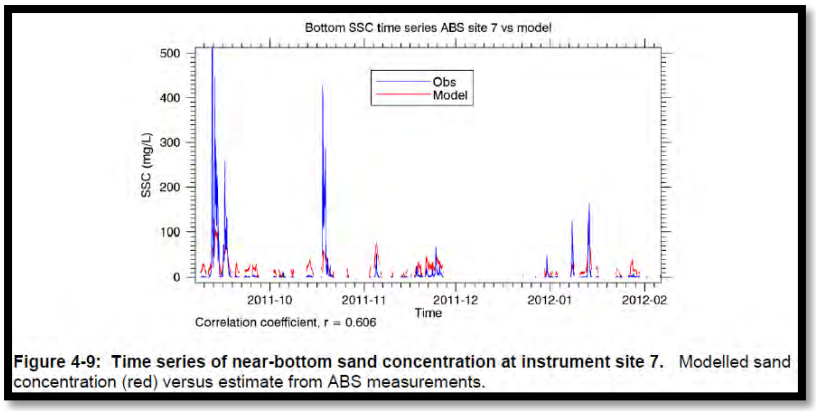


Figure 4-9: Time series of near-bottom sand concentration at instrument site 7. Modelled sand concentration (red) versus estimate from ABS measurements.

LIMITATION ELEVEN: variation in results reported in Executive Summary and body of report

Page 45 of Sediment Plume Modelling Report verses Executive Summary

The Executive Summary (page 8 of Plume Modelling Report) states the following:
At the Whanganui River site, natural sediments dominate over mining-derived sediments. At the off shore site (8km from source A) the mining-derived SSCs were larger than the natural SSCs

You get a different impression if you look at the data (based on graphs on pages 44 & 45).

- I do not see how the natural sediments are 'dominating' over mining derived sediments at the Whanganui site.
- One could say the mining-derived SSC's are *significantly* larger (rather than simply larger) than the natural SSC's.

The data below evidences my point:
Whanganui site:
The median has stayed the same at 5.3 mg/L
The 95th percentile has *increased* from 57.2 to 59.8 mg/L;
The 99th percentile has *increased* from 122.5 to 124.6 mg/L
The maximum has *increased* from 188.0 mg/L to 220.6 mg/L.

At the off-shore site (8km from source location A) which is frequently in the path of the mining plume:
The median has *increased f*rom 0.8 mg/L to 3.8 mg/L
The 95th percentile has *increased* from 3.7mg/L to 11.7mg/L
The 99th percentile has *increased* from 8.2 mg/L to 15.8 mg/L

The maximum has increased from 17.3 mg/L to 23.6 mg/L

LIMITATON TWELVE: The plume modelling has a Section 5.6 for freshwater, but has no modelling for salinity

Page 33 of the Impact Assessment discusses the salinity of the discharge stream (an output from the reverse osmosis) of a change from 35 parts per thousand, to 37 part per thousand. There has been no analysis of the environmental impact of this increase – keeping in mind also that the freshwater discharge is so low that it is not anticipated to depress salinity. So it appears the water discharge from the ship will not contribute to reducing the burden of the salinity.

How far will the increased salinity travel? What biological impact is there? What about the life that accumulates under the hull of the ships (e.g.fish & squid).

Page 70 of Plume Modelling Report: Figure 5-21 shows the median and 99th percentile of the surface concentration from the freshwater source (Section 3.2.4), expressed as a percentage. They are low, so that the effect of the freshwater in depressing salinity will not be significant. To estimate the concentration of any dissolved substances in the freshwater, the values in Figure 5-21 can be scaled once the concentration of that substance in the freshwater stream is known.

SALINITY GUIDELINES

The water standards contain a section 8.2.1.4 on 'salinity' which are not referred to in the Impact Assessment. EPA would need a biologist to determine if there are 'stenohaline' organisms that are at risk should the Project go ahead.
The impacts are direct, influencing osmoregulation and indirect by affecting the composition of the ecosystem.

LIMITATION THIRTEEN – the effects of suspended sediment on light and ecological impacts are not determined in any reports. There are optical property guidelines in the water standards.

> The 'Optical Effects' NIWA Report October 2013, **did NOT assess the ecological effects, or environmental impact** of reduced visibility (affecting reactive distance of fish and aquatic birds, and reduced light penetration for benthic algae and phytoplankton). See point 7, on page 11.
>
> *The protocol to be used to derive the appropriate optical properties guidelines for Australian and New Zealand waters is outlined in Section 8.2.3.6, this Volume.*

LIMITATION FOURTEEN 'generalisations' are made due to lack of information

Dr McClary acknowledges on Page 266 (IA), that proposed activities on larval settlement and recolonisation are not categorically defined, so a number of ***generalisations* are** made.

It is important to know the site specific ecological effects. The Graham Bank for example has had no benthic sampling from NIWA.

OSPAR COMMISSION: Quality Status Report 2010 'Assessment of the environmental impact of dumping wastes at sea' - notes that ecological effects will be site specific

- Bolam et al. (2006a, 2006b) concluded that **ecological effects** associated with dredged sediment disposal were **site-specific** and any assessment of the consequences of sediment disposal at sea must take account of site-specific variation in prevailing hydrographic regimes and in ecological status, along with information on the disposal activity itself.

  LIMITATION: There is no discussion in Dr McClary's Report of the effect of light penetration in the mined area, and its impact on re-colonisation.

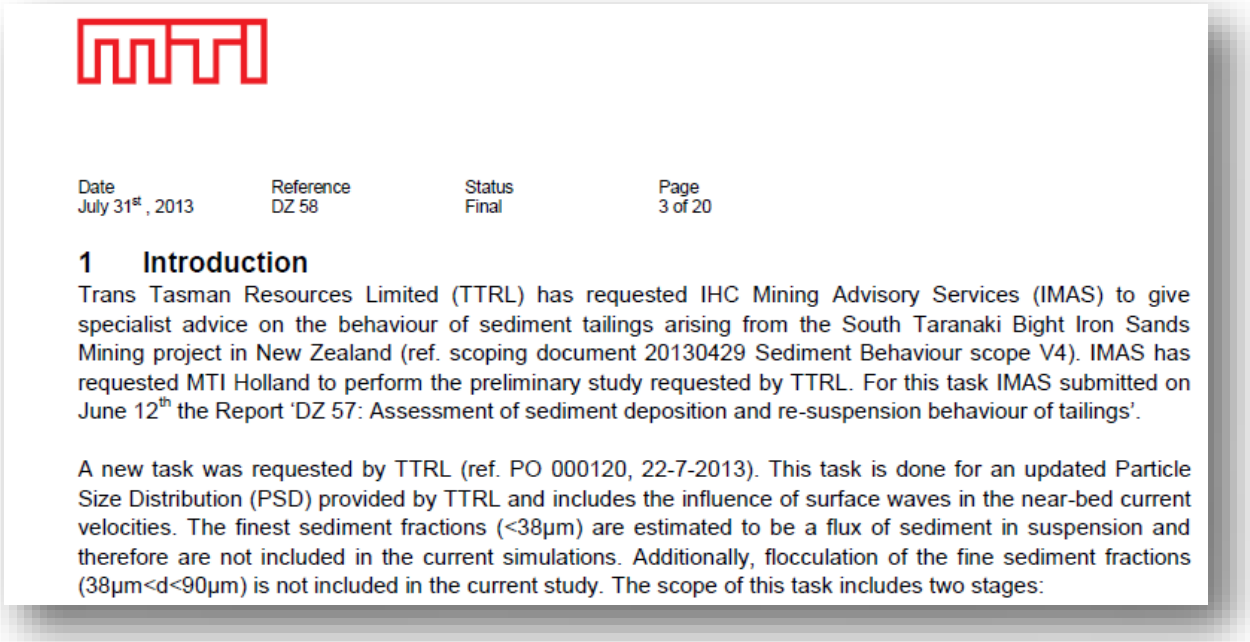
  *Page 69, point 5 of the Optical Effects Report states: "close to the mining source, the median light penetration (euphotic zone depth) was **reduced 4-5 fold, such that light which reached the benthic environment under natural conditions was no longer able to do so.** Lower euphotic zone depth is also **likely to reduce primary productivity** in the water column. Visibility was similarly reduced and there was a shift towards a greyer appearance"*

LIMITATION FIFTEEN: chemical cues for macroinvertebrate larvae will be removed

Page 267 (IA) of Dr McClary's Report states macroinvertebrate larvae preferentially select chemical cues present on the substrates on which to settle and grow. The **Project processes result *in the removal of those cues.***

LIMITATION SIXTEEN: The 'patch area' where the worms are, did not include fine sediment in the modelling – so there is a suspended sediment aspect not addressed

Page 267 (IA) says surficial sediments will be continually winnowed away. However in terms of the patch, and the impact on the benthos community - the tailings modelling done (MTI Holland) for the patch area, did not consider the impact of sediment. The finest sediment fractions (**<38µm**) are estimated to be a flux in suspension **and not included,** and the flocculation of fine sediment fractions (**38<d<90µm**) **is not included** in the study (see page 3 of MTI Report).



Date: July 31st, 2013 | Reference: DZ 58 | Status: Final | Page: 3 of 20

1 Introduction

Trans Tasman Resources Limited (TTRL) has requested IHC Mining Advisory Services (IMAS) to give specialist advice on the behaviour of sediment tailings arising from the South Taranaki Bight Iron Sands Mining project in New Zealand (ref. scoping document 20130429 Sediment Behaviour scope V4). IMAS has requested MTI Holland to perform the preliminary study requested by TTRL. For this task IMAS submitted on June 12th the Report 'DZ 57: Assessment of sediment deposition and re-suspension behaviour of tailings'.

