BEFORE COMMISSIONERS APPOINTED BY THE CANTERBURY REGIONAL COUNCIL

UNDER	the Resource Management Act 1991
IN THE MATTER	applications for resource consents by Lyttelton Port Company for capital and maintenance dredging

TABLED AT HEARING

Application: Lyttelton Port Co - channel deepening

Date: 5 May 2017

SUMMARY OF EVIDENCE OF JOHN OLDMAN FOR TE HAPŪ O NGĀTI WHEKE, TE RŪNANGA O KOUKOURĀRATA, NGĀI TAHU SEAFOOD, AND TE RŪNANGA O NGĀI TAHU

5 May 2017

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SUMMARY OF EVIDENCE

1 The modelling that has been carried out is about sediment - how it is removed from the seabed, how much is spilt during that process, where that spill material ends up and how it may behave at the offshore spoil ground.

2 As set out in my evidence, current best practice with regard to modelling is to take into account the combined effects of tides, winds, waves, broader scale oceanic currents and resuspension, especially with respect to understanding and quantifying the transport of fine-grained sediments, as found in Whakaraupō.

3 It is also best practice to acknowledge the uncertainties relating to modelling. No model will ever reproduce exactly what happens in nature.

4 Different models use different assumptions, and numerical methods and can include or exclude different processes, such as flocculation, wave/current interaction, hyperpycnal flows, consolidation, fluidisation etc. as discussed in the LPC application and evidence.

5 No model will ever reproduce exactly what happens in nature. The only true test of a model is to compare its predictions to observations. In the absence of a complete calibration of a model any predictions must be treated with caution and the implications of the model results being wrong understood in terms of the potential impacts.

6 Steping back from the all modelling that has been done, current best practice guidelines indicate that approximately 5% of the overall dredge volume may be spilt during a dredging campaign.

7 The management of the potential impact of the spill material is a crucial part of both the planning and execution phase of any dredging project.

8 Dredge operators internationally spend significant resources, time and money to quantify the potential impacts from dredging works and then plan, design and implement dredging works to minimise potential risks.

9 Over the course of the proposed capital dredging of Whakaraupō a total of 900,000 m^3 is likely to be spilt from the dredger – the majority of which will occur during the overflow events. In Dr. Beamsley's summary evidence he states that "It is unclear how this figure has been arrived at". It is 5% of the proposed capital dredge volume.

10 Essentially, this spill material represents a new source of fine grained material to Whakaraupō. It is a significant input compared to the current infilling rate in the harbour (assumed to be less than 30,000 m^3/yr) and so it is important to manage any potential risks that this material might have on the environment.

11 This spill material will be deposited in and around the dredger as it operates along the dredge corridor. That cannot be argued against.

12 Modelling presented in the application and subsequent evidence indicated that this material only ever stays in the dredge corridor. That is not a surprising result given that waves and winds have not been included in the model.

13 There is no quantification as to what extent that subsequent capital and/or maintenance dredging may "mop up" the spill material. The only scenario that seems to be considered in the application is that the spill material will be "dredged again" and it will all be removed and placed at the offshore spill site. Maybe; if you just come back and dredge the same spot over and over again. Or that you assume it stays in place until maintenance dredging is done and then it is dredged up.

14 The logical conclusion, based on all of the above, is that there will be no impact from the dredging operation at any time, under any conditions in any parts of the harbour.

15 Using all the modelling assumptions, the predicted impact can only occur at the dredge site. If all the spill material either sits on the sea-bed forever or is subsequently dredged up, then a model isn't even needed. The effect of the dredge operation on observed elevated turbidity levels outside the dredge corridor will also be zero and trigger level exceedances could never be attributed to the dredging operation.

16 As I set out in my evidence, I do not believe this will be the case if the combined effects of important processes are considered and the uncertainties relating to simulating the fate of recently deposited fine-grained sediment spill material are allowed for.

17 The summary evidence of Dr Beamsley is, rightly, dismissive of my demonstration model. It is uncalibrated, I have made assumptions about model parameters and in particular the spill source terms. It was never intended to be used as tool to provide an alternative assessment of effects.

18 The demonstration model was developed for Ngāi Tahu to show that if a three-dimensional model is used which considers the combined effects of tides, winds and resuspension then a physically realistic outcome is that some spill material may be transported away from the where dredge material is initially placed. This outcome is clearly indicated in the application with regard to the offshore spoil and maintenance grounds based on results from a three-dimensional model that includes the effects of waves, tides, oceanic currents and resuspension.

19 My demonstration model showed that material spilt in and around Cashin Quay can indeed be resuspended under certain conditions. The summary evidence of Dr. Beamsley presented further modelling, using new model parameters, which indicate that erosion of spill material in and around Cashin Quay may actually be a possibility. Information in that summary evidence of Dr. Beamsley states "possible that adaptive management could be used to mitigate potential re-suspension" in the area in and around Cashin Quay. This is the first time I have seen any indication that model results may actually be used to provide input to the management of the proposed dredging works.

20 This is a major breakthrough.

21 As my uncalibrated demonstration also showed if winds are considered, material that is eroded from the bed can be transported away from the dredge channel. So, material is eroded from the bed into the water column where it can be influenced by winds and then moved away from where it was initially placed by the dredger. This combined effect has not been modelled as part of the LPC application and as such the level of impact of possible dredging operations in and around Cashin Quay has not been fully quantified.

22 Once spill material moves into shallower water the combined effects of winds, waves and subsequent resuspenion need to be considered.

