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Dear Nicolette

PETROLEUM DRILLING ACTIVITIES: BUFFER DISTANCES FROM OUTSTANDING AREAS AND SUBSTRATE TYPES REQUIRING PROTECTION

Taranaki Regional Council (TRC) is currently reviewing its coastal plan and in particular its policy and rules around offshore petroleum drilling in the TRC coastal management area (CMA). Cawthron Institute (Cawthron) has been commissioned by TRC to provide advice on two objectives associated with this review; these are listed as follows:

A. Outstanding substrates/benthic habitats

Identify any known substrates and benthic habitats that should be protected from drilling within the Taranaki CMA, *e.g*. reefs, bivalve rubble and bryozoan rubble. These may be known to exist, or suspected to exist. Where possible, provide an estimate of the area these sensitive habitats are known to occupy.

B. Determining appropriate buffer zones

With the aim of ensuring that any impacts associated with petroleum drilling (discharges of cuttings, drilling fluids and muds) within the Taranaki CMA are less than minor, Cawthron will provide advice on drilling buffer-zone distances used in other similar studies (where possible, in similar environments) and will discuss the typical methods of determining appropriate buffer distances for drilling activities.

Limitations

In regard to natural features and landscapes in the coastal environment, the descriptor ‘outstanding’ is defined in Policy 15 of the New Zealand Coastal Policy Statement (NZCPS 2010) with particular regard to a number of social, cultural and environmental values. However, this letter will focus only on a limited selection of ecological references (natural science factors) containing information relating to specific marine habitats (sensitive, rare, unique and outstanding) within the CMA. The buffer zone determination (Section 2) is also based on a selection of relevant available information sources, and should not be considered exhaustive.

It was difficult to obtain accurate estimates of outstanding habitat/substrate areas (spatial extents) through the available reference materials. Nonetheless, identified locations of sensitive and outstanding habitats, as well as general substrates, marine features and benthic sampling locations have been shown in Figure 1. To better achieve this part of Objective A, a more comprehensive habitat mapping investigation is suggested.

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1. OUTSTANDING SUBSTRATES / BENTHIC HABITATS

The Taranaki Regional Council has already defined a list of 66 sites as 'sensitive' habitats along the Taranaki coastline (MOSCP 2012).The following list is additional to this, and is by no means exhaustive. It does however, provide some guidance on which habitats and substrates might need to be protected from exploration / production drilling activities (based on the review summary in Appendix 1). Habitat locations are shown in Figure 1.

- The sensitive habitat types described in Schedule 6 of the EEZ Act (EEZ 2012) and MacDiarmid *et al.* (2013) represent a reasonable bench mark, or at least a starting point, for which habitats should be protected.
- North and South Traps. These are already identified as sensitive habitats in TRC's Marine Oil Spill Contingency Plan (MOSCP 2012), but could be investigated further.
- Patea Shoals / Rolling Ground area (LINZ charts and Beaumont *et al*. 2013) are worth considering as outstanding habitats in terms of ecological sensitivity (EEZ 2012). Further investigation is suggested into the regional significance and distribution (within the CMA) of potentially outstanding or sensitive habitats found in this area:
    - bryozoan rubble (possible thickets)
    - bivalve rubble
    - bivalve beds
    - other possible sensitive habitat identifiers (brachiopods, algae and sponges) described in the Beaumont *et al.* (2013) report.
- Graham Bank has not been investigated (as far as is known), and may be a potentially outstanding area.

Other key findings

- North Taranaki Bight (NTB) and the South Taranaki Bight (STB) are two different biogeographic regions, and should be considered as such (DOC 2011).
- The NTB was ranked higher in terms of habitat complexity compared to the STB. Compared to some other regions of New Zealand the STB was almost 10 times lower in terms of habitat complexity. Despite this, all of the potentially outstanding areas listed above are in the STB area, which suggests there is still more to discover in the TRC CMA (Beaumont *et al*. 2009).
- There are potential similarities between the finer sediment mud habitats and benthic communities in the Taranaki CMA (as described in McKnight 1969; Grange 1991; DOC 2011) and some of the Taranaki offshore areas (outside of the EEZ) (from the Cawthron offshore database).
- Exploration of relevant marine taxa databases for characteristic species of sensitive habitats (EEZ 2012) and the New Zealand Threat Classification System lists (Freeman *et al.* 2010) may help to identify more outstanding habitats or substrates within the Taranaki CMA (see Appendix 1 for details).
- Further information on CMA habitats might be obtained through further review of council consent applications and databases (see Appendix 1 for details).

