QUESTIONS OF CLARIFICATION ON TECHINCAL REPORTS 18 – 20 RELATING TO EFFECTS OF THE EXTENSION ON MARINE ECOLOGY, SUBMITTED WITH THE WELLINGTON INTERNATIONAL AIRPORT LIMITED'S APPLICATION FOR RESORUCE CONSENTS.

REVIEW UNDERTAKEN BY DONALD MORRISEY – CAWTHRON INSTITUTE (questions outlined in black text below) AND RESPONSES PROVIDED BY NIWA AND AQUATIC ENVIRONMENTAL SCIENCES (outlined in blue text below), DATED 28 JULY 2016

TECHNICAL REPORT 18. NIWA – ECOLOGICAL CHARACTERISATION OF LYALL BAY

1. My only major comments relates to the boosted regression tree modelling used to predict the composition of the fish community likely to be present in Lyall Bay. This is a sensible approach, however, the report would benefit from an explanation of why the model was used rather than some form of fish counts. Presumably it was considered to be a more reliable identifier of what species should occur here (less susceptible to sampling error, seasonality, etc.)? It would also be useful to include some detail of the validation of the model that was presumably done by Smith et al. (2013) for reef fish and Leathwick et al. (2006a, 2006b), cited in the report, for demersal and pelagic fish. I assume that they would have used part of the original dataset for developing the model and kept some data back for testing?

   A one-off survey of demersal fish suffers from excessive cost, seasonality, and impact of the destructive sampling method (bottom trawling) both on the demersal fish population and the benthic fauna and flora. This is particularly important in Lyall Bay itself which is not important to commercial fishers but is of interest to recreational fishers, and is adjacent to an urban area. A one-off survey of reef fish using diver counts is moderately expensive and suffers from seasonal effects. The nationwide models for both groups of fish, from which information relevant to the study area were extracted, were considered to be more reliable indicators of long-term patterns of distribution and abundance.

   To obtain an estimate of the error associated with their predictions Leathwick et al. (2006) undertook repeated bootstrap samples, to which they fitted a BRT model and used this to make a separate prediction for the spatial data. Once these had been accumulated they identified the 5- and 95-percentile values for each grid cell as an estimate of the confidence intervals around their predictions.

   Smith et al. (2013) used a stepwise, 10-fold, cross-validation procedure to objectively determine the number of trees to be fitted in each model, thus reducing the risk of over-fitting. This approach divides the dataset into 10 subsets, each withheld in turn while models are fitted to each group of 90% of remaining sites. The holdout deviance is then calculated from the average of the prediction errors of the models to the respective withheld subsets.

2. Executive summary, page 15, paragraph 8: How would monitoring of the meiofauna provide a "meaningful indicator of environmental conditions present at the seabed"? Given the naturally disturbed nature of the seabed, a stable meiofaunal (or macrofaunal) assemblage may not occur, and comparison with one-off baseline data is unlikely to provide an assessment of recovery. Should discussion of options for monitoring recovery be included in this report or in Technical Report No. 19 on assessment of effects (it is not discussed in Section 12 – monitoring of TR19)? There is no discussion of monitoring in relation to other receptors in this report.

Meiofauna could provide a meaningful indicator of environmental conditions present at the seabed because they are by far the most abundant component of the seabed fauna and the analyses show a relationship between sediment granulometry (sand content) and meiofaunal community structure. Therefore, we would expect that if hydrodynamic conditions change sufficiently to alter sedimentation/erosion processes (e.g., following the building of a runway extension), a shift in meiofauna communities would occur. These shifts could help identify areas of sediment erosion (increase in coarse particle fraction) and deposition (increase in fine sediment fraction). The data are of course limited in extent and no information is available on temporal variation in meiofaunal community structure, which may make the detection of such a shift more difficult than if more extensive data were available. Nevertheless, continuing to monitor meiofaunal communities at the Lyall Bay study sites (before and after building commences) would likely give a good indication of the extent of any environmental footprint of a new runway extension.