A new task was requested by TTRL (ref. PO 000120, 22-7-2013). This task is done for an updated Particle Size Distribution (PSD) provided by TTRL and includes the influence of surface waves in the near-bed current velocities. The finest sediment fractions (<38µm) are estimated to be a flux of sediment in suspension and therefore are not included in the current simulations. Additionally, flocculation of the fine sediment fractions (38µm<d<90µm) is not included in the current study. The scope of this task includes two stages:

LIMITATION SEVENTEEN: 'recolonisation' is not truly correct – it is 're-adjustment'

Throughout the Impact Assessment the word 'recolonisation' is used. I think it pertinent to consider the following:

- DeGrave and Whitaker (1999) suggest that recovery is not a suitable term to apply when assessing decolonization after a disturbance since recovery implies return to faunal compositions and associated ecological pathways developed over many years. They suggest that **"re-adjustment" rather than recovery is the appropriate terminology.**

LIMITATION EIGHTEEN: repeated disturbances result in succession failing to proceed

The Executive Summary in the Impact Assessment fails to consider the impact at the mining patch due to sediment. The sediment will be continually in the patch environment. The benthic community could never recover because **sediment is disposed there more or less continuously.** Repeated disturbances, such as described by Leuchs and Nehring (1996) to a benthic community results in a succession that never proceeds beyond the initial readjustment phase.

LIMITATION NINETEEN: Cumulative impact of copper and perhaps mercury not determined

In light of the concentrated levels of copper that result from the beneficiation process, and the need to reduce their concentration before 'de-watering' – I have the following comments from the OSPAR Commission, which I believe are pertinent. Aquatic life is particularly vulnerable to copper.

OSPAR COMMISSION 2009

- page 3: More effort is needed to investigate biological responses

- Page 9: Many OSPAR contracting parties have regulatory controls on contaminants levels in dredged materials, but not on total loads.
- Page 11: The EIA should assess the environmental effects to a level of detail sufficient to provide the public and authorities with a proper understanding of the importance of the predicted effects

I am unsure if there are any 'regulatory controls' yet developed for the EEZ. Certainly these would need to be determined before any license could be granted.

Not only the levels of copper concentrations will need to be regulated, but there needs to be an evaluation of the cumulative effect over the life time of the Project.

GREENWAY REPORT

TOURISM

The Greenway Report states the following: Potential adverse effect (only very little) due to effect on TOURISM as activity has limited adverse environmental effects and occurs well away from internationally and nationally important tourism settings.

Given the significance tourism plays in the NZ economy*, before comments are made that there is 'very little effect' – a suitably robust analysis should be done by the Ministry of the Environment and Tourism NZ – to predict the likelihood of the Project impacting on the perception of visitors to NZ. Whales, especially endangered whales, generate international attention. The Blue Whale is such a species, and the proposed extraction site is in close proximity to a likely significant feeding ground. Other species of endangered Whales are known to frequent the South Taranaki Bight.

Factors to consider are: the Project has no historical comparisons for the impact on tourism to be known. There has been no site specific research conducted on whale species and acoustic effects of the Project – any negative impact is unknown with any kind of certainty.

Discussions with Tourism NZ's corporate division (Chris Roberts) indicates that they have had no discussions with TTR on this matter. Mr Roberts indicated that the impact on tourism from environmental impacts caused from Projects of a dredging nature in the EEZ has not been evaluated.

The 3 year marketing strategy FY2014-FY2016 states 'leveraging a strong foundation to accelerate growth'. Any aspect that could potentially impact on this strong foundation needs some analysis done. A 'worst case scenario' could be explored – to try and quantify if there might be an impact on future tourism spend. Given the importance to the NZ economy, this would appear prudent.

*Tourism plays a significant role in the New Zealand economy. In the year ended March 2012 international tourism expenditure contributed **$9.6 billion (15.4 per cent) to New Zealand's total exports** of goods and services up 1.6 per cent, and directly accounted for $6.2 billion (3.3 per cent) of GDP. The tourism industry directly provides **employment for 6.2 per cent of New Zealand's work force and generates $1.3 billion in goods and services tax (GST) revenue.**

Environmental considerations are part of the 'The NZ Tourism Strategy', which has as one of the outcomes 'leading role in protecting and enhancing the environment'.

http://www.nztourismstrategy.com/

LIMITATION: SECONDARY DATA used in Greenway Report have limitations which are not detailed in the Greenway Report

(A) NIWA Recreational Harvest estimates Report 2011

Underestimate of boat harvest for STBight: There was no survey conducted for offshore fishing in the south and north Taranaki Bights. This was acknowledged in the Report as possibly leading to an underestimate of the boat based harvest. This is important to remember when looking at comparative data used in the Greenway Report section 4.3.1.

Geographical excursions in flight path, biases numbers seen towards harbour areas

Figure 4, page 22 of Greenway Report & page 164 of the Impact Assessment

Excursions were made off the 1km flight path, to survey harbour mouths, which is one of the reasons greater numbers of boats can be seen in these areas in comparison to alongshore. This is a geographical bias within the survey.

To get an un-biased representation of activity in the ST Bight, especially the area between Hawera and Patea – the Coast Guard could be contracted to do an aerial survey. An area further out than 1km from the shore should be surveyed.

- Pilot study 2005-06, 10 days of flights
- Full study 2006-07, 45 flights (9 days limited visibility)

The point was not made by Greenway that the project area was flown over as the Coastguard thought the area was commonly fished

The Greenway Report, Page 22 states 'by coincidence' the flight path flew over the proposed mining activity.

The NIWA Report states the reason the area of the Project was flown over, was that the Wanganui Coastguard thought the area was commonly fished.

NIWA Report: Most of the flight path was within one kilometre of the coastline, but with some notable exceptions (Figure 11). Wide loops were flown off harbour entrances, towns and around offshore islands, where fishing is known to occur. The southern flight also ***routinely passed through a series of waypoints off the South Taranaki Bight, which were based on features which the Wanganui coastguard thought were commonly fished.***

SUBMISSION ON WAVE MODELLING

WAVE MODELLING

Seabed mining/dredging results in pits and mounds in the sea bed that can bend the wave direction (refraction) and change the wave height (shoaling). The magnitude of the impact is has been determined using numerical modelling (using the SWAN near shore wave model). The model predicts wave conditions produced as a result of specified wind conditions acting over a specified 'bathymetry' (various depths of the seabed). Waves are affected by currents at the top and bottom of the sea.

TWO MODELLING APPROACHES WERE USED IN PHASE 4:

'SCENARIO BASED' & 'LONG TERM SUPERCOMPUTER'

LIMITATION ONE: BATHYMETRY FOR PHASE 4 – doesn't extend to Wanganui and does not include the area out to where the ship will be moored

Page 16 and 17 give the bathymetry grids used. IMPORTANTLY the 'red grid' shown on page 17, was NOT used in the Phase 4 modelling. This grid covers the area down to Wanganui. Instead the reduced bathymetry shown as 'orange' was used. This grid is known as 'Xantia'.

It is interesting to note that the grid area for bathymetry goes to a maximum longitude of 173.924ºE, yet the ship will have a mooring at a longitude of 174.1950. I would have thought it appropriate to have the bathymetry for the area of operation, rather than 'fall short' as has been this case (see page 27 Wave Modelling Report).

NIWA's forecasting system used weather (NZLAM-12), tide (NZTIDE-12) and wave models (NZWAVE-12).

LIMITATION TWO: USE OF THE SUPERCOMPUTER, only one of the eight bathymetry cases was done, because of the 'high computing resource'.

Included were the tidal sea level and current inputs
A long term simulation was run on the NIWA supercomputer – for only one bathymetry case. The 'worst case' scenario was used, Case 01, where there is a pit and a mound at the end of each run.

See page 45 of the Wave Modelling Report

LIMITATION THREE: RESULTS GIVEN ARE ON A MEAN BASIS ONLY, WITH STANDARD DEVIATIONS. I would like to know the maximums, page 48

Results from the supercomputer, as per page 48 of Wave Modelling Report – for the worst case for pits and mounds (Case 01). The results are on a mean basis (average).

MEAN INCREASE with two standard deviations – which gives 95% confidence has not been done. Nor for that matter has three standard deviations – to give 99% confidence.

I think you need to be careful when discussing the mean. Whilst of benefit, it is also good to talk in terms of the 99% or 3 standard deviations. The top graph shows a range between a **7cm drop in waves at Patea, and a 5cm increase just North of Patea (at 1 standard deviation results).**

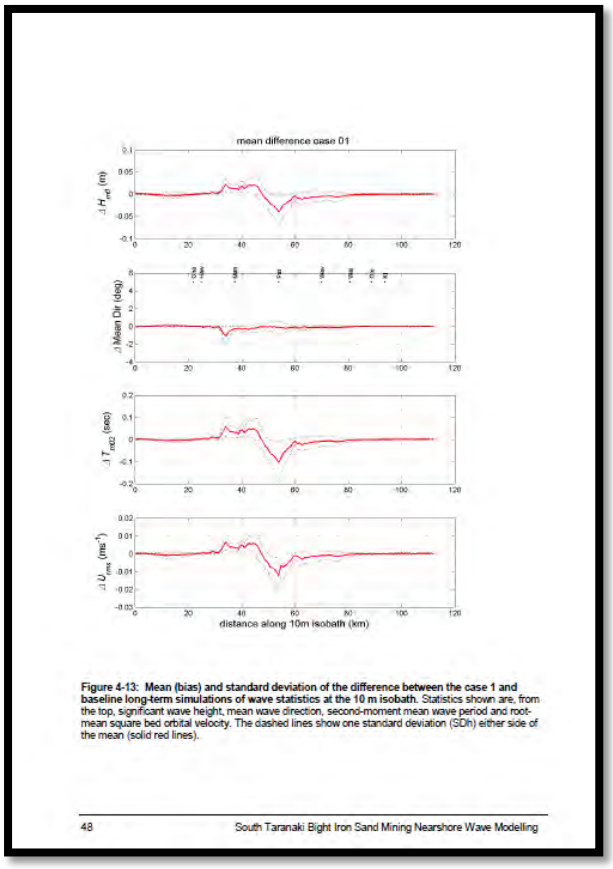


Figure 4-13: Mean (bias) and standard deviation of the difference between the case 1 and baseline long-term simulations of wave statistics at the 10 m isobath. Statistics shown are, from the top, significant wave height, mean wave direction, second-moment mean wave period and root-mean square bed orbital velocity. The dashed lines show one standard deviation (SDh) either side of the mean (solid red lines).