23 Within his summary evidence Dr. Beamsley tries to imply that the demonstration model must show only a minor impact (even though he is very critical of the model itself) and that I have tried to exaggerate the potential impact by hiding model values. I concede that my early attempt at trying to unravel the intricacies of the dredge spill terms (as presented in the application) were incorrect. That is the reason I reverted to just modelling the relatively straightforward propeller wash and drag head terms for my evidence.

24 The purpose of the demonstration model was only ever to show that a difference in impact can be predicted – in the demonstration model case either we have predictions that say no impact beyond the dredge corridor occurs (consistent with the application) or (if you consider winds and resuspension) there is some impact. The "some" can only be fully quantified using appropriate models that have been fully calibrated. So, my demonstration model results presented in my evidence was only ever qualitative.

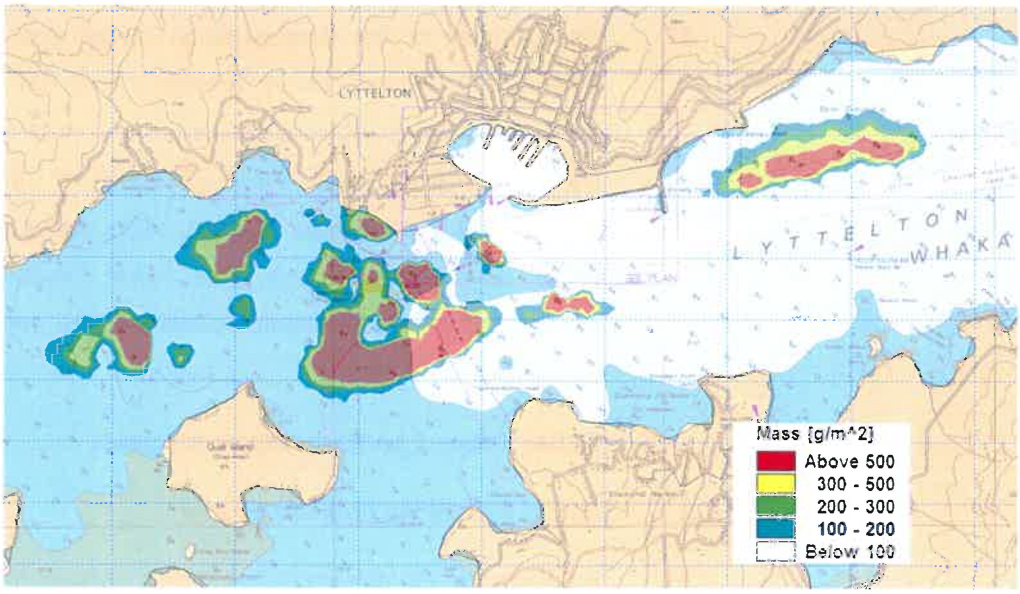
SLIDE 1 then 2 showing plume footprint

SLIDE 3 showing time-series plot

25 Furthermore, my demonstration model showed that 15% of the spill material ended up outside the dredge corridor if winds and resuspension are considered. Typical productions rates of 500,000 m^3 per week are presented in the evidence. So, if we assume only a 1% spill rate of a weekly production of 500,000 m^3 has occurred during the 14-day simulation period (which is a very low estimate), 15% of that spill material would be 7,500 m^3. This material is predicted to be moved away from the dredge corridor and into the upper harbour. ***SLIDE 4***

26 The important point with this figure is not the magnitude of the numbers (because those totally depend on all the assumptions I have made) but that there is predicted connectivity between Cashin Quay and the upper harbour. Spill material released near Cashin Quay under some combination of tides, winds, dredger location and spill timing can be transported into the upper harbour.

27 I do not expect the panel to accept this is a true assessment of effects, merely a potential that needs to be properly quantified and, if it is a concern, then managed.



Predicted deposition rates (g/m^2) at the end of the 14-day simulation which includes winds, tides and resuspension of spill material. These values account for the combined effects of the propeller wash, drag head and overflow spill source terms. Assuming a density of 300 kg/m^3, a deposition rate if 300 gm/m^2 equates to a deposition rate of 1 mm.

28 Based on the information in the application, LPC model results would have been used to say no impact, anywhere, at any time in the harbour under any conditions. Taking such a stance, implies there is either no need for developing any sort of adaptive management plan (because there is no predicted impact) or that ongoing monitoring will capture any impacts that the model has not predicted.

29 If erosion in and around the Cashin Quay area is important (as the summary evidence of Dr. Beamsley indicates) then more modelling is required to assess the impact of dredging from spill material initially depositing (or moving into) this area.

30 The debate about which erosion threshold should be used could go on ad-infimum. Unless a full quantitative calibration of a three-dimensional sediment transport model is carried out against observations a value (or a range of values) needs to be considered.

31 If an erosion threshold of 0.1 N/m^2 is to be rejected then the calibration of the models used offshore to assess the effects of the spoil ground dynamics <u>must</u> be revisited. Table 2.3 of Appendix B of Dr Beamsley's evidence shows that altering the erosion threshold from 0.1 N/m^2 (which provides the best calibration of the model) to a value of 0.3 N/m^2 results in model predictions which are wrong by 80%. A model run is not carried out for a value 0.2 N/m^2 – even though it is strongly argued that this is the value that should be used in

the harbour. However, it is hard to imagine that a model run with a value of 0.2 N/m^2 would produce a "good" calibration unless a higher erosion rate is used – it is likely an error of around 50% would occur. Alternatively, a higher erosion rate would be required to achieve a "good" calibration. Model simulations would therefore predict less frequent, higher levels of suspended sediment concentration.