3. Executive summary, page 16, paragraph 1: In what way do the rocky reef communities sampled during this survey "reflect the annual average for this site"? On page 22 (section 4.5) it is said that indices of reef biodiversity varied seasonally at Moa Point, peaking in winter. So how does sampling done in October capture or reflect this seasonality?
   The survey of rocky reefs carried out for Wellington International Airport Ltd (WIAL) provided a snapshot of the flora and fauna at a point in time. It was not designed or intended to characterise seasonal variation in presence or abundance of intertidal reef species. To put this snapshot into a broader temporal context reference was made to a wider area survey of intertidal reefs along Wellington's south coast over a period of two years carried out by Tam (2012). Tam (2012) found that three biodiversity indices of all peaked in winter, with lowest values in summer, and spring values midway. Thus, the intertidal reef community sampled during spring in the present study may be expected to reflect this mid-point in biodiversity.

4. Page 31, paragraph 5: why wasn't a 500-µm sieve used to screen out macrofauna (the usual definition of meiofauna is that they pass a 500-µm mesh)?
   A 1mm mesh was used because some of the larger meiofaunal organisms would be excluded by a 500 micron mesh. Given the low abundance of macrofauna in lyall Bay, their abundance in a small syringe core would be very low indeed and unlikely to affect the data much at all. So a slightly larger upper mesh was used to ensure that no meiofauna were missed.

5. Page 32, paragraph 6: Was the correlation matrix examined to see if there was redundancy among variables used in the DistLM analysis (for example, is it valid to include silt, sand and gravel, since these are not independent)?
   No, the DistLM sequential test was used to explore which environmental data were the most important in explaining faunal total abundance and species abundance. The percentage of sand, gravel, and silt were all initially used despite the possibility for redundancy amongst some of them.

6. Page 40, last paragraph: What does the last sentence mean – how was the opportunistic species list collected by divers used to "ensure that all relevant model data were extracted and presented"? It could only be used to check that all of the species seen were included in the modelled dataset, not check all relevant data were included.

Agreed. The opportunistic species list collected by divers used to check that all of the species seen were included in the modelled dataset.

7. Page 41, paragraphs 2 and 3: Could the fish assemblage have changed over the 20 years that data were collected, for example, through fishing pressure or climate change?
   Yes this a possibility, but on the other hand, the 20 years of data provide a smoothed view of the fish abundance free of inter-annual variability.

8. Page 43, Section 2.8: What about data on occurrence of pinnipeds?
   Sightings of pinnipeds would have been captured from the DOC sightings database (referred to in Section 2.8 as the 'cetacean sightings database' but perhaps more correctly the 'marine mammal sightings database'). New Zealand fur seal is referred to in Table 3-22, and certainly occurs in the harbour and along the south coast.

9. Page 67, Figure 3-23: Why do POC and phaeo figure so prominent in the vector plot but not in the DistLM? Similarly for gravel and phaeo in Figure 3-27.
   The reason for this is that the vector plot attempts display in 2 dimensions what is in fact a multi-dimensional space. The axis in the vector plot are selected by the routine to maximise the fitted variation and do not necessarily give an accurate representation of the importance of any one variable. The DistLM should be used for the quantitative assessment.

10. Page 118, paragraph 1: What is the conclusion of this discussion of the possibility of modelling effects on optical water quality – that it would be too difficult?
    Though difficult, this modelling could be undertaken if, as explained in this paragraph, the previously measured properties of water in Lyall Bay were combined in some suitable fine scale model with new knowledge about the particle size distribution of the introduced suspended sediment, its size mass-specific intrinsic optical properties, and its tendency to form flocculants of various sizes.

11. Page 118, paragraph 2 (Section 4.2): Was *Pseudochattonella australis* detected in the present study or is this referring to the earlier studies cited? It is not mentioned in Section 3.2 or Table 3-3.
    A small number (0.9×10^3 cells per litre) of chain-forming *Pseudonitzschia australis* was recorded at Station #9. In Table 3-3 *P. australis* was listed in line 6 under Pennate.

12. Page 120, Section 4.4.5: Why is such a wide geographic comparison made (worldwide)? How relevant is this to Lyall Bay (such a broad comparison is not made for macrofauna)?
    For the purpose of this Discussion, it is assumed that most readers are not familiar with meiofauna (readers are more likely to be familiar with the larger macrofauna). The comparison to global average densities of meiofauna is given so that readers can appreciate that the high densities of meiofauna observed at the study sites (100-1000s per 10 cm2) are not out of the ordinary. It was also judged necessary to introduce the main taxa to provide some context as to which group are normally dominant (i.e., nematodes and copepods) and which are normally less abundant (kinorynchs, tardigrades etc..). These comparisons, although admittedly of limited direct relevance to the Lyall Bay sites, help provide context by showing what one might expect to find in a coastal area. More specific comparisons with the few New Zealand studies available are made in the following sub-section.