LIMITATION FOUR: Impact Assessment, Executive Summary, misses long term supercomputer modelling

The Executive Summary only discusses the 'scenario-based' modelling AND DOES NOT REFER TO THE LONG-TERM SUPERCOMPUTER modelling results.

Waves	The overall conclusion from the scenario-based modelling is that the proposed sand extraction operations will have minor effects on the physical driver of waves by refracting (bending the wave direction) and shoaling (changing the wave height) them as they pass over the modified seabed. The changes in wave height, period and direction are very small.

LIMITATION FIVE – the environmental scenarios were in November, when the weather is good. This is a bias against poor winter weather conditions

A set of SIX ENVIRONMENTAL SCENARIOS (page 23)

1. N/W waves + closest wave to 2m for November 2011
2. N/W waves + highest wave height for November 2011
3. S/W waves + closest wave to 2m for November 2011
4. S/W waves + highest wave height for November 2011
5. S waves + highest wave height for November 2011
6. S waves + highest wave height for November 2011

LIMITATION SIX – the SWAN modelling did not input tidal level and **currents**, for scenario based simulations

SWAN was then run on the Xantia domain for each of the **eight bathymetry configurations (page 22)** Tidal sea level and current inputs were NOT used in these 'scenario based' simulations.

Picture below, as per Page 22 of the Wave Modelling Report, showing all the different 'pits and trough' scenarios i.e. the 'bathymetry configurations'

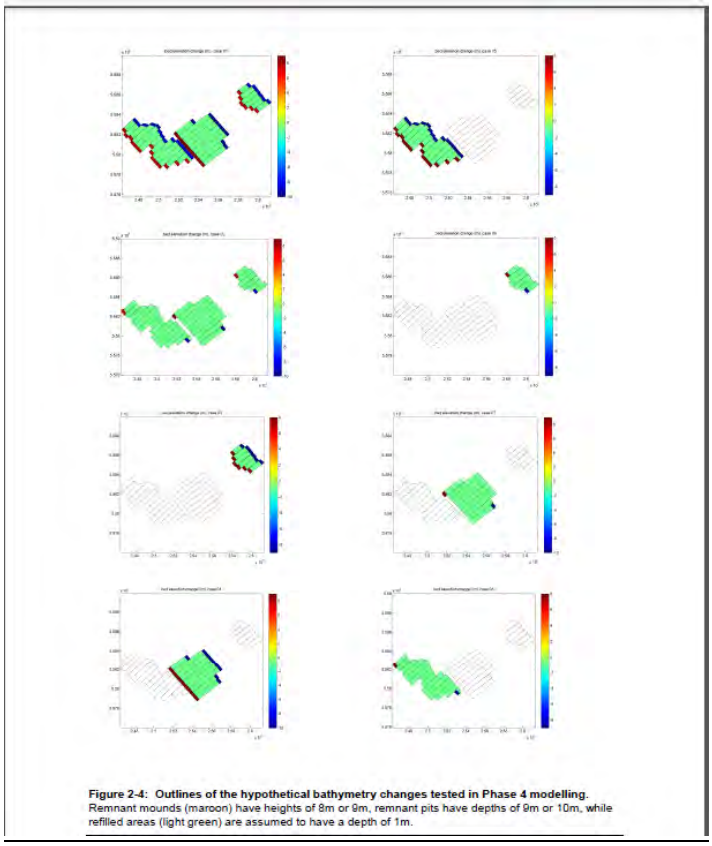


Figure 2-4: Outlines of the hypothetical bathymetry changes tested in Phase 4 modelling. Remnant mounds (maroon) have heights of 8m or 9m, remnant pits have depths of 9m or 10m, while refilled areas (light green) are assumed to have a depth of 1m.

LIMITATION SEVEN: 'scenario based approach on wave conditions only considers one large vessels & misses other ones

See page 27 of the phase 4 'near-shore wave modelling Report'.

- Simulations were run ONLY RUN for the FPSO (Floating Production, Storage and Offloading Vessel)
- FPSO 330m (page 18 Impact Assessment) SIMULATION INCLUDED THIS
- FSO 230m (page 33 Impact Assessment) THIS WAS **NOT** INCLUDED
- Anchor handling Tug 64m, (page 38 Impact Assessment) THIS WAS **NOT** INCLUDED
- TANKER VESSEL, large (page 39 Impact Assessment) THIS WAS **NOT** INCLUDED
- BULK CARRIER EXPORT VESSEL (page 36 Impact Assessment) THIS WAS **NOT** INCLUDED

Page 63 states that (at the 10m isobath) the effect in wave height is less than 1cm, between Manawapou and Patea.

LIMITATION EIGHT: the SWAN model provides a satisfactory representation of wave conditions at 10m, but this is the limit. **Model bathymetry is too poorly defined further shoreward, to reliably use the SWAN model** to take wave conditions from 10m into the coast (page 26 wave modelling report)

Due to this limitation, to determine wave conditions at the beach 'refraction and shoaling relationships' using piece-wise straight coast approximations and **sediment transport parameters were derived using relationships in the 'Shore Protection Manual'**.

LIMITATION NINE: for the study, information on the varying beach sediment properties (e.g. grain size) was not incorporated. Page 26 Wave Modelling Report

The formula for the 'longshore sediment flux' is as follows:

Q = fKP ls (see page 26 of the Wave Modelling Report). K is the 'constant' at 0.8 which is appropriate for 'sandy beaches' – LOWER VALUES will be required if coarser material is present.

From this we can deduce that the large areas of rocky shore along the coastline, **have not been factored into the modelling formula.**

LIMITATION TEN: there is a recognised limitation of the model, where it tends to over-estimate wave heights at the offshore measurement sites, particularly for short periods of westerly dominated conditions (page 29)

The comment is made that should an 'absolute value' of predicted wave statistics be of primary importance – this limitation would be needed to be taken into account.

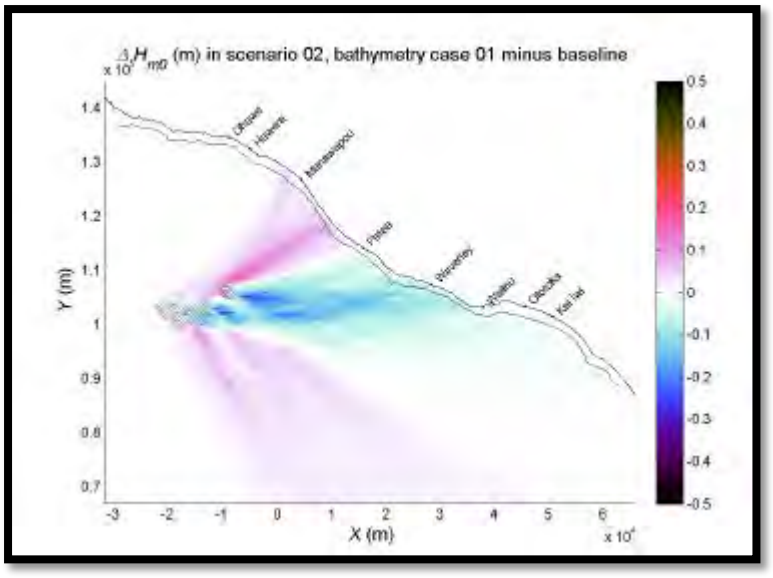
LIMITATION ELEVEN: the model is accurate for determining near-shore conditions to off-shore conditions – but localised bathymetric influences on swell may not be fully represented.

Once again this supports the comments made earlier – the impact of the rocky shore – has not been well determined by the SWAN model.

LIMITATION TWELVE: the 'worst case scenario' for the 'worst case bathymetry': **(30cm difference in wave height)** could be higher if November wasn't used in the modelling.

You can see from this extract from page 36 – that the 'difference in wave height' due to the mounds and pits is **30cm greater height towards Manawapou and 30cm less wave height towards Patea.**

If the Environmental factors were changed to winter months, rather than having used November, we would see even bigger wave height variations.



Graph from page 26 of Wave Report

LIMITATION THIRTEEN: **THE IMPACT ASSESSMENT SHOWS THE WRONG CASE STUDY on page 208 and so underestimates the increase in wave height – stated 10cm when the result was 30cm**

The Impact Assessment on page 208, states the worst case scenario is for case 01 scenario 06 at 10cm. The worst case scenario is actually case 01 scenario 02 at 30cm.