32 If on the other hand a value of 0.1 N/m^2 is accepted as being physically possible then more modelling is required which uses this value and includes winds and waves.

33 Similarly, the decision to include or reject a depositional threshold can only be resolved using a fully calibrated three-dimensional sediment transport model. Determining the size of the initial zone to place spill material "has been modelled by HR Wallingford". Their industry standard software which is used to carry out this type of modelling is the TASS model. It's manual clearly states that the model will only allow dredge spill material to settle if the shear stress on the bed is less than 0.1 N/m^2. Either HR Wallingford have ignored their own advice/model or have assumed that a depositional threshold isn't applicable for Lyttelton – I don't know which.

34 Other references in my evidence use similar values for a depositional threshold and, rather than producing "improbable results" or "unrealistically" behaviour (as per para 259 of the Dr. Beamsley's precirculated evidence), models referenced have been fully calibrated against observations and used to predict and manage the impact of actual dredge programmes.

35 Using a depositional threshold means that in areas where the combined shear stress from currents and waves is greater than the specified value, the dredge spill material will not settle on the bed. It will remain in the water column longer and spread further than if a depositional threshold is ignored. This possibility has not been considered in the application.

36 I am not making a recommendation that a depositional threshold must be used rather that (in the absence of data) the implications of not doing so are understood in terms of the potential impact of the dredging.

37 Getting the size and shape of the initial zone is important as it defines the initial concertation (same mass, different volumes) which then cascades into what the model predicts away from the dredger. ***SLIDE 5***

38 Similarly, assumptions about where in the water column the dredge plume is initially placed in the model has huge implications. New evidence presented by Dr. Beamsley now states that the water column term could be as low as 1% (not 25% as modelled). I have not had time to consider the implications of this, but I note that making such a significant change to a model assumption two days before a hearing is quite a bold move. I don't know what the implications maybe without some further thought and information about how the 1% was derived (all I know is it cannot have been measured yet).

39 If we assume a total of 40 hours a week spill (Pronk evidence) at a rate of 1600 kg/s (Beamsley evidence) then 1% of that (which could be what is now being assumed, I'm unsure) equates to 2304 tonnes each week in the water column. Currently there is no plan to manage that at all (because modelling says no impact beyond the dredge corridor ever happens because no winds have been modelled).

40 Nevertheless, whatever assumptions are made it can never be assumed that no spill material will end up in the water column. ***SLIDES 6 & 7***

41 Finally, I would like to present to the panel why I believe waves should be included in the harbour model.

42 The assessment offshore stresses the importance of waves for resuspending material.

43 The calibration of the model at Godley Head (just inside the harbour) includes waves to provide a good calibration.

44 Waves are also included when considering the modelling of the movement of the material from the proposed maintenance ground just offshore of Godley Head.

45 However, along the outer part of the dredge corridor no waves are considered at all. See my summary figure below. **SLIDE 8**

46 Significant quantities of dredge spill material are predicted to be deposited along the outer part of the corridor. The exact amount has not been quantified but could be estimated by combining the dredge source terms used in the modelling and the workings of Mr. Pronk with regard to likely weekly production. One estimate could be that 45 hopper loads occur in a week (based on the evidence of Mr Pronk) plus an overflow rate of 1600 kg/s for ten-minutes each hopper load (as presented in the evidence of Dr. Beamsley). This represents a significant amount of fine sediment deposited

on the outer part of the dredge corridor. Some of the spill material will be dredged again – but only if it always stays in the dredge corridor. You could assume none of it is mopped up (very unlikely) or all of it is mopped up. The reality will be somewhere between those two. If you assume the later (that everything spilled stays where it was placed, it remains in the dredge corridor) then it will eventually be mopped if you keep a track of all the spill material and keep revisiting the spill site (without spilling more material). Based on all these assumptions you don't even need to consider a plan for managing the possible resuspension of spill material along the dredge corridor. In that case why do you even need to have a model?

47 The reality is that any spill material moving outside the dredge corridor (by whatever process) will never be able to be "mopped up" by further capital and/or maintenance dredging.

48 However, just like at the offshore spoil ground and proposed maintenance ground, winds, waves and tide in combination, must at some time, influence the behaviour of the spill material, even if it is all initially placed near the sea-bed.

49 At the offshore spoil ground and proposed maintenance spoil ground it is accepted that waves need to be simulated if the dynamics of the dredge material are to be quantified but when you consider the outer limit of the dredge corridor, it has been assumed that waves are no longer important and do not need to be considered. ***SLIDE 9***