13. Page 6, paragraph 4: The upper ends of the visibility range (20–30 m) and euphotic depth (40–50 m) were the maximum values recorded (see table 3-2 of Technical Report 18). The change in visibility caused by storms was probably less than this (e.g. from the median values of 7.9 m and 21.8 m to < 1 m and < 10 m). Some of the change in water quality caused by storms was presumably due to resuspension of seabed sediments, rather than just from runoff?
Figure 4-9 and text in Section 4.3 of the Coastal Processes Assessment clearly shows that wave resuspension is the dominant driver of turbidity in the wider Lyall Bay (rather than runoff), and only above a threshold of around > 2 m wave height. However, it is likely that locally around stormwater discharge locations, run-off will dominate. Note: no field-monitoring site was located near any of these discharges – but further out in the Bay.

14. Page 8, paragraph 2: "Shrimps (Malacostra)" – should be "Malacostraca", but this is a very general category of crustaceans and not informative – better to give the scientific name (*Tenagomysis* sp.) and refer to it as a "Mysid shrimp". What were the scientific names of the gastropods? For what types of taxa did the gravels provide "greater opportunities for attachment", and is a surface for attachment the property that is responsible for the correlation between faunal composition and % gravel or some other effect on the sediment environment?
Agreed that Malacostraca is a very general term.

    The gastropods sampled included *Amalda australis* and *Antisolarium egenum*. Their distribution among sampling sites is shown in Figure 3-22 in MacDiarmid et al (2015).

    Gravels provide greater stability and attachment than fine sands in shallow exposed locations for a range of organisms including hermit crabs and burrowing brittle stars. This characteristic of gravels may responsible for the correlation between faunal composition and % gravel.

15. Page 13, paragraph 2: To put the Lyall Bay seabird fauna in context, how many taxa use Cook Strait (at present the text just says "a large number")? What types of gulls, terns and shags are likely to occur in Lyall Bay?
It is extremely difficult to be specific about how many taxa use Cook Strait, because this hasn't been systematically recorded. However, of the 160+ taxa that have been recorded in New Zealand (as listed in Robertson et al. 2013) 42 taxa are listed in Table 3-21 as occurring in Cook Strait, to which further taxa are also very likely to occur in Cook Strait. A reasonable best guess might be a total of 55 taxa for Cook Strait, or close to 33% of all taxa recorded in New Zealand.

    Red-billed gull, black-backed gull, white-fronted tern, Caspian tern, black shag, little black shag and spotted shag are all likely to occur in Lyall Bay.

16. Page 20, paragraph 20: Is there a rough estimate of the "relatively small number" of blue penguins that could be affected – 1 or 2 individuals, 10+, etc.? What is the estimated size of the Wellington population?
A rough estimate would be less than ten pairs that could be affected, and to our knowledge there is no accurate overall Wellington population estimate, but this would be in the hundreds of pairs.

17. Page 22, paragraph 3: Is there any evidence that the rock dyke provides an equivalent habitat to the natural reef? The discussion in Appendix 2 suggests that it is not, even without the mitigating features proposed.
    Evidence from the international science literature regarding the equivalence of artificial versus natural hard substrata to support reef communities is well reviewed in Appendix 2 and does not require further elaboration here. We suggest that the key point from this review is that generally the greater the level of spatial complexity in any reef structure (whether natural or artificial) the greater the variety of reef species likely to be supported.