Case 1, scenario 2 results in 30cm increases in wave height north of Patea, and 30cm decrease around Patea.

CASE 01 THE 'WORST CASE SCENARIO' over the full domain shows a maximum wave height change of 40cm – a 12.6% change

This Table 4-1 on page 38 of the Wave Modelling Report, shows that for Case 1 (which is where there is a pit and a mound at the end of each run) over the whole area modelled, there would be a maximum change of 40cm – a 12.6% change in wave height.

Table 4-1: Maximum changes in significant wave height predicted for the eight bathymetry modification cases. Changes are expressed in absolute terms (metres) and relative terms (%), either over the full model domain or along the 10 m isobath.

	full domain		10 m isobath	
case	max (m)	max (%)	max (m)	max (%)
1	0.436	12.6	0.116	9.2
2	0.232	9.0	0.045	3.8
3	0.348	10.9	0.050	3.5
4	0.245	10.0	0.050	4.3
5	0.228	9.1	0.052	4.8
6	0.239	7.9	0.018	1.4
7	0.177	6.6	0.022	1.9
8	0.096	4.6	0.010	0.9

LIMITATION FOURTEEN: THE TTR IMPACT ASSESSMENT, PAGE 208 HAS the WRONG FIGURES, TTR state a full domain result as 28cm, when the result was 44cm

For example for case 1 – the maximum change in wave height is 44cm. Whereas the TTR figures on page 228 show 28cm.

THE WAVE DIRECTION CHANGES BY -2º IN AN ANTI-CLOCKWISE DIRECTION IN A LOCALISED AREA WEST OF MANAWAPOU page 37 of the Wave Modelling Report.

LIMITATION FIFTEEN: 'wave model verification' differences between modelled & measured

As detailed on page 81 – the main difference between the modelled results and the measured results at Sites 1 & 3 'Dobbie sites' were due to Southerly conditions. The explanation for the difference was put down to bathymetry data not being accurately represented in the model.

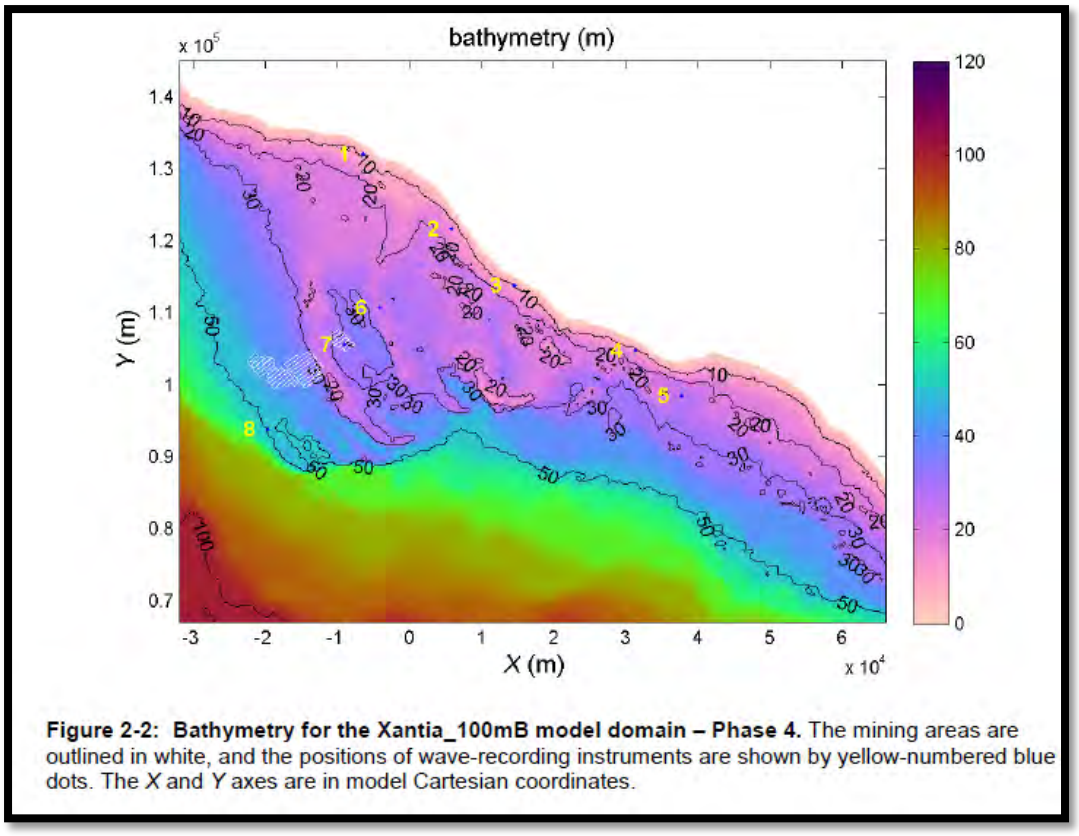


Figure 2-2: Bathymetry for the Xantia_100mB model domain – Phase 4. The mining areas are outlined in white, and the positions of wave-recording instruments are shown by yellow-numbered blue dots. The *X* and *Y* axes are in model Cartesian coordinates.

SUBMISSION ON 'MARINE MAMMALS'

SUBMITTER'S RECOMMENDATIONS &

LIST OF LIMITATIONS CONTAINED WITHIN THE IMPACT ASSESSMENT & SUPPORTING REPORTS

The Impact Assessment 'Executive Summary' states the following:
*"The STB in the region around TTR's operational area **generally is not a recognised habitat for marine mammals.** No interactions with marine mammals are anticipated. In any event, TTR will establish protocols for encounters with marine mammals to ensure adverse effects do not arise."*

*Noise generated from the FPSO and the Crawler will have **no more than minor** effect on fish and marine mammals.*

MARINE MAMMALS: OVERVIEW

The Impact Assessment is severely deficient in explanatory comment. Indeed there is none! See pages 156-159. Considering that we know the endangered blue whales feeds on plankton masses the borders of which lie in close proximity to the dredging site – this lack of detail is unacceptable.

No attempt has been made in the supporting technical Report by Hegley, to determine the total sound levels in dB for this Project. The Report fails to provide substance for assumptions on frequencies of sound. Acoustic analysis for the endangered species frequenting South Taranaki Bight waters was not provided either – a significant omission being for the Blue Whale.

A specialised **marine acoustic specialist** will need to determine the ***sensitivity*** of mammals, especially endangered mammals, to the frequencies and dB emitted from the Project site. Based on the limited analysis I have done in 'Point 7' – endangered species may be *sensitive* to the proposed Project.

The *probability/vulnerability* of mammal species is the likelihood the mammal will be exposed to the stressor to which it is sensitive. The NIWA report on **habitat** details a habitat suitability in proximity to the proposed Project of 62-69% for killer whales, 30-50% for the southern right whale, and a 46-80% suitability for the Hector dolphin. One can probably conclude from this that the *vulnerability* of these species is high – to the proposed Project.

RECOMMENDATIONS TO ADDRESS SEVERE DEFICIENCIES IN CURRENT KNOWLEDGE ABOUT THE IMPACT FOR MARINE MAMMALS

Overall Recommendation:

To enable a **robust risk assessment** of the potential impact this Project will have on marine mammals – a number of the recommendations listed below need to be addressed.

Recommendation One: Conduct a systematic survey for marine mammals in the ST Bight region.

This will provide a **scientific basis for making comments on the habitat suitability** of this region. It will also provide a ***non-biased distribution pattern*** of mammals. It is important to note, recent research papers comment on the fact that 'the ecological function and purpose of this region for all five endangered species of mammals remains poorly understood',

Recommendation Two: Obtain further research into the blue whale foraging ground

A 2013 Research Article published by Dr Torres presents evidence that the **South Taranaki Bight is a blue whale foraging habitat.** Also in response to the recent 2012 NIWA Report that the region is likely to be **an important foraging ground for blue whales.**

Recommendation Three: Conduct further research into meso-zooplankton – as the South Taranaki Bight may represent a breeding ground for zooplankton

If the STBight is a breeding ground – this in turn promotes aggregations of larger predatory species – particularly squid. **Biomass estimates are among the highest recorded when other coastal regions around NZ are considered**. The meso-plankton species is a 'near-shore' species and is influenced by the currents from Cape Farewell and D'Urville. The TTR Project is 50km to the east *of the centre* of the foraging area (so a lesser distance, if you consider the edge of the foraging area.)

Recommendation Four: Local divers, fishermen and public should be surveyed about whale and dolphin sightings.

Consider how other recreational fishermen and **divers** may be sampled to determine their sightings. Consider how the general **public sightings** are to be obtained. The data period could be 2012 and 2013. Consideration needs to be given to continually updating the data set – by ensuring all these groups continue to report sightings.

Recommendation Five: Encourage 'sightings' data to also include the number of mammals at each sighting.

This enhances understanding for the reader and aids in interpreting the significance of numbers given. For example page 141 of the Impact Assessment has the nationally critical Killer Whale shown as 6 '*sightings*', but the '*number*' of mammals seen was 17.

Recommendation Six: Determine the vocalisations of marine mammal species in the South Taranaki Bight – with acoustic monitoring to detect the presence of marine mammal and anthropogenic sounds using a 'high frequency acoustic recording package (HARP).

Obtain data analysis of sounds of interest, such as obtaining long-term spectral averages and spectrograms and where possible automated computer algorithm detection. The HARP packages

can record underwater sound from 10Hz to 100 kHz and are capable of storing 150 days of continuous data storage.