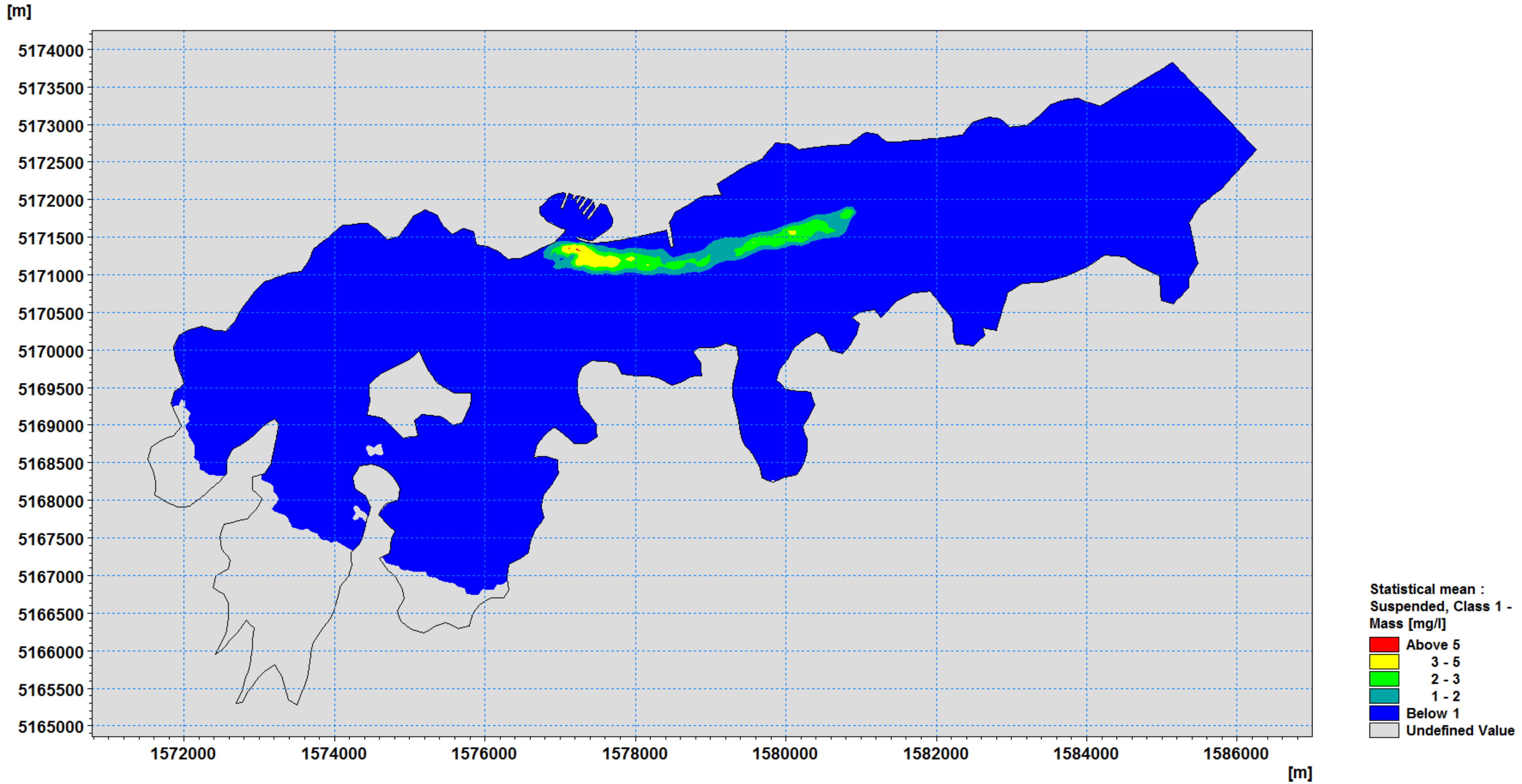
50 Again we have no idea of how much spill material might be moved away from the outer dredge corridor and, if there is any movement, where it might move to. The "some" has just assumed to be zero so the "where" does not need to be considered.

51 The possibility of newly deposited spill material being resuspended by waves and subsequently moved outside the dredge corridor (by tides and/or winds) along the outer dredge corridor has not been considered. This could be very important given the proximity of Port Levy to the outer limits of the dredge corridor and the potential magnitude of spill material being considered.