18. Page 24, paragraph 4: The sentence about basing effects of suspended sediments on changes above background because there is no information available on the nature of the fill does not make sense. You still need to know what the effect of the fill will be to estimate this relative change. The following sentence should say "dewatering rate of 1 kg/sec and 2 kg/sec", not "concentration". I do not understand the last sentence of this paragraph – is it suggesting that there will be no deposition of material from the plume (i.e., that storms and waves would keep it continuously in suspension)? This does not fit with the observed increase in water clarity / decrease in TSS between storms.
    The 2nd sentence of this paragraph incorrectly connects the lack of information on the fill material to using above-background changes from the modelling. Firstly, modelling effects of turbidity is usually undertaken as an "above-background" as the background naturally fluctuates substantially, and we can't forecast the background ahead for the construction period. In any case, for such investigations, the focus is on modelling the change in turbidity or SSC due to the project activities. Secondly, the approach to uncertainty in the fine-sediment fraction of the fill aggregate (and the exact method of infilling has not been prescribed), was to simulate various loads of fine sediment from the discharge locations until two alternate thresholds of SSC were reached within a few hundred metres of the discharge in respect of bird foraging and general benthic effects from turbidity. That process resulted in sediment loads of around 1 and 2 kg/s to match those thresholds, assuming medium silt sediment (15□m). Aspects of the background SSC has been built into the monitoring conditions, to ensure an absolute SSC limit is not exceeded during clear calmer conditions and limited extension of the level when background conditions are turbid (during wave and storm conditions). Also includes a focus on erosion and sediment controls at source.

    The last sentence refers to the situation during storms or swell wave conditions – which is when any fine sediment on the bed will be entrained in the water column, with any fine sediments derived from the construction de-watering joining the "natural" fine sediment re-suspension from throughout the Bay. Again monitoring conditions apply to the background SSC (turbidity) measured at the time and would include both sources. The second aspect is because of the regular occurrence of wind/wave events, then lengthy periods of deposition on the seabed from construction are unlikely to occur – and therefore limits any persistent effects of fine-sediment blankets during the temporary construction period.

19. Page 24, paragraph 6: Are the concentrations in the first sentence relative to background? The sentence beginning "Thus we would expect the discharge from the NW location…" is confusing – it does not follow from the maximum values cited in the first sentence. Presumably these are the modelled concentrations at inner Lyall Bay?
    Not quite worded right. The first two sentences are about the concentrations in the near field after allowing for reasonable mixing. Then the 3rd sentence is about the far-field effects, where a NW discharge, which is closest anyway to the inner Bay, would have those

maximum TSS in the wider inner Bay for those sediment loads. All modelled values are "above-background". As mentioned above, the background levels have been considered in the derivation of the turbidity monitoring conditions.

20. Page 26, paragraph2: In what ways have cockles been found to benefit from small amounts of suspended sediment? Whether there is a benefit will depend of the quality of the sediment.
    In the experiments of Hewitt & Norkko filtration rate (ml cleared per hour per gm DW) increased up to at least 250 mg/L and thus they removed more food from suspension and there was a corresponding increase in dry flesh weight. Agree that quality of sediment important. Small amounts of sediment would; help some molluscs break up diatoms and other algae. I gather that experiments were run with samples from Whitford Embayment so may have contained relatively high levels of fine material than potentially in Lyall Bay situation. We don't know the exact make-up of the sediment fill yet.

21. Page 26, paragraph 5: What information is there to back up the statement that any effects from suspended and settled sediment would be temporary and populations would recover on timescales of months to a few years?
    There have been a number of studies following recolonization including:

    - Recolonisation within 1-2 years for larger biota such as barnacles, chitons, mussels and gastropods on new concrete following trench excavation (East Coast sewer pipe replacement – Paul Kennedy Golder Associates, pers. comm)
    - Experiments showed 180 days for recolonization following deposition of fine dredge spoil and a few weeks for sand spoil (Port Otago Dredging project (Paavo & Probert 2005)
    - Polychaetes recolonised immediately following disposal of spoil for Port of Auckland dredging , longer lived ones took several months (8-11 months) (Gowing et al. 1997)
    - 2-3 years for sand communities and months for mud communities to recover (Newell et al. 1998 overseas studies)

    Should also note that many taxa in these dynamic environments are ready colonisers because of episodic events.

22. Page 28, Section 8.3: What is the reference for the information about *Macrocystis* in the second paragraph, and what is the implication of the seasonal cycle of *Macrocystis* recruitment and canopy thinning? The review of information on effects of suspended sediments here is rather selective and limited. There is a published review by Airoldi (2003) that could be referred to.
    Most of the information on Macrocystis comes from Jim Fyfe's MSc – see refs below. Not sure which 2003 report is referred to as the one I have for Airoldi 2003 (Oceanography and marine Biology: an Annual Review) is for sedimentation not TSS. Happy to add other relevant information and was no intention to be selective.