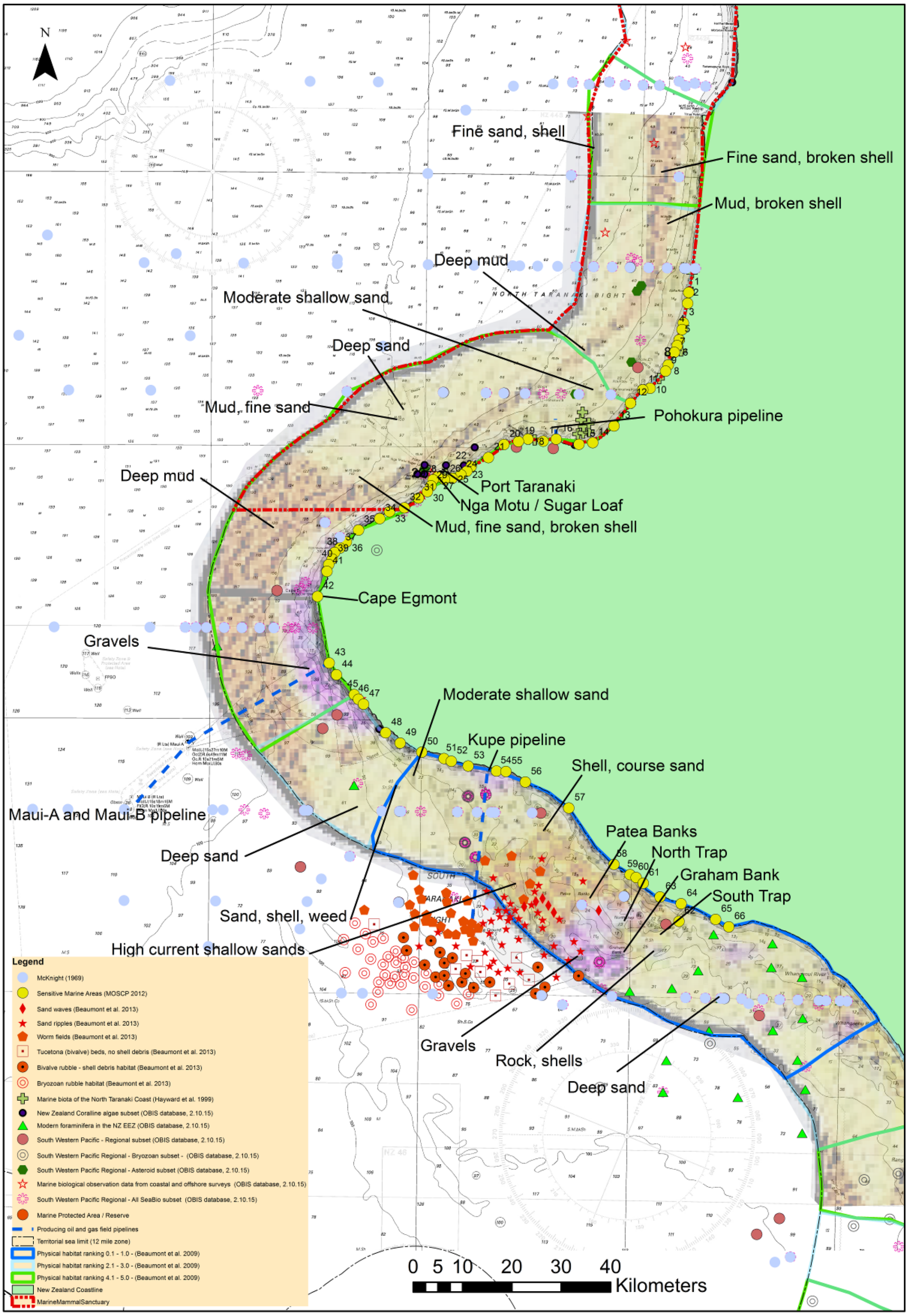

Figure 1: Taranaki marine habitats and data sources (sediment type overlay rectified from: DOC 2011).