52 That is a summary of my evidence and I am happy to answers any questions from the Panel.

DATE 5 May 2017

John Oldman



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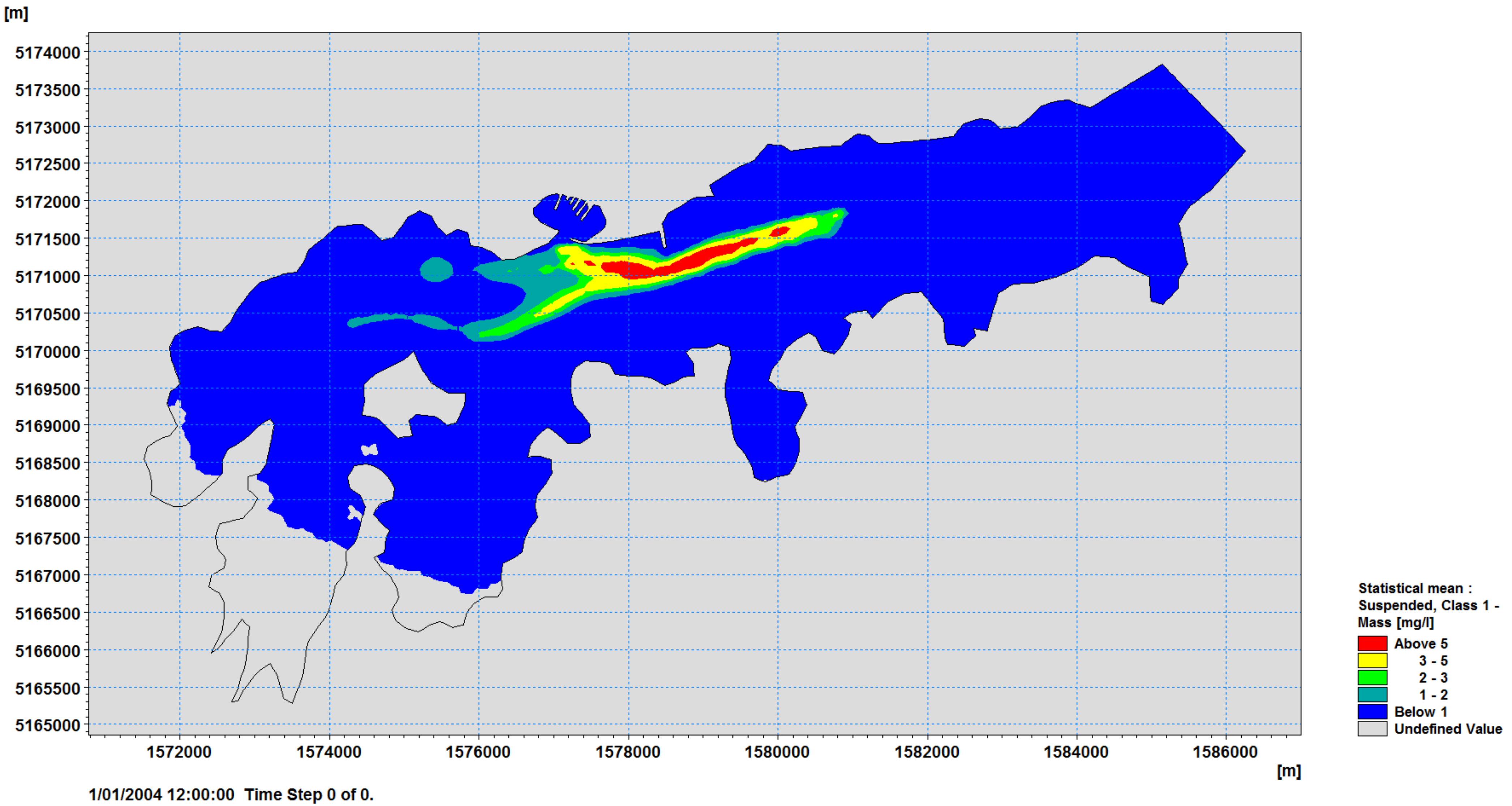
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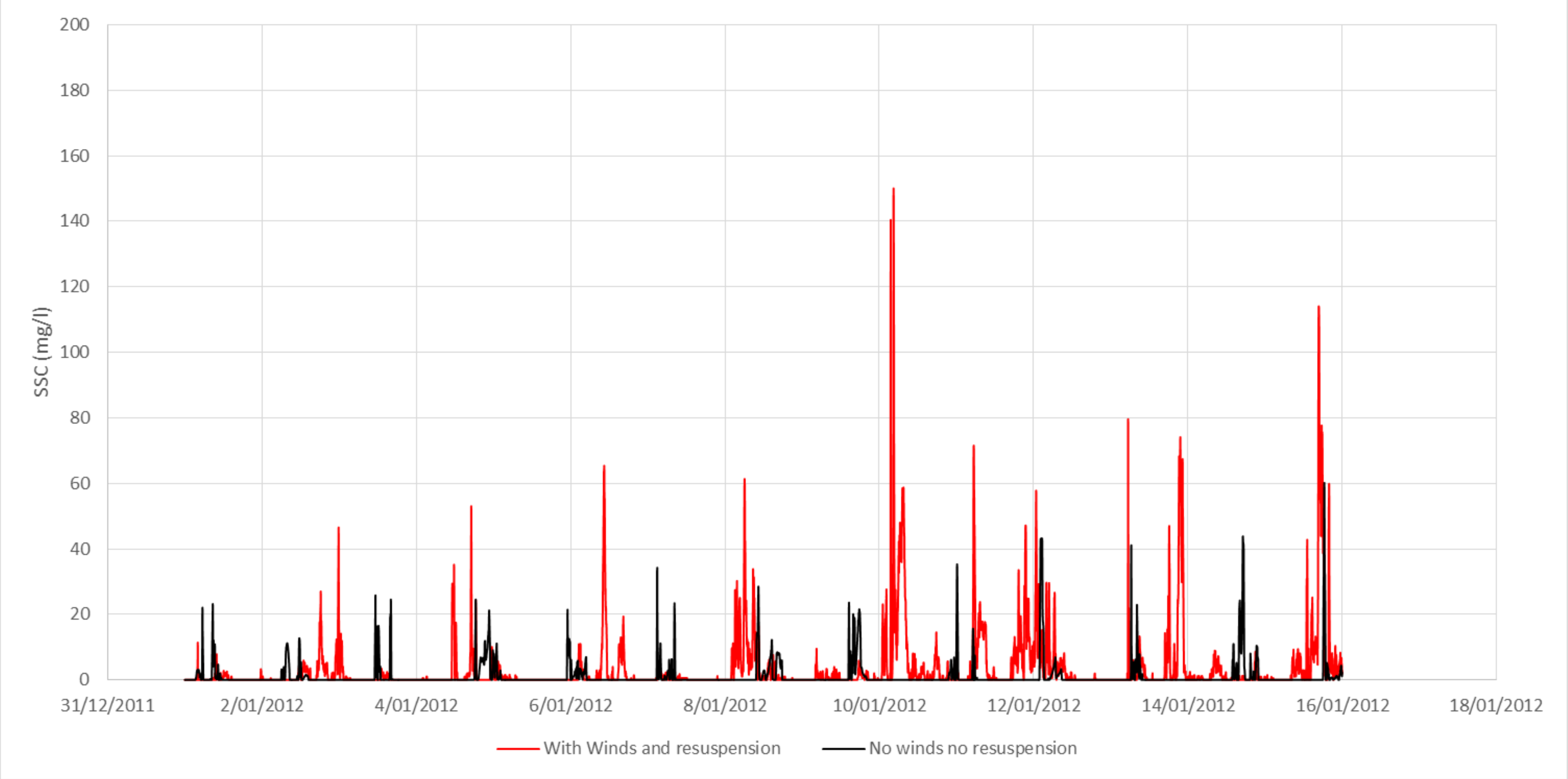
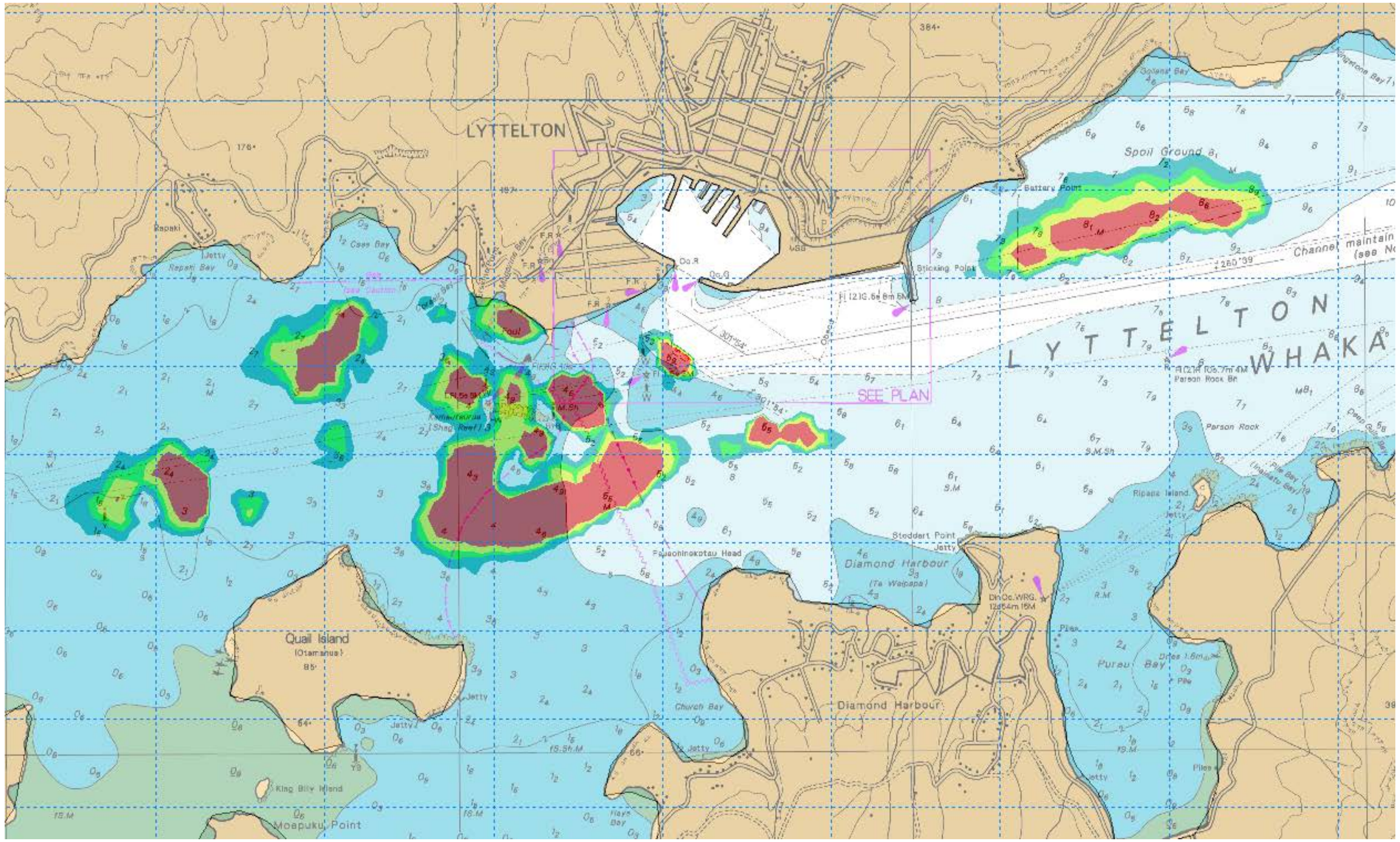