Recommendation Seven: Obtain current data spanning the periods 2011, 2012 & 2013 from DOC observational datasets

Obtain scientific analysis of those results (this can mean using 'confidence ratings' for sightings, and ensuring 'no double-ups' of sightings). I have pulled a set of data from the periods suggested, and while the data will be subject to the limitation of not having been 'scientifically analysed' – the data does at least give an indication of the levels of 'sightings' in the region of interest (see limitation two below for this data)

Recommendation Eight: For each marine mammal of interest a schematic diagram showing zones of sound should be prepared

A graph of similar construct to that below should be prepared. This graph shows dB, but it would be beneficial to prepare one with frequency (kHz).

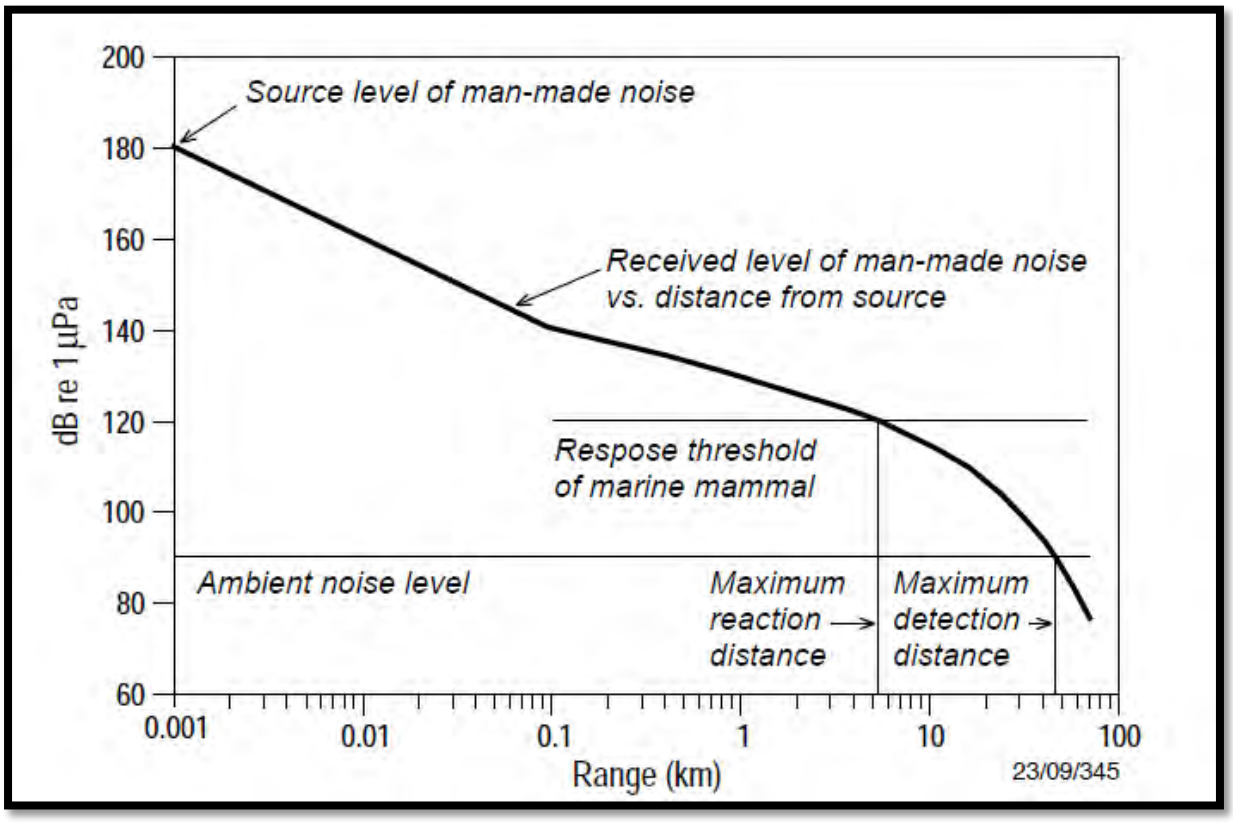


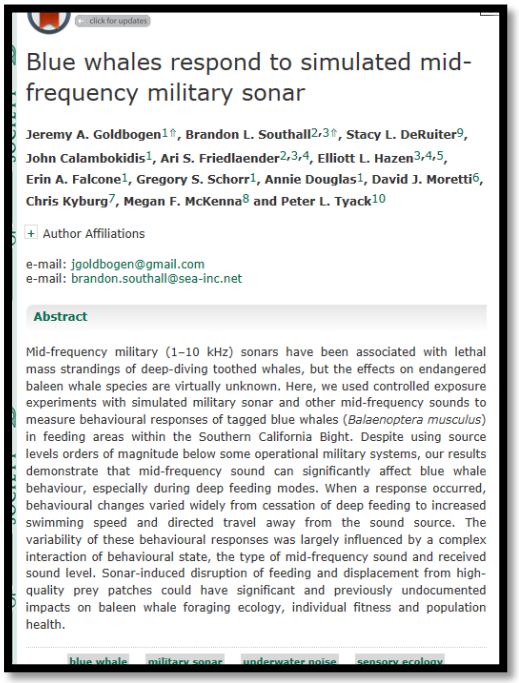
Figure 1: Schematic diagram showing zones of influence around a sound source in the ocean (Richardson et al., 1995).

The area of influence of an acoustic survey can be understood using the schematic

Diagram of Richardson et al. (1995) (Fig. 1).

The *maximum detection distance* is the distance at which a sound is audible above the ambient noise. The *maximum reaction distance* is the distance at which animals exhibit behaviour changes.

Consider 'best available data' such as current Stanford University research into Blue Whales – showing mid-frequency sounds significantly affecting feeding behaviour



Blue whales respond to simulated mid-frequency military sonar

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Abstract

Mid-frequency military (1–10 kHz) sonars have been associated with lethal mass strandings of deep-diving toothed whales, but the effects on endangered baleen whale species are virtually unknown. Here, we used controlled exposure experiments with simulated military sonar and other mid-frequency sounds to measure behavioural responses of tagged blue whales (*Balaenoptera musculus*) in feeding areas within the Southern California Bight. Despite using source levels orders of magnitude below some operational military systems, our results demonstrate that mid-frequency sound can significantly affect blue whale behaviour, especially during deep feeding modes. When a response occurred, behavioural changes varied widely from cessation of deep feeding to increased swimming speed and directed travel away from the sound source. The variability of these behavioural responses was largely influenced by a complex interaction of behavioural state, the type of mid-frequency sound and received sound level. Sonar-induced disruption of feeding and displacement from high-quality prey patches could have significant and previously undocumented impacts on baleen whale foraging ecology, individual fitness and population health.

blue whale military sonar underwater noise sensory ecology

Consider the fact that auditory damage is more likely and thresholds lower for repeated exposure – such as the Project noise will be

Auditory damage

The thresholds of auditory damage in marine animals is difficult to assess and the Subject of ongoing research. Richardson et al. (1995) and Gordon et al., (1998) review the problem. They note that damage is more likely and thus thresholds are lower for repeated exposure. The dredging process will be a 'repeated exposure' situation.

Consider the STBight as a 'sensitive area' due to high biomass of plankton

The areas in which whale concentrations are likely to be highest are zones of high krill abundance. (Gordon et al., 1998).

The South Taranaki Bight is known for its high biomass of plankton.

Recommendation Nine: Obtain a robust, inclusive total dB from the Project

One this has been determined – calculations on 'masking' can be done.

Recommendation Ten: The Risk Assessment prepared for the Ministry for the Environment in 2011, needs to be re-evaluated

In light of the recent NIWA research and other data that has come to light over the recent years the MfE Risk Assessment needs to be re-evaluated.

Recommendation Eleven: Impact Assessment, Section 15 'Measures to avoid, remedy and mitigate adverse effects' presently fails to address the need to manage noise and its impact on marine life. **This needs to be remedied.**

Recommendation Twelve: Commission a report from the Orca Research Trust

A database not utilised is the Orca Research Trust. Ingrid Visser, specialises in Orca and may have useful information on Orca in the STBight.

Recommendation Thirteen: Tap into the Inshore Observer Programme 2013/14

The Ministry for Primary Industries (MPI) and the Department of Conservation (DOC) have asked for submissions by Wednesday 29 May 2013 – for the purposes of observations of dolphins on NI West Coast. If the observations also included whales, it would prove beneficial in increasing local and national knowledge of the biodiversity of this region.

LIMITATION ONE: A significant data-set has been ignored

A significant data-set has been ignored when presenting findings on mammals frequenting the region. This data set is the **observations of recreational fishermen and public *who fail to report sightings to DOC***. While this data-set will have its limitations (need for a 'confidence rating' from DOC and 'observational bias') it provides an indication of the frequency with which sightings are occurring in the ST Bight. These sightings are occurring within the limited nautical miles out to sea that recreational fishermen go or within viewing distance of the shore.

The brief time I have spent talking over the past two weeks with residents of Hawera has enabled me to gather the following information about sightings of whales & dolphins – all of which were **not reported to DOC.**

WHALES

1. Denby Road (outside of Hawera) in **September 2013:** A mother whale and her calf, who were seen very close to the mussel beds. The observer was in his paddock which overlooks the sea.

2. **2013** in the Patea river mouth was a whale. The local Coast Guard alerted boaties. Details could be obtained from the Coast Guard if needed.

3. Patea sighting of 5 killer whales on **06/12/2013**, one of which was a calf. A video of the event has been taken and as at 15/12/2013 we are looking at obtaining 'stills' should they be required in the Hearing. 7 miles out west of the bar.

4. **19/05/2013**: Sighting of orcas – 3 to 4 miles off the coast of Patea.