2. DETERMINING AN APPROPRIATE BUFFER ZONE

The TRC objective is to determine acceptable distances[1] between marine drilling activities and sensitive marine habitats. In the following sections I describe the concept of a buffer zone, what it would be protecting against, what might constitute an appropriate distance and difficulties associated with its generation, and finally some recommendations to inform discussion and decision-making.

Purpose of a buffer zone

Creating a buffer zone around, or setting an acceptable distance from, sensitive marine environments beyond which drilling activities may occur, is done to protect important or outstanding marine habitats. Undersized buffers may place marine ecological resources at risk; and those that are too large may unreasonably deny marine consent applicants the use of extractable resources. Therefore, it is important to conservatively establish the minimum buffer width necessary to afford appropriate protection to sensitive environmental resources. Such distances depend on a number of factors including:

- the characteristics of the receiving environment (*e.g.* the sensitive environments identified)
- the composition and flow volume of the discharges
- the duration, dispersion patterns and overall spatial extent of plumes from drilling discharges.

To better predict the fate (dilution and spatial extent) of chemical constituents in produced water and drilling discharge plumes, site-specific numerical discharge models are typically recommended (Johnston *et al.* 2014). Using discharge modelling data, spatial scales of effects and dilution concentrations for site-specific discharges can be estimated (usually reported in a preceding EIA document) and subsequently, site-specific monitoring hypotheses can be developed (*e.g.* reasonable mixing zones, or expected zones of influence, and primary direction of plume propagation).

What are the marine drilling activities?

The drilling activities in question relate to exploration and development of oil and gas resources within the Taranaki Regional Council's coastal management area (*i.e.* within the territorial seas—12 mile zone). Exploration, development and production can result in discharges of wastes, including: drill cuttings, production / formation water from wells and other processes, chemicals and hydrocarbons.

The main environmental issues associated with the discharge of cuttings contaminated with these fluids to the marine environment are:

- direct toxicity to marine biota
- fate, persistence and biodegradability
- bioaccumulation / bio concentration by marine biota

[1] As local hydrodynamic conditions and the nature of the individual habitats may indicate that a range of distances is appropriate.

- smothering effects on the benthos from accumulated drill cuttings
- organic enrichment of benthic sediments leading to anoxia
- leaching of chemical constituents from non-water based drilling fluids into the water column
- tainting of commercially exploited demersal fish stocks

For all drilling discharge types (containing oil-, synthetic- or water-based fluids), the degree of effects from drilling fluids on ecology is highly dependent on local environmental variables (*e.g.* depth, current and wave regimes, substrate type), as well as the nature and volume of the discharges (including cuttings size and location of the outfall in water column). However, some consistent trends do exist for drilling fluids and the biological effects arising from them. These are discussed in the following sections.

Spatial extent of effects - local and international trends

Assuming that drilling programmes are undertaken and the receiving environment characteristics within the CMA would be similar to those found in the EEZ (outside of the TRC's NZ territorial seas), it may be expected that the ecological effects within a zone of influence might be similar. While this may be the case for some of the deeper soft sediment areas within the NTB CMA, effects within less depositional areas of shallower depth, and stronger currents in, for example, the STB, could be substantially different. In the NZ EEZ, Elvines *et al.* (in prep.) have reported preliminary results from benthic ecological monitoring of predominantly single well drilling activities, production water and operational discharges, and occasionally multiple well drilling activities[2]in Taranaki soft sediment habitats (90–140 m depth range). These have shown:

- localised benthic ecological effects, typically confined to within 250–500 m of the point of discharge
- there were typically elevated sediment levels of TPH, PAHs and metals in this close proximity area, as well as courser sediment texture and visible changes to the physical habitat
- An exception to these relatively close proximity effects was the occurrence of identifiably anthropogenic debris (*e.g.* paint chips, rust, coal, plastic *etc.*) and the metal barium (an effectively inert drilling mud constituent) which appeared to be deposited up to 4-6 km from some activities.