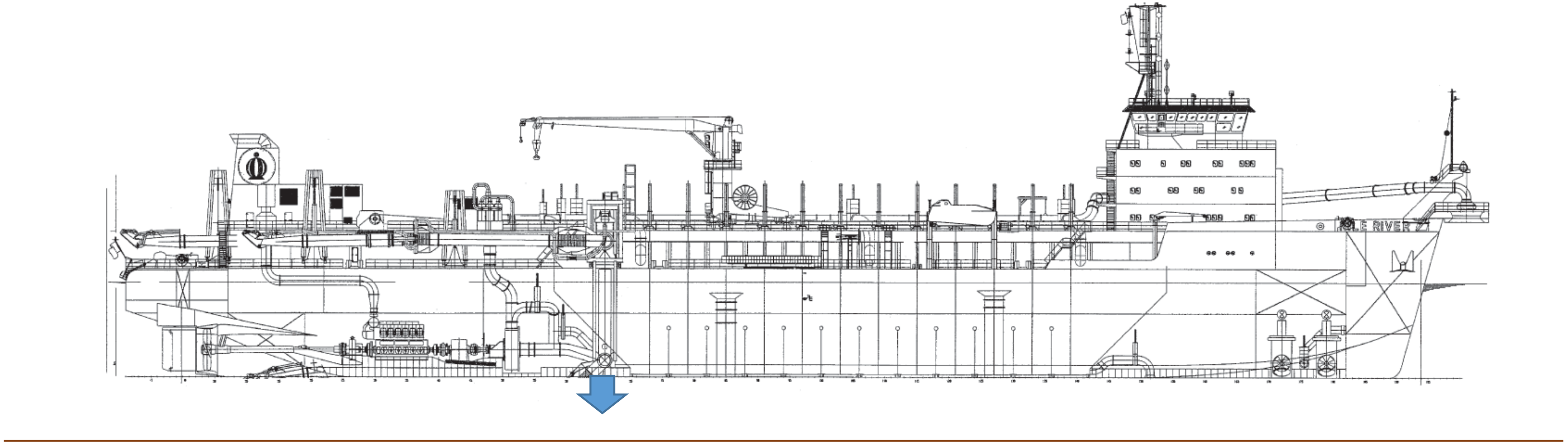
Depth-averaged suspended sediment concentration over a 14-day period showing differences between a model with no winds and no resuspension (black line) and with resuspension and winds (red line).