DOLPHINS

1. **22 November 2013** – a pod of dolphins estimated at 150m wide.
2. Approximately **early November** a pod of dolphins sighted 300 metres offshore at Ohawe beach – estimated size of 100m x 30m.

Note: I have all the contact details for people supplying the information above

LIMITATION TWO: Recent data relevant to the TTR Project, has not been incorporated in TTR's Impact Assessment – s61 (1) of the EEZ requires the EPA to base decisions on the 'best available information'

Recent data relevant to the TTR Project, has **not** been incorporated in TTR's Impact Assessment:

1. the latest sightings reported to NIWA scientist Dr Torres in 2013
2. Research results from a 2012 NIWA study.
3. DOC database, for all marine mammal sightings from 2008 to end of 2013.

1. *Recent South Taranaki Bight sightings reported to Dr Torres* (after the acceptance of her paper *'Evidence for an unrecognised **blue whale** foraging ground in NZ')* were 49 blue whale sightings, including 33 from a 2011 seismic survey. As the TTR Impact Assessment used older data – only 2 blue whale sightings are listed by comparison (page 141 of the Impact Assessment)

2. *The second is NIWA study on marine mammal distribution off Taranaki, published in March 2012 – "Marine mammal distribution patterns off Taranaki, NZ, with reference to OMV NZ Ltd petroleum extraction in the Matuku and Maari Permit areas".*

   This Report contained more recent research, than used by TTR in their Impact Assessment. For this Report, a wider study area around the OMV area of interest was done so as to include *potential feeding grounds* and *migration pathways. Particular attention was given to the distribution of blue whale sightings **due to increased sighting rates in the study region, limited knowledge of their ecology and distribution, and their high conservation status.***
   - Incidental sightings collated by DOC
   - Incidental sightings recorded by transiting ships by Martin Cawthorn
   - Observations collected by Ministry of Fisheries inshore fisheries observers.
   - Seismic survey data conducted by OMV (May, June, July **2011**)

3. *DOC database 2008-2013*

   I have reviewed a subset of this – 2011 to 2013:Understanding that I have not 'scientifically analysed' the following data, so there *will be limitations associated* at looking at the results (see Recommendation six) – I feel it is pertinent to share DOC sightings data for 2011,2012 & 2013.

DOC DATABASE 2012 to DECEMBER 2013

Sighting Number	Species	Date	Latitude Decimal	Longitude Decimal	Number	Numberof Calves
2450	SEI WHALE	8/3/2013	-40.03966667	173.0456667	1	0
2547	TOOTHED WHALE	13/4/2013	-39.21916667	173.2955	1	0
2555	TOOTHED WHALE	18/4/2013	-39.24516667	173.3825	1	0
2545	TOOTHED WHALE	11/4/2013	-39.22083333	173.418	1	0
2550	PILOT WHALE	14/4/2013	-39.27333333	173.2688333	30	0
2618	PILOT WHALE	22/7/2013	-39.6469	173.3156	5	0
29	PILOT WHALE	11/3/2012	-39.28775	173.4575444	100	10
2541	UNKNOWN BALEEN WHALE	6/4/2013	-39.25166667	173.3341667	4	0
2548	TOOTHED WHALE	14/4/2013	-39.30033333	173.4703333	1	0
590	UNKNOWN WHALE	4/2/2012	-40.26666667	173.4833333	3	0
2458	COMMON DOLPHIN	1/1/1900	-40.17683333	173.0058333	88	0
2459	COMMON DOLPHIN	20/3/2013	-40.11133333	173.006	6	0
2457	COMMON DOLPHIN	20/3/2013	-40.24686667	173.0060667	420	0
2481	COMMON DOLPHIN	31/3/2013	-40.13866667	173.0305	125	0
1009	COMMON DOLPHIN	17/11/2012	-39.623673	173.309326	50	0
2510	BLUE WHALE	22/2/2013	-40.33666667	173.00135	3	0
2469	BLUE WHALE	24/3/2013	-39.91771667	173.0022667	1	0
2461	BLUE WHALE	21/3/2013	-40.1015	173.0071667	1	0
2515	BLUE WHALE	23/2/2013	-40.23833333	173.0108	10	0
2437	BLUE WHALE	3/3/2013	-39.79283333	173.026	1	0
2454	BLUE WHALE	11/3/2013	-40.02818333	173.0326667	2	0
2427	BLUE WHALE	1/3/2013	-39.79416667	173.0326667	1	0
2453	BLUE WHALE	10/3/2013	-40.1595	173.03545	2	0
2464	BLUE WHALE	22/3/2013	-40.12721667	173.0367333	1	0
2465	BLUE WHALE	22/3/2013	-40.01	173.041	4	0
2442	BLUE WHALE	3/3/2013	-40.17133333	173.0425	1	0
2428	BLUE WHALE	2/3/2013	-39.8625	173.0436667	3	0
2436	BLUE WHALE	2/3/2013	-39.85533333	173.0463333	1	0
2443	BLUE WHALE	3/3/2013	-40.0965	173.0503333	5	0
2444	BLUE WHALE	3/3/2013	-39.951	173.0506667	1	0
2432	BLUE WHALE	2/3/2013	-40.1165	173.0518333	2	0
2433	BLUE WHALE	2/3/2013	-40.09566667	173.052	3	0
2434	BLUE WHALE	2/3/2013	-40.02566667	173.052	2	0
2435	BLUE WHALE	1/1/1900	-39.98981667	173.0535333	4	0
2426	BLUE WHALE	1/3/2013	-39.99316667	173.0571667	1	0
2511	BLUE WHALE	22/2/2013	-40.32878333	173.06315	1	0
2512	BLUE WHALE	22/2/2013	-40.25746667	173.0806	4	0
2518	BLUE WHALE	29/3/2013	-39.75941667	173.0809	1	0
1008	BLUE WHALE	19/11/2012	-39.623673	173.309326	1	0
1869	BLUE WHALE	19/11/2012	-39.64694444	173.3155556	5	0
1870	BLUE WHALE	22/11/2012	-39.64694444	173.3155556	5	0
814	BLUE WHALE	26/11/2012	-39.63033333	173.4551111	1	0

DOC (OLD) DATABASE FOR 2011 SIGHTINGS

Sighting Number	Species	Date	Location	LatitudeDecimal	LongitudeDecimal	Number	Numberof Calves
8449	COMMON DOLPHIN	4/7/2011	CHA	-39.65873333	173.015	8	
8445	BALEEN WHALE	24/6/2011	CEW	-39.62216667	173.0262667	2	
8441	BALEEN WHALE	16/6/2011	CEW	-39.40496667	173.031	1	
8437	BALEEN WHALE	9/6/2011	CEW	-39.547	173.0674833	1	
8414	BALEEN WHALE	23/5/2011	CEW	-39.51621667	173.0859667	1	
8443	BALEEN WHALE	21/6/2011	CEW	-39.63956667	173.1036333	1	
8420	BALEEN WHALE	31/5/2011	CEW	-39.57283333	173.10555	1	
8419	BALEEN WHALE	31/5/2011	CEW	-39.49113333	173.1256667	1	
8413	BALEEN WHALE	23/5/2011	CEW	-39.47886667	173.1465667	1	
8431	BALEEN WHALE	6/6/2011	CEW	-39.53063333	173.1616	1	
8433	BALEEN WHALE	7/6/2011	CEW	-39.6821	173.1853	2	
8412	BALEEN WHALE	23/5/2011	CEW	-39.48108333	173.2061	2	
8389	UNKNOWN DOLPHIN	14/5/2011	CEW	-39.60983333	173.2221	8	
8434	UNKNOWN WHALE	8/6/2011	CHA	-39.6901	173.0739833	1	
8432	UNKNOWN WHALE	7/6/2011	CEW	-39.61188333	173.0980333	1	
8436	UNKNOWN WHALE	8/6/2011	CEW	-39.62598333	173.137	1	
8936	UNKNOWN WHALE	8/12/2011	CEW	-39.61175	174.6033667	2	
7031	MINKE WHALE	12/4/2011	New Plymouth	-39.16835	173.74985	1	
8709	HUMPBACK WHALE	7/12/2011	Off Port Taranaki	-39.00669	174.00044	1	
8440	BLUE WHALE	16/6/2011	CEW	-39.52686667	173.0061833	1	
8438	BLUE WHALE	10/6/2011	CEW	-39.53121667	173.0622	1	
8439	BLUE WHALE	10/6/2011	CEW	-39.59011667	173.0628167	2	
8421	BLUE WHALE	31/5/2011	CEW	-39.64633333	173.1034833	1	
8425	BLUE WHALE	3/6/2011	CEW	-39.40468333	173.1211167	1	
8424	BLUE WHALE	3/6/2011	CEW	-39.43356667	173.1475	1	
8429	BLUE WHALE	6/6/2011	CEW	-39.6575	173.1564333	1	
8423	BLUE WHALE	3/6/2011	CEW	-39.44511667	173.1570167	1	
8418	BLUE WHALE	31/5/2011	CEW	-39.5837	173.17615	2	
7029	BLUE WHALE	11/4/2011	Taranaki	-39.6169833	173.613733	2	
7030	BLUE WHALE	11/4/2011	Taranaki	-39.6169833	173.613733	2	
6961	KILLER WHALE	13/1/2011	Stent Road, Taranaki	-39.22705111	173.7732653	15	6
6962	KILLER WHALE	13/1/2011	Oakura, Taranaki	-39.11035	173.94791	2	
6960	KILLER WHALE	13/1/2011	North of Tapuae Marine Reserve	-39.0641675	174.0151533	2	
8470	KILLER WHALE	7/10/2011	Port Taranaki	-39.04932	174.03889	5	
6963	KILLER WHALE	17/1/2011	80m off East End beach	-39.04626083	174.0920833	2	2
6964	KILLER WHALE	17/1/2011	100m off East End beach	-39.04626083	174.0920833	1	1
7041	KILLER WHALE	6/6/2011	Off Waiwhakaiho River	-39.0332	174.1052167	3	