Internationally, the general effects from synthetic- and water-based drilling fluids (as predominantly used here in NZ) are very similar to those observed in the Taranaki offshore environment. Ellis *et al.* (2012) summarised that :

- The zone of biological effects on benthic community diversity and abundance ranged from 100 to 1000 m for both water- and synthetic-based fluids. In contrast, the use of oil-based drilling fluids was reported to result in large-scale (out to 6 km) and persistent (decadal time scale) impacts on benthic communities. Effects included changes to benthic species diversity and abundance and alterations to community structure. Functional changes

[2] Using predominantly synthetic type drilling muds.

included a loss of suspension-feeding species and increases in deposit feeders and polychaete worms.

- Barium was deposited up to 2 to 20 km when using water-based drilling fluids, and 200 to 2000 m when using synthetic-based fluids.
- Of particular note was the reference to an overall loss of benthic biodiversity and suspension-feeding communities and the potential for large-scale effects on sensitive communities such as deep-sea, coral and vegetated habitats.

The Australian petroleum production and exploration association (APPEA 1998) reported the following typical effects for single well operations:

- major contamination and community effects were limited to within approximately 250 metres
- in many cases the zone of effect was either not detectable or of marginal size
- beyond 250 metres, it was difficult to detect any community effects
- elevated concentrations of heavy metals and / or hydrocarbons associated with drilling fluids were generally not detected beyond 1,000 metres.

Multiple well drilling operations in Australia (APPEA 1998) were reported to double the distance of effects: major community effects limited to within approximately 500 m of the point of discharge; community changes reported up to 2 km; the biota not affected beyond 2 km; and elevated concentrations of heavy metals and / or hydrocarbons restricted to within 2 km of the point of discharge. However, traces of contaminants below community effect levels have been reported up to 10 km from the point of discharge.

What is a conservative buffer distance based on these findings?

It is extremely difficult to determine a conservative buffer distance based on the variability of possible discharge characteristics, and the limited information concerning the sensitivity of outstanding substrates. Consequently, I strongly caution against the stipulation of a one-size-fits-all buffer zone distance to protect sensitive habitats from the effects of drilling activities. Nonetheless, some guidance may be ventured as follows:

<u>Community based effects – localised</u>

In order to go some way towards addressing the objective, the results discussed above suggest that, typically, a distance of 1,000 m from any single well drilling activity should be adequate to minimise effects to benthic communities from the discharge of synthetic and water-based drilling fluids, as well as protecting against the majority of sediment contaminants. However, if oil-based drilling fluids are used, or if multiple wells are being drilled, a much larger buffer distance could be required to reduce community-based effects (*e.g*. approximately 6 km or over).

<u>Maximum zone of effects</u>

A strongly conservative approach would be based on the maximum zone of effects, which could be discerned by the limits of barium tracers and the extent of the oil-based drilling fluids and potentially anthropogenic debris (rather than being limited to observable benthic community effects), so this could be 6 km for synthetic-based drilling fluids, up to 20 km for water-based drilling fluids, and even further for oil-based fluids.

I am aware of recommendations for acceptable distances from sensitive marine environments developed by the Australian Petroleum Production and Exploration Association (APPEA 1998). These may be of some use in terms of developing management guidelines. However, they appear somewhat relaxed, including acceptable distances for oil-based drilling fluids, which would ideally be used rarely in this local context, or not at all.

Ultimately, a standardised 'habitat buffer distance' may not effectively guard against adverse ecological effects from all drilling activities, other cumulative effects, accidental spills or any of the other potentially harmful activities relating to the development of a facility (*i.e*. shipping, drilling anchors / warps *etc*.). While it is useful to have at hand relevant review information concerning a range of typical development and environmental scenarios, it is likely to be more practical to consider drilling activities in the territorial seas on a case by case basis, with the overall objective of avoiding significant adverse ecological effects to important habitats.