Source terms included in the model are just the drag head and propeller wash terms at 25 kg/s for 25 minutes every two hours.

Dredger operates in the area in and around Cashin Key moving up and down the channel.



Predicted deposition rates (g/m^2) at the end of the 14-day simulation which includes winds, tides and resuspension of spill material.
Total spill assumed to be 1% spill rate of a weekly production of 500,000 m^3
These values account for the combined effects of the propeller wash, drag head and overflow spill source terms.
Assuming a density of 300 kg/m^3, a deposition rate if 300 gm/m^2 equates to a deposition rate of 1 mm.
All material in the dredge channel (85% of the total spill material) is removed from the harbour



28 m wide, 2m deep, 12 m^3/s overflow = under keel velocity of 0.2 m/s?
Source term 1600 kg/s, 12 m^3/s = 133 kg/m^3 (13,000 mg/L)
Reality is highest near the source, gradual decrease in concentration away from source

20,000 TSHD, Southern coast of Johor, Malaysia, fine sediments

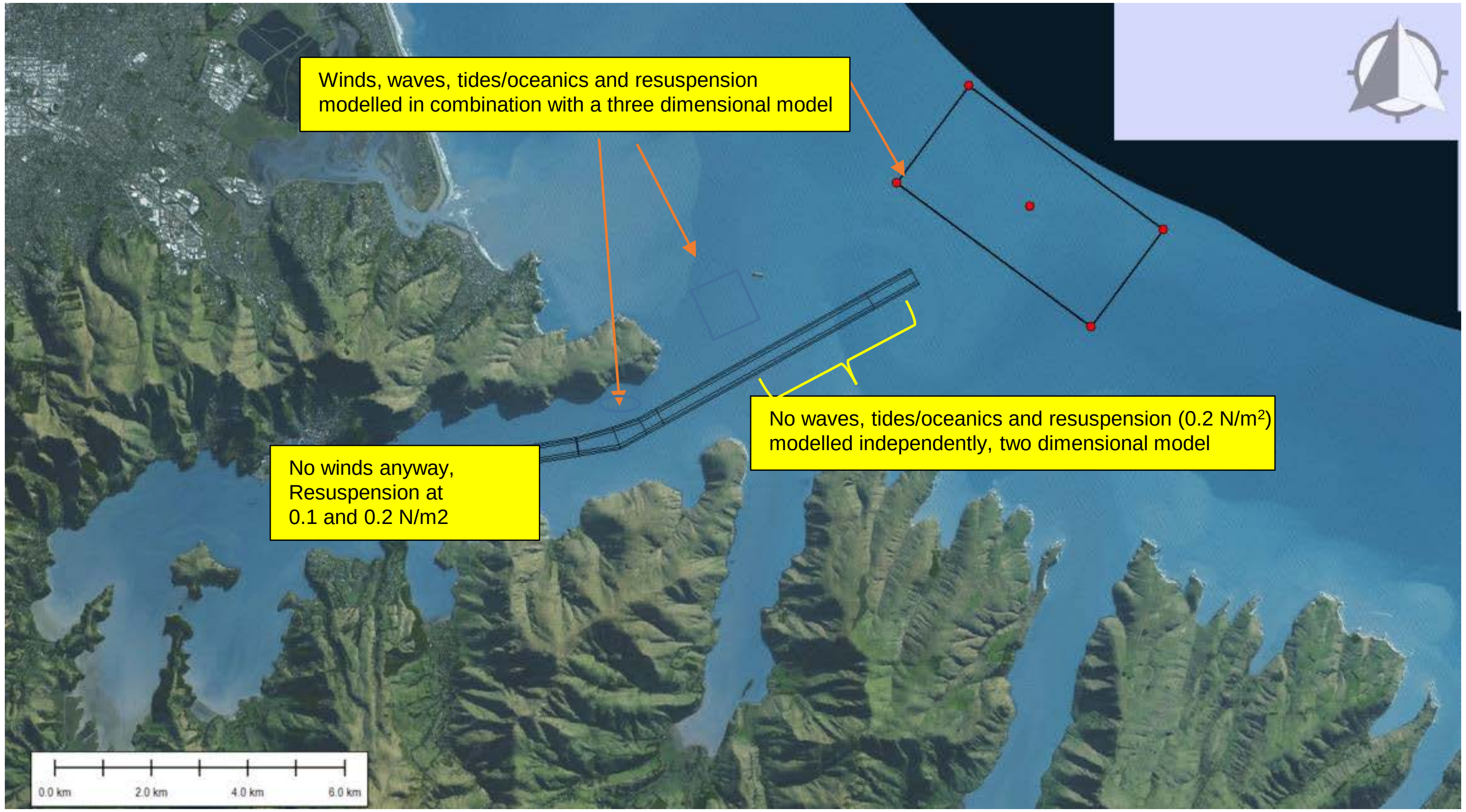
The overflow structure was equipped with the Green valve, and as a result the water level inside the overflow shaft is high and almost close to the water level inside the hopper.