23. Wilber study does not refer to NZ oysters. Where have concerns been raised that even small amounts of suspended sediment could impact on "survival of grazing", and what is meant by this phrase? The TSS concentrations in the study by Schwarz et al. (2006) are within the range of predicted concentrations around the weirs draining the reclamation (page 24). Although the plume would be rapidly dispersed during storms, reducing the potential impact of increased TSS, background concentrations would also be higher.

Agree the Clarke & Wilber work is not NZ but never was claimed to be that I can see. There is little NZ work available. The “of” grazing should be “or” grazing. Schwarz et al. raise the issue of effects on grazers and other work is summarised in the James et al. referenced in the report. It should be clarified that “small amounts” is applied as relative term and thus levels of 15-20 mg/L could be regarded as small relative to natural events which can be up to 1000 mg/L. The communities are tolerant of the sort of levels that would be generated based on information available. Levels would only be high close to the weir and would disperse quickly when background high.

24. Page 29, paragraph 1: The turbidity range (actually TSS concentration—18–74 mg/L) that caused mortality of kina and paua larvae in the Phillips and Shima study cited here spans the range of predicted increase due to construction of the reclamation (up to 34 mg/L above background). So it is not correct to dismiss it as being “considerably higher… than those predicted to occur as a result of the construction of the reclamation”. Are there implications for recruitment of these species to the area—how does the timing of the construction work compare with recruitment timing?
    We would expect recruitment once construction was completed and would only impact a small area as well. The 34 mg/L is only if the higher discharge is used and within 150 m of weir so a very small area and would be a maximum not median or average. The surrounding reefs would not experience levels anywhere near the 18-74 mg/L used in the experiments.

25. Page 29, paragraph 2: Would the community colonising the rock walls be expected to be similar to the existing one if concrete accropodes were used (with different surface texture and initial high pH)?
    Yes, it can be expected that the colonising rock wall species will reflect the source species assemblages in Lyall Bay and on the Wellington south coast. By planning for a range of textures on the surface of the artificial structures, combined with the range of light intensities created by the 3-dimensional aspect of the layers of accropodes a range of species will find suitable settlement habitat. The initial high pH of new concrete can be artificially weathered by painting with a weak acid (such as vinegar) before deployment.

26. Pages 29–30, Section 8.4: What were the experiments on effects of suspended sediments on zooplankton (paragraph 3 of Section 8.4)?
    The experiments are reported in Clarke and Wilber (2000) and Wilber & Clarke (2001) and involved looking at survival of juvenile crustacea and larval shellfish among others when exposed to concentrations up to 10,000 mg/L. Importantly there was no effect below 100 mg/L (juvenile crustacea, eggs (hatching rate) and fish larvae survival).

27. Page 31, paragraph 3: Are the thresholds for protection of terns and gannets in Port Melbourne applicable to “any birds”? Terns and gannets, which identify prey from above the water surface, forage differently to shags, for example, which chase prey underwater. How were the thresholds derived?
    We only have data from the Port of Melboune (POM) study for terns and gannets and these were used in the absence of other data to protect seabirds in the PoM and Port Otago cases. In the PoM case the limit was derived based on observations of bird behaviour and feeding. We am not aware of any published data on shags but we have personal observations by Mark James in the Whangamata estuary are that shags will continue to feed even at very high turbidities and TSS and successfully capture small fish.

28. Page 31, Section 8.6: Some additional information about guidelines for dredging and construction operations when marine mammals are present would be useful. Have there

been any incidences, in New Zealand or overseas, of marine mammals being affected by this sort of operation?
The two relevant sets of guidelines would be the Marine Mammal Protection Act (http://www.legislation.govt.nz/act/public/1978/0080/latest/DLM25111.html) and the seismic survey code of conduct (http://www.doc.govt.nz/Documents/conservation/native-animals/marine-mammals/seismic-survey-code-of-conduct.pdf).

29. Page 35, paragraph 1: I don't agree that communities on exposed coastlines are necessarily resilient to episodic periods of higher sedimentation – the exposed nature of the habitat keeps any sediment in suspension, and sources of fine sediment are generally much more limited (because the substratum has been eroded to coarse sediments or rock by water movement). What is the evidence that recovery from sediment deposition only takes a few or several months?
See above re recovery. The TSS from monitoring in the outer Lyall Bay during storm events and observations of Lyall Bay indicate that TSS and turbidity can be very high and thus along with strong wave events that can go for several days they need to be resilient to such events. The plume of higher TSS will be very localised to the weir area as well.