3. CONCLUSIONS AND RECOMMENDATIONS

***Objective 1. Outstanding habitats/substrates – further investigation required*.**

The sensitive habitats described in, Schedule 6 of the EEZ Act (2012) and MacDiarmid *et al.* (2013), represent a good starting point for the potential range of habitats in the territorial seas that may require a level of protection. However, other than sensitive (nearshore) coastal habitats (MOSCP 2012), sparse benthic communities information, and South Taranaki Bight habitat descriptions (Patea Shoals, the Rolling Grounds, Graham Bank, North /South Traps) there is limited information available to comprehensively define outstanding habitats in the region. What information is available suggests there is yet more to discover. In order to develop this pool of knowledge, I would recommend that applicable EIAs include provision for characterising the potentially affected receiving environment (via marine benthic surveys). In addition, territorial sea survey / sampling programmes could also be developed (*e.g*. as part of state of the environment monitoring) to begin to identify any unique, sensitive or otherwise 'outstanding' substrates in the CMA bioregions further offshore (NTB and STB).

While this letter touches on some of the potential rare, sensitive and outstanding habitats in the TRC CMA, there are certainly more avenues of investigation and review that could assist further. For example, the 'conservation status of New Zealand marine invertebrates' list (Freeman *et al*. 2010) may be worth investigating against regional taxa lists(McKnight 1969; Hayward *et al*. 1999; Beaumont *et al*. 2013; OBIS 2015). Regional taxa lists could also be investigated further for identification of species characteristic of sensitive habitats (EEZ 2012).

All of these information sources could be used together to develop a comprehensive habitat map for the TRC coastal management area.

Objective 2. Recommendations for buffer zone distances depend strongly on the type of drilling fluid used.

Using the most conservative approach, the maximum zone of effects is in the range of 6 to 20 km for synthetic- and water-based fluids (as determined by barium tracers and anthropogenic debris) and could be significantly further if oil based drilling fluids are used. However, if the concern for the coastal management area relates principally to documented benthic community related effects, then the buffer distance could potentially be a smaller 1 km to 6 km.

<u>Other options</u>

Mixing zones around drilling sites may be a practical alternative to buffer zones. Mixing zones (or a 'zone of non-compliance') around activities can be proposed by the consent applicant through the environmental impact assessment (EIA) process, and evaluated by TRC on a case-by-case basis. In areas where there is little existing baseline information, it could be a requirement for EIAs to include a marine survey of the wider area for sensitive environments. This would increase TRC's knowledge pool and potentially protect any as yet unknown sensitive or outstanding habitats. Mixing zones can be determined on a case by case basis, relating to the specific activity, discharge type and prevailing environmental conditions, rather than relying on a standardized buffer zone distance around known sensitive environments.

I trust the contents of this letter address your immediate requirements, if you have any further questions or concerns please let me know.

Yours sincerely,

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Appendix 1: Outstanding marine environment reference summary, and further areas of investigation

- ***Taranaki Regional Council oil spill contingency plan for sensitive coastal environments** (MOSCP 2012).*
  Includes a range of sensitive coastal environments in the CMA (66 listed sites), these are presented in Figure1. The majority of these areas are a diverse array of nearshore or intertidal habitats, for example: boulder reefs, rocky reefs, rock/fossil platforms, volcanic reefs, tidal boulder reefs, geologically important (internationally) mound field created by volcanic debris avalanche deposits, andesitic boulder reefs (caused by erosion) and black sand deposits. Further offshore, habitats mentioned as 'of regional importance' are the North and South Traps. These sandy habitats consist of two large adjoining reef systems approximately 6 km offshore from Patea. This is an important marine habitat, with diverse and abundant marine life, and large seaweed (*Ecklonia*) forests, in an otherwise sandy environment.