Therefore, the effect of air entrainment is insignificant. Water column term small 1-5%

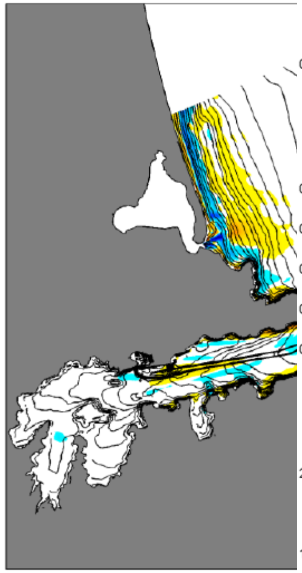
“Some” at the surface

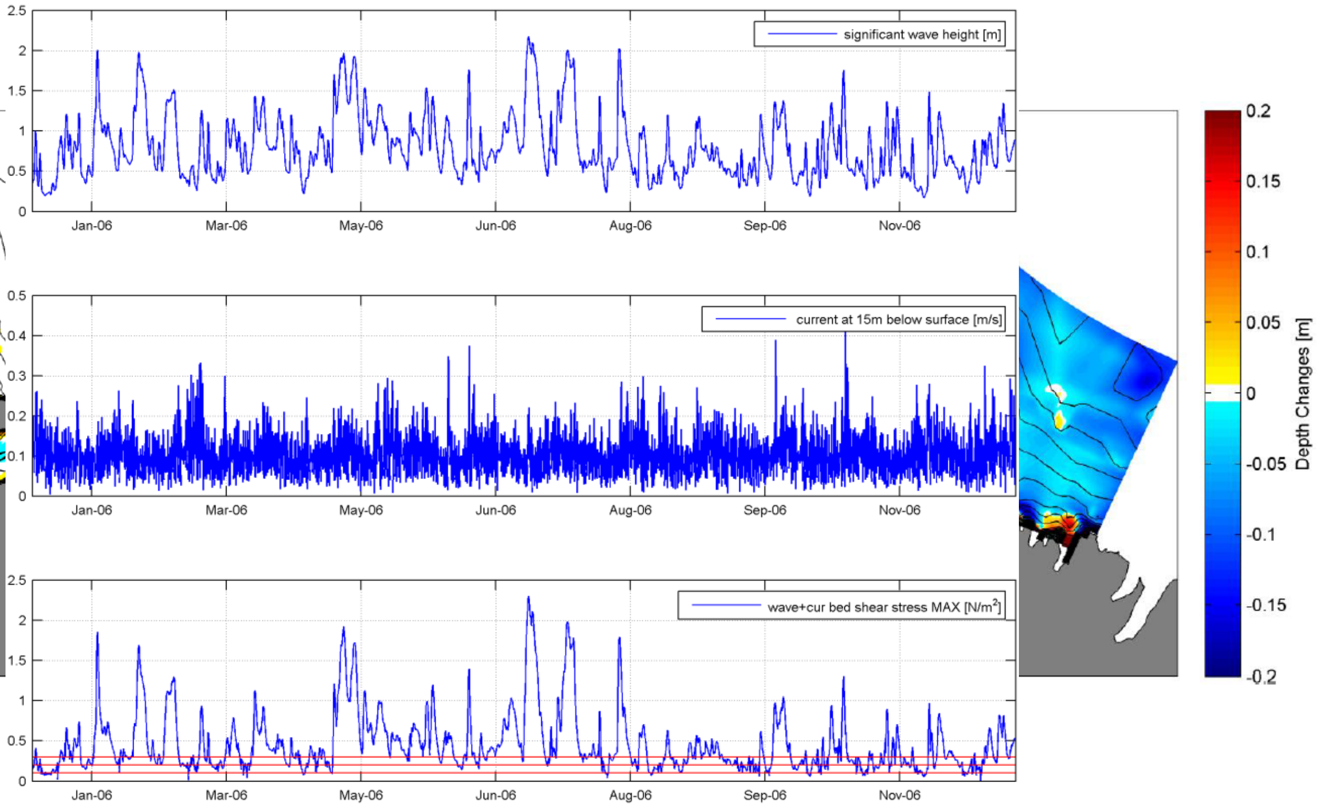
This 1% will be influenced by winds, in 5-10m of water can stay in the water column for extended periods of time (even in Lyttelton)
So it can be moved away from dredge corridor into areas where it may be influenced by waves (and can’t be mopped up)

Predicted impact, however, is zero because no spill material can ever move outside the dredge corridor



Summary of model approaches used for the assessment of effects





Appendix 12

erosion is predicted within the entrance to Whakaraupō.

the general patterns of erosion are likely to be accurate