MarMamObs_occurenceID_number	Historic_ID	Species	verificationStatus	Date_event_observed	decimalLatitude	decimalLongitude	location verbatim	Number_adults	Number_juveniles
715	800	Maui's	3	18/2/2012	174.884	-39.938	Between Kai Iwi beach and Whanganui Bar	3	1
725	810	Maui's	5	24/3/2012	174.2912	-39.8013	Offshore from Patea, South Taranaki	4	0
723	808	Maui's	**3**	19/4/2012	173.4509	-39.6267	Maui A Offshore Oil Platform	1	0
911	996	Maui's	**0**	23/11/2013	173.2439	-40.0333	alled Manaia 2. offshore in Cook Strait inbetween Farewell Spit a	1	0

verification status:

3	Description of colour and dorsal fin is consistent with Hector's/Maui's, but not considered within CURRENT range of either species
5	Description of dorsal fin is possibly consistent with Hector's/Maui's, but given the location, group size, and lack of other information considered not possible to confidently score
3	fits the desricption of Hector's/Maui's but outside of current range
0	with validator

Karen's Note: Please see the above comments in light of a recent NIWA report on 'Habitat Models of southern right whales, Hector's dolphins and killer whales' which states on page 10 "The Maui dolphin population is distributed along the western coast of the North Island, potentially including the TTR proposed project area". Also on page 10 of that report " DNA genotyping of individuals suggest that both SI Hector dolphins and NI Maui dolphins use the ST Bight"

Listed below are the **Reports used by TTR** in the October 2013 Impact Assessment – note the dates of the data.

1. NIWA Habitat Models – of southern right whales, Hector's Dolphin and Killer Whales 2013
   Please note, Blue Whales and Humpback's not in this Report

   - DOC database of *verified* sightings **2012**
   - Martin Cawthorn (unpublished data) of recordings by transiting ships, between **1979-1999**
   - Ministry of Fisheries COD database **2011**
   - NIWA (unpublished data) January **2012**

2. NIWA STBight Factual Baseline Environmental Report 2011– section 9 – Whales & dolphins of the ST Bight
   - *February **1980** to December **2007** from DOC database and Martin Cawthorn.*

LIMITATION THREE – the Impact Assessment uses sightings data 1980-2007

The Table of 'sightings' on page 141 of the **Impact Assessment** referenced off to the 2011 NIWA report. Unless readers have read the NIWS Report they would be unaware of how dated the research was. Data used in the 2011 Report spanned the period 1980-2007.

LIMITATION FOUR The habitat models report by NIWA missed the blue whale and humpback whale

The 'habitat models' TTR commissioned NIWA to do, was only for a subset of endangered whale species. Two other endangered species are the blue whale and humpback whale – the blue whale in particular has been recorded in the ST Bight region in significant numbers.

LIMITATION FIVE The Impact Assessment Executive Summary is misleading about habitat suitability

The Impact Assessment details on **habitat suitability*** as per the 2013 NIWA Report - **does not appear to be clearly reflected** in the IA Executive Summary.
'*The STB in the region around TTR's operational area generally is not a recognised habitat for marine mammals.'*

Hector's dolphins: average to above average suitability
Pockets of increased **habitat suitability** (>46%) were predicted about 8km offshore adjacent to the TTR proposed project area. If you look at Figure 3-20 of the NIWA Report, there are two areas along the coast just to the left and right of the Project (three 1 km² grids) with a predicted **habitat suitability** of **80%.**

Southern Right Whales: low to moderate predicted habitat suitability
The ST Bight may reflect a migration pathway that southern right whales use while transiting to more suitable wintering ground to the North or South.

Southern Right Whales are known to 'hug' shorelines while migrating with calves in order to avoid predators.

Figure 54 on page 144 of the Impact Assessment is useful:
30% habitat suitability on the coastal strip within 5km of the coastline - opposite to the TTR proposed project
50% habitat suitability further south along the ST Bight

Killer Whales: low to moderate suitability
8 km seaward of the proposed Project is a **habitat suitability** of **62-69%.** Whales may be using this habitat as a foraging ground as it is known to have increased abundances of prey fish such as Kahawai and school shark. (See Figure 3-34 of NIWA Habitat Models Report 2013)

In the proposed ***Project area*** the highest **habitat suitability** is 29%.

LIMITATION SIX: Sightings data must be interpreted with caution

The NIWA Reports have the following comments to make about the data used in their reports: *the sightings data **must be interpreted with caution,** as the sampling is **presence only** i.e. the absence of sightings in an area does not indicate that marine mammals do not use that habitat, only that no sightings have been recorded there. The databases also suffer from **observational bias** – for example higher sightings can be due to **increased observational effort** due to higher population density and observation programmes such as was taken with the development of the Pohokura gas field.*

LIMITATION SEVEN: THE REPORT BY HEGLEY ACOUSTIC CONSULTANTS *'ASSESSMENT OF NOISE EFFECTS'* HAS A NUMBER OF LIMITATIONS.

I shall address these as follows:

- Existing noise environment (7a)
- Noise from dredging (7b)
- Effects of underwater noise (7c)

Limitation 7a: No reliable measurements taken of EXISTING NOISE ENVIRONMENT

No reliable measurements were taken of the existing noise environment on proposed Project site (page 8 of Hegley Report). Instead research on the 'existing noise environment' was done based on research in Lyttelton Port.

LYTTELTON PORT RESULTS:

- ships 'arriving and departing' at low speed, within 100m of sound receiver = 158dB
- no shipping and calm seas = 129dB
- Comment is made, that there are a number of passing ships within 10nm of the proposed Project, and they will have an effect on the 'existing noise environment' of up to **132**dB as *the ship passes.*

HUMAN SOUNDS:

Data presented on page 11 of the report:

- Container ship length 274m 198dB
- Super tanker length 340m 190dB
- Offshore Dredge (AQUARIUS) 185dB
- Tug pulling loaded barge 170dB

Page 14 details:

- FPSO 188dB When transiting
- FSO 185dB When transiting
- Tug 170dB When transiting

Page 15 details – ship on site and low boat speed, has 14dB less than travelling ship

- FPSO 174dB When on site and boat speed in very low
- FSO 171dB When on site and boat speed in very low
- Tug 156dB When on site and boat speed in very low

A useful graph in on page 13 which shows the sound levels of ships ranging from a length of 157m to 352m – the dB varies between 178dB and 193dB)

Limitation 7b: No attempt was made to use TTR's specialist subsea extraction advisor to obtain predicted NOISE FROM DREDGING

Point 7b (1): *"Very little information is available on the noise generated from dredge operating & no specific information is available on the noise level from a suction dredge (page 13 of Hegley Report).*
Attempts should be made to access **engineering specifications for noise levels for dredging equipment** used around the world. IHC Merwede is TTR's specialist subsea extraction advisor (see page 10 of Impact Assessment) and would certainly have been able to have supplied details.

- Engineering specifications need to cover both dB and frequency (kHz)
- Present the variation in details – much as has been done for 'transiting ship noise levels' above.
- Provide analytical commentary – comparing Project dredge size verses dredge size details obtained from a sample of dredges used internationally.

Point 7b (2): *Confusingly page 23 states that the cutter suction will be 59dB 'above the threshold of hearing for dolphins and whales'.*
I assume from this comment – you simplistically obtain the threshold limit mentioned on page 17 which is 80dB at 1 kHz (which is where the majority of noise from dredging occurs) and add 59dB, which gives 139dB.

Point 7b (3): *Variability in threshold levels depends on species involved.*
Page 17 shows the Report limiting itself to documenting threshold levels for dolphins and whales found in *coastal waters off northern Europe – not NZ.* **The blue whale and the southern right whale are important species not captured in this Report.** Other species not graphed are the sperm whale, fin whale etc.

Page 19 graphs the humpback, and shows a spectrum of 0.1-0.40 kHz and two thresholds varying between 60 and 80dB (re 1µPa).

Point 7b (4): *There is no external referencing to support the comment on the frequency spectrum of dredging – this needs to be determined*
The assumption has been made on page 16 that the hearing ability of mammals is relatively poor below 1 kHz, which is that part of the sound spectrum where the majority of noise from dredging typically occurs.

Generalised/non species specific comment made by Hegley:
At 1 kHz the **hearing threshold is 80dB** (per comment on page 17 of report)
At 500Hz the hearing threshold is 100d (per comment on page 17 of report)

Point 7b (5): *Calculation of **total** dB levels at the project site*
There has been no calculation of the TOTAL dB - due to all the equipment and all of the ships. Only a sub-set has been referred to in the Hegley Report
Background details:

Extraction System includes (as per page 4)

a. *Suction Head (or suction head and cutter)* *includes jet water nozzles*
b. *Pump system*
c. *Dredge pump* *(2,000 – 2,500kW capacity)*
d. *Dredge pump electric motor*
e. *Mechanics of SSED* *tracks, hydraulics, gear etc.*

Equipment (b) - (e) above, which *excludes* the suction head, is 117dB re 20µPa, which equates to an underwater level of **172dB** re 1µPa at 1m (*page 13 Hegley*)

Calculation:

- an underwater level of most of SSED **172dB** re 1µPa at 1m
- the suction head and cutter **139Db** **(**see point 2 above)
- FPSO 174dB
- FSO 171dB
- Tug 156dB

Total excluding beneficiation process 812dB

PLUS, any attempt to find a total dB needs to consider:

- beneficiation process – screening/magnetic separation and grinding
- fuel ship
- ship bulk carrier export vessel
- Grade control drilling (p17 Impact Assessment) could be every 200m, likely during the summer months.