- ***Sensitive marine habitats defined** (Schedule 6 EEZ 2012; MacDiarmid et al. 2013)*
  Potential sensitive habitats in New Zealand are discussed in MacDiarmid *et al*. (2013) and Schedule 6 of the EEZ Act (2012), and are listed as follows:
  - Stony coral thickets or reefs
  - Xenophyophores (sessile protozoan) beds
  - Bryozoan thickets
  - Calcareous tube worm thickets
  - Chaetopteridae worm fields
  - Sea pen field
  - Rhodolith (maerl) beds
  - Sponge gardens
  - Beds of large bivalve molluscs
  - Macroalgae beds
  - Brachiopods
  - Deep-sea hydrothermal vents
  - Methane or cold seeps

  While these habitats may not necessarily exist in the Taranaki CMA (and certainly some are unlikely to exist due to the environmental conditions in the region), they represent a reasonable bench mark for what should be protected.

- ***Mapping the Values of New Zealand's Coastal Waters - A Meta-analysis of Environmental Values** (Beaumont et al. 2009)*
  Beaumont *et al.* (2009) used meta-analysis of available biological and habitat diversity to create a ranking system overlaid onto NZ charts. Of particular interest were the Marine Environmental Classification (MEC) physical habitat categories (overlaid in Figure 1). Whereby the number of habitat categories in each coastal cell were ranked 0 to 10 (low to high number of habitats). The North Taranaki Bight (NTB) was given a mid-range rank of <4.1–5.0, comparatively the South Taranaki Bight (STB) coastal regions was ranked as low as 0.1–1.0. Compared to some other regions of New Zealand the STB was almost 10 times lower in terms of habitat complexity, and suggests the STB coastal management region is of a uniform physical environment. However, it is noted that the maps were generated using patchily-distributed presence-only data, suggesting there is more habitat to discover in the Taranaki CMA.

- ***Coastal marine habitats and marine protected areas in the New Zealand Territorial Sea: a broad scale gap analysis*** *(DOC 2011)*
  The Taranaki bight differences noted in Beaumont *et al.* (2009) ties in well with the biogeographic regions and coastal marine areas described in a report by Department of Conservations (DOC 2011), and overlaid in Figure 1. The DOC (2011) report suggests there are more gravel, sand and rock (higher energy) habitats in the STB area, with generally more muds, fine sands and depositional sediments in the NTB area.

- ***Marine biota of the north Taranaki Coast, New Zealand*** *(Hayward et al. 1999)*
  This study provides biogeographic information on the marine biota on the west coast of the North Island (along a 60 km length of north Taranaki coastline stretching from the Awakino River mouth in the north to New Plymouth in the south (sampling sites overlaid on Figure1). The study does not identify whether or not the habitats are outstanding, or sensitive, however they do identify contributing characteristics and associated taxa of sensitive environments later identified in the MOSCP (2012).

  Of particular interest is that the benthic epifauna and infauna recorded along the seabed from Urenui (Figure 1) to approximately 5 km offshore (6–22 m depths) was relatively uniform in composition with amphipods being the numerically dominant species. Also, two of the deep stations exhibited greater cumacean diversity; while this may have regional significance/importance, the authors go on to say that more diverse communities like these are known from other regions at similar depths. Also the record of the crab *Petrocheles spinosus* at New Plymouth reef was defined as being of special interest. As it is thought to be restricted to deeper water and '*absent from littoral records in the North Island*'.

- ***Infaunal communities of the New Zealand Continental Shelf*** *(McKnight 1969)*
  This well referenced 1969 study classified areas based on 17 benthic infaunal community types found on the NZ continental shelf. Areas in the vicinity of Taranaki Bight were described as having open-sea and coastal communities with distinctive infaunal benthic organisms and (elements of the 'Venus' and '*Nemocardium*' communities) matching those soft-sediment substrates characteristics described in the DOC (2011) investigation. Communities and soft sediment substrates in the vicinity of the Taranaki CMA were also recorded in other regions of NZ, and were not described as outstanding (rare/unique/sensitive) at a national level.