30. Page 35, Section 9.3: This section is entitled "Reef communities" but almost exclusively discusses algae. It concludes that "Overall impacts on macroalgae from sedimentation are likely to be very low, if at all, and will be very localised and short-term if they did occur". However, in the third paragraph in the summary box on page 36 this conclusion is extended to "Overall impacts on reef animals and macroalgae from sedimentation, if it did occur, are likely to be very localized, short-term and negligible". Justification for this extension is needed.
The reviewer is correct that it is mostly macroalgae that is discussed. This section could be extended based on the review undertaken as part of the Port Otago study and reported in James et al. in the references. Although there is not as much information as for soft sediment taxa, Nicholls et al. (2003) does discuss effects on grazing gastropods. Work Mark James has undertaken in lakes has showed that grazers benefit from some sediment amongst the benthic algae and it helps them process diatoms etc. So the conclusion would be the same.

31. Page 35, paragraph 3: What is the source of the information about the ability of *Gracilaria* to survive burial?
A study by Anderson et al. (1992) of Gracilaria in Saldanha Bay, South Africa indicated that it could survive burial 0.2 m deep for up to year.

32. Page 38, summary box: Have the potential risks to marine mammals from collision with vessels working on the reclamation, or entanglement with structures such as silt curtains, been assessed?
Not specifically that we are aware although mammal presence and actions will be included in the construction plan based on best practice.

33. Page 38, Section 11 paragraph 3: The guidelines for Port of Melbourne and Port of Otago relate to concentrations above background. The 50 mg/L guideline related to protection of sea tulips (*Pyura* spp.), which live on hard substrata. The suggested guideline for benthic invertebrates in general was 15–35 NTU (assumed to correspond to 15–35 mg/L).
Our understanding is that most of the PoM limits are absolute ones and absolute limits are used for port Otago not limits above background. The actual limits depend on the ratio of NTU:TSS with the former being monitored and calibrated against TSS limits.

34. Page 38, Rock wall construction: What is the source of information that certain habitat features increase biodiversity?
    See review of international literature in Appendix 2.

35. Page 40, Section 12: There is a problem with assessing compliance with water quality limits set as concentrations of suspended solids (mg/L) by measuring turbidity. Where is the proposed maximum value for TSS of 10 mg/L above concentration at the control site derived from? What is meant by "plume ring construction"?
    Plume ring construction refers to monitoring the shape and extent of the plume to demonstrate it is as predicted. NTU or turbidity will be monitored and calibrated against TSS which is standard and as practiced by Port Otago. The control site will be out in Lyall Bay and monitored so that the max can be continuously checked against the condition.

TR 19 APPENDIX 2 – ENHANCING THE ECOLOGICAL VALUE OF THE ROCK DYKE FOR ROCKY REEF SPECIES

36. Page 52, paragraph 4: Could the problem of scour around artificial structures on the seabed, particularly in high-energy environments, adversely affect organisms colonising the wave-focussing structure proposed for Lyall Bay (and its structural integrity)?
    Sand scour around the base of reefs is a factor currently present around reef structures (both natural and artificial) in Lyall Bay. This tends to favour the growth of early colonising or resilient species in these locations. An engineer would need to comment on the impact of scour on the structural integrity of the wave focusing structure.

37. Page 52, paragraph 6: Why are these particular dimensions suggested for the rock pools created in the concrete blocks?
    The design of the pools is approximate only.

TR 20 ECOLOGICAL ASSESSMENT OF A PROPOSED WAVE FOCUSSING STRUCTURE IN LYALL BAY, WELLINGTON

38. Page 12, Section 4.1: The loss of habitat within Lyall Bay as a result of placing the wave-focussing structure was estimated at 1% of all soft-sediment habitat and 5% of this habitat in the depth range 5–10 m. What would the cumulative loss of this habitat be if the footprint of the airport extension is included?
    The total loss of soft sediment habitat resulting from both the airport extension and the construction of a wave focusing structure would be approximately 4% of that occurring in Lyall Bay.

Additional References:

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