GRAND TOTAL ????

Dolphins & Whales can hear to low frequencies if the noise level is high

Of importance is the comment on page 19 "While the hearing of the dolphin and whales is best between about 10-100 kHz **they can hear to relatively low frequencies, providing the noise level generated is relatively high.**

I would conclude by saying that if dolphins and whales can hear at low frequencies, as stated by Hegley – then certainly the noise level generated will be sufficiently high for marine mammals to hear it, above any background noise levels.

Projected distances that the Project noise could travel and still be at a high noise level

Using the details in point 6 below – this could conceivably mean at a distance of **2km** from the Project – there would be a total of **511Db** (at a minimum, as there are a number of dB unknown). However whether this kind of 'total accumulation of dB' is an accepted practise I do not know. I did send an e-mail to TTR to clarify this point, but the response was that "The information in response to your queries can be found in the impact assessment and supporting reports".

Karen Pratt <dekap1@clear.net.nz>
Hegley Acoustic Consultants

Hi Rose,

Just wondering if I might have missed a report somewhere . . . I have a few questions about the 'Assessment of Noise Effects' Report.

1. Page 13 "very little information is available on the noise, generated from dredges operating". IHC Merwede would surely have the equipment specifications, and if not then a comparable piece of equipment leased out to someone else?
2. The dB calculations didn't appear to be cumulative ie. adding up the ships and the SSED and equipment.
3. No account seems to have been made of the equipment and processing sounds from those items of equipment e.g. benefication module, power generation module and desalination plant.

Thank you,

Karen Pratt

Limitation 7c Effects of Underwater Noise:

7c (1) The Hegley Report has not calculated dB for all the equipment and ship noises on a varying distance basis.

This should be done if there is to be a comprehensive understanding on the impact on mammals.

For example, Hegley Consultants (page 13) have provided the following information for the **suction dredge** dB levels only (***excluding*** *the cutter head*)

@200metres	130dB
@500metres	121dB
@1 km	115dB
@2km	108dB (63% of Project site location noise)

Cutter suction dredge (page 23)

@ 900 m	122dB

Recommendation: These calculations need to be extended to include <u>all</u> Project equipment and ships.

Point 7c (2): Calculation of frequency ranges (kHz) of project equipment and ships needed

As the Hegley Report, on page 16 states *mammals have 'high thresholds at or below 1kHz and* ***<u>best hearing at >20kHz</u>*** – I have looked at two graphs to see what the FPSO noise level is at this spectrum, and then looked at the hearing threshold for this threshold for just two species. It would appear that both the killer whale and hector dolphin will 'notice' the noise. 'Sensitivity' analysis, especially for endangered mammals needs to be done.

Important is the 'duty cycle' - The proportion of time that the source is actually emitting acoustic energy. Continuous sound has more potential to disrupt animal communications than pulsed or intermittent signals. Continuous noise is more damaging to human hearing than pulsed sounds so a similar effect is possible in animals (Richardson et al., 1995).

I have found the following Tables, which is of interest – and should have been used in the acoustic analysis – as it is at least for Southern Ocean mammals.

Species	Frequency (Hz)	Dominant frequency	Estimated Source Level (dB re 1 µPa.m)
Southern right	30 - 2200	50 - 500	172 - 192
Pygmy right	300 +	60 - 135	165 - 179
Humpback	25 - 8200	25 - 4000	144 - 192
Fin	10 – 28,000	20, 1500 - 2500	155 - 186
Blue	12 – 31,000	16-25, 6000-8000	130 - 188
Bryde's	70 - 950	124 - 900	152-174
Sei	1500 - 3500		
Minke	60 – 20,000	60 – 12,000	151 - 175

Table 4. Sounds produced by baleen whales found in the Southern Ocean (Richardson et al., 1995, McCauley, et al., 1998).

Species	Call frequency (kHz)	Dominant frequency (kHz)	Source level (dB re 1 µPa.m)	Echo location frequency (kHz)	Eco location source level (dB re 1 µPa.m)
Sperm	0.1 - 30	2-4, 10-16	160-180		
Pygmy sperm	60-200	120			
Killer	0.5-25	1-12	160	12 - 25	180
False killer		4-9.5		25-30, 95-130	220-228
Long-finned pilot	1-18	1.6-6.7		6-11?	
Short finned pilot	0.5-20	2-14	180	30-60	180
Common dolphin		2-18		23-67	
Bottlenose dolphin	0.8 - 24	3.5-14.5	125-173	110-130	218-228

Table 6. Sounds used by toothed whales found in the Southern Ocean (Richardson et al., 1995). Long-finned pilot whales produce clicks like echo location clicks of other species.

The sound spectrum graph (p15 Hegley) at <u>20 kHz</u>:
For a FPSO at lowest speed of 86rpm: **135dB**

The mammal audiogram (page 17) at <u>20 kHz</u>:

- for a *killer whale* shows **a hearing threshold of 30dB**
- For a *harbour porpoise** **a hearing threshold of 42dB.** **used by Hegley to represent the Hector dolphin*

- underwater level of most of the SSED perhaps 0.125 – 1kHz
- the suction head and cutter information needed
- FPSO 0.10 – 40 kHz (page 15)
- FSO 0.008 kHz
- Tug 1.0 – 5.0 kHz (page 11)
- Sonar imaging 720kHz (page 13 IA)

Point 7c (3) 'Masking effects'

In order for a sound to be 'heard' the sound must be:

1. Above the background sound
2. Or if below the background sound, it must have a distinct spectrum content for it to be picked out.

Page 23 of the Hegley Report uses a 'background sound' of 132dB and then states 'if the dredge in no more than 122dB the sea noise will mask the noise.

To achieve masking, *if you only consider the suction cutter dredge,* this will be achieved 900m from the dredge.

To achieve masking, *if you consider a subset of total noise in dB detailed in point 5 above,* at **2km** from the dredge there will **not be masking** as the level is **511dB.**

Calculations need to be done to determine **how many kilometres away from the Project before masking is achieved** – keeping in mind that there has been no dB calculation of the beneficiation process.

Point 7c (4): NIWA Risk Assessment 2011, prepared for Ministry for the Environment

I note in this Report that the NIWA assessment was deemed to pose low risk (8), and that recovery would take weeks to months after the noise stopped. Recent NIWA reports have analysed the Project area in greater depth, subsequent to the production of this Report – and I would like to suggest that based on their findings, and the limitations in both the NIWA Reports and the Hegley report – that until further work is done – a 'low risk' assessment is no longer appropriate.

LIMITATION EIGHT: The impact on marine mammals from the optical effects of SSC has not been evaluated or assessed in the Impact Assessment and there has been no report commissioned on this matter

Importantly on page 60 (NIWA Optical effects Report, October 2013) is the comment that the reduced visibility might be of concern in regards to reactive distance of fish, marine mammals and aquatic life.

Section 15 of the Impact Assessment (measures to avoid, remedy or mitigate adverse effects) does not refer to this adverse effect. Other sections of the IA likewise do not appear to have addressed this issue.

LIMITATION NINE: Marine acoustic specialists rather than engineering acoustic specialists should be used

The impact of the Project on marine mammals I believe is best done by marine acoustic specialists – as opposed to perhaps an engineering acoustic specialist. I have found the following details obtained from the SCAR Group very informative.

IMPACTS OF MARINE ACOUSTIC TECHNOLOGY ON THE ANTARCTIC ENVIRONMENT
Version 1.2 July 2002 SCAR Ad Hoc Group on marine acoustic technology and the environment

- *Concerns relate to persistent displacement of animals from important, localised habitats and masking of acoustic cues i**nterfering with socialisation and breeding.***
- *Persistent displacement of cows and young calves could make the calves vulnerable to exhaustion and predation. (McCauley et al., 2000a, b).*
- *McCauley et al.(2000a) found in their study that humpback cows with young calves, exhibited **avoidance behaviour at sound levels 156-159 dB re 1 µPa p-p** (McCauley et al., 2000a)*

- *The potential for disturbance of toothed whales also is poorly understood. It seems to vary with species, their behaviour state and degree of habituation (Richardson et al. 1995). Sperm whales seem to cease calling or move away from noise sources at quite large distances in some instances. Other studies found that they seem to adapt to echo sounders. The AOTC experiment near Heard Island found that Sperm whales ceased calling during transmission and there was some inconclusive evidence for avoidance of the area around the source.*

- *Cetaceans may be displaced by **powerful, low frequency sound sources** and there is now a documented case of injury to whales from multiple, mid frequency military echo sounders.*

LIMITATION TEN: 'entanglement' was not raised in the 'assessment of environmental effects on page iv of the Executive Summary in the Impact Assessment.

The following is an excerpt from a 2011 NIWA Report (Expert Risk Assessment of Activities in the NZ EEZ and extended Continental Shelf) prepared for the Ministry for the Environment, page 53.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as moderate (9) with a high level of confidence (Table 4-4). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

[i] http://www.epa.govt.nz/Publications/TTR_Impact_Assessment_Final_Part_I_Chapters_1-5.pdf