- ***Marine biological resource data as an aid to oil exploration impact assessment*** *(Grange 1991)*
  This report analysed the New Zealand Oceanographic Institute database of biological communities on the Taranaki continental shelf, and summarises the findings from McKnight (1969). Using a similar process to that of McKnight, the author identified four main biological communities separated by depth and sediment characteristics as well as species contributions. Of particular note were the:
  - *Scalpomactra/Nemocardium* community - Fine silty sands, mostly less than 100 m deep. Described as having high ecological values, and being susceptible to environmental alteration.
  - *Neothyrus/Flabellum* community - Medium sands, mostly greater than 100 m deep. Contains brachiopods, corals and urchins, susceptible to smothering, medium to high ecological value
  - *Dentallum/Peronella* community –Silt substrate. High diversity. All greater than 100 m depth. Dominated by tusk shell, urchin and bivalve. Low ecological value. Could be recruited from adjacent communities (few endemic species).

- o *Paguristes/Pervicacia* community – Coarse sands. High diversity. Less than 40 m depth. Dominated by hermit crabs, and snails adapted to unstable sediments. Low to medium ecological value. Resilient to environmental disturbance.

The investigations did not identify any rare of unusual species assemblages in north Taranaki, and surmised that oil exploration *'*should not cause significant ecological disturbance but more detailed sampling would be required to define the precise boundaries between the communities should production drilling occur'.

- ***Benthic flora and fauna of the Patea Shoals region*** *(Beaumont et al. 2013)*
The study region was situated over an area of seabed known locally as the "rolling grounds" or "Patea shoals." This is a shallow (approx. 20 m to 50 m depth) subtidal sandy area offshore from Patea Township. The area is exposed to southerly and westerly storms resulting in regular large swell events. Video footage and still photography identified seven main habitat types within the broader Patea Shoals region of the STB (overlaid in Figure 1). These included: sand waves, rippled sands and small patches of rock outcrop on the inner shelf, rippled sands and worm-fields on the mid-shelf, low-lying biogenic habitats dominated by bivalve beds (live and shell-debris zones) and bryozoan/rubble habitats further offshore.

No habitats were described as unique or outstanding in this study, with the shallow sandy highly disturbed habitat in the vicinity of the study area (mid-shelf and inner shelf area) supporting low overall faunal abundance and species richness. Species were either ubiquitous across the region and/or were typically mobile[3] , and none of the species sampled were listed as threatened in the New Zealand Threat Classification System lists (Freeman *et al.* 2010). The report stated that 'there was no evidence to suggest that the area was "unique" with respect to macrofauna collected or observed on the seabed during this survey,' and that 'National scale studies (NIWA 20/20 surveys, unpublished data) have also found bivalve shell-debris and bryozoan habitats at similar depths around the North and South islands of New Zealand'.

Irrespective of this, results suggested the study area was more diverse than some of the previous references and charts suggested. With new species of bryozoan, sponge, annelids and algae being identified, new regional records for many groups, and naturally uncommon mollusc genera being identified (Freeman *et al.* 2010). Also when compared with the EEZ Act (2012) guidance on what constitutes a sensitive habitat in the EEZ (listed in the text box below), the bivalve beds (live and dead), bryozoan[4] rubble (and potentially some other habitat indicators *i.e.* brachiopods[5], algae[6], sponges) could well fit the description of sensitive habitats:

A bed of large bivalve molluscs exists if living and dead specimens—
- o cover 30% or more of the seabed in a visual imaging survey; or
- o <u>comprise 30% or more by weight or volume of the catch in a sample collected using towed gear</u>; or
- o comprise 30% or more by weight or volume in successive point samples.

[3] deposit feeders and small scavengers
[4] particularly the large reef forming bryozoan *Cinctipora elegans* – forming bluff oyster habitat; (Batson P, Probert P 2000. Bryozoan thickets off Otago Peninsula. New Zealand Fisheries Assessment Report 2000146, November 2000. Published by Ministry of Fisheries, Wellington, 2000. 31 p.)
[5] Brachiopods were collected from 3 sites: Four specimens of *Calloria inconspicua* were collected from 2 sites (Sites 46 and 146), while 1 specimen of *Neothyris lenticularis* was collected from a single mid-shelf/PPA site (Site 70).
[6] Some macroalgae species detected in deeper areas, results require further investigation.

A bryozoan thicket exists if—

- o colonies of large frame-building bryozoan species cover at least 50% of the of an area between 10 m^2 and 100 m^2; or
- o colonies of large frame-building bryozoan species cover at least 40% of an area that exceeds 10 km^2; or
- o a specimen of a large frame-building bryozoan species is found in a sample collected using towed gear; or
- o 1 or more large frame-building bryozoan species is found in successive point samples.

Further investigation into the TTR (2013) data, and it's comparison to new legislation (EEZ Act 2012) is required to make firm conclusions about potential outstanding/significant/ sensitive habitats. Additionally, while this investigation holds a wealth of habitat information in the study region, without similar level investigations from other localities within the CMA it is difficult to make relative comparisons.

- ***Cawthron's offshore monitoring reports and database*** *(2011 to present)*
  Using results obtained from benthic grab sampling and video seabed footage, the Cawthron offshore monitoring database (2013-2015; unpublished data) showed no evidence of sensitive marine environments (as described by MacDiarmid *et al*. 2013 and Schedule 6, EEZ Act 2012) in the vicinity of areas monitored for effects from oil and gas related activities, or their associated control sites in the offshore Taranaki area, outside TRC's CMA.

  The offshore habitats studied were soft sediment environments dominated by the fine silt and clay fractions, as opposed to some of the higher energy, courser grainsize habitats found closer to shore (particularly in NTB). Based on this, it may be expected that the courser sediment found in the TRC CMA will grade into a more soft sediment environment in the proximity of the territorial sea boundary, to the west (as shown in Figure 1). Additionally, there may be similarities between habitats in the mid and north Taranaki Bight deep-mud lens (DoC 2011)and the offshore areas investigated by Cawthron, particularly given their comparable sediment grainsize descriptions. However further investigation would be required to confirm this.

  Note: Cawthron's findings are limited to the areas sampled (in the vicinity of proposed or existing offshore oil and gas activities), and data suggests there are latitudinal differences in the benthic communities (increasing diversity and abundances to the south), therefore homogeneity of the entire offshore area must not be assumed.

- ***Land Information New Zealand charts***
  LINZ Marine charts NZ43 and NZ48 (2007) are also overlaid (and identified) in Figure 1. These charts include general sediment/habitat types for the region and generally match the DOC (2011) habitat maps. With the inclusion of shell matter (mixed with sand or rock) and weed (mixed with shell and sand) described in the STB area, and shell and broken shell (mixed with muds or sands) in NTB. The marine charts also specifically identify the Patea Shoals, Graham Bank and the North and South Traps as distinctive habitats (Figure 1). The North and South Traps habitats were also identified as being of regional importance in the MOSCP (2012) and Patea Shoals in Beaumont *et al.* (2013), Graham Bank has not been investigated (as far as is known).

Further areas of investigation

There are certainly more avenues of investigation that could identify outstanding substrates and habitats in the Taranaki CMA. While there is no available ‘state of the environment’ (SOE) information for the Taranaki territorial seas, a couple of avenues to obtaining more information on outstanding habitats are summarised below:

- ***Conservation status of New Zealand marine invertebrates*** *(Freeman et al. 2010)*
  This spreadsheet list, is available on the DoC website, allows the classification of marine invertebrates that are considered to be threatened or at risk, or very poorly known but seldom encountered and possibly threatened in New Zealand. Endemics, non-endemic natives, migrants, vagrants, and introduced and naturalised species are all included, as are taxa which have not been formally described. It may be worth investigating this spreadsheet against recorded taxa lists for the region, to determine if there are any threatened or at risk marine invertebrates in the Taranaki CMA, which might constitute an outstanding substrate or habitat.

- ***Ocean Biogeographic Information System database*** *(OBIS 2015)*
  The Ocean Biogeographic Information System (OBIS) is a web-based provider of global geo-referenced information on marine species. Marine invertebrate data (within the Taranaki CMA) was obtained from OBIS, and the sample locations have been included in Figure1. It may be worth investigating this database in detail for characteristic species of sensitive habitats (EEZ Act 2013) and the New Zealand Threat Classification System lists (Freeman *et al*. 2010).

- **Consent applications** (TRC)
  The council will be privy to a host of applications for resource consent to perform activities in the CMA. These could be collated and may provide specific information which could be added to an overall CMA habitat database.