Before a Board of Inquiry
Transmission Gully
Notices of Requirement and Consents

under: the Resource Management Act 1991

in the matter of: Notices of requirement for designations and resource consent applications by the NZ Transport Agency, Porirua City Council and Transpower New Zealand Limited for the Transmission Gully Proposal

between: **NZ Transport Agency**
Requiring Authority and Applicant

and: **Porirua City Council**
Local Authority and Applicant

and: **Transpower New Zealand Limited**
Applicant

Second statement of rebuttal evidence of Michelle Kathleen Malcolm (Water Quality) for the NZ Transport Agency and Porirua City Council

Dated: 16 February 2012

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CHAPMAN TRIPP

SECOND STATEMENT OF REBUTTAL EVIDENCE OF MICHELLE KATHLEEN MALCOLM FOR THE NZ TRANSPORT AGENCY AND PORIRUA CITY COUNCIL

INTRODUCTION

1 My full name is Michelle Kathleen Malcolm.

2 I have the qualifications and experience set out at paragraphs 2 – 4 of my statement of evidence in chief, dated 22 November 2011 (*EIC*).

3 I repeat the confirmation given in my EIC that I have read, and agree to comply with, the Code of Conduct for Expert Witnesses (Consolidated Practice Note 2011).

4 In this second statement of rebuttal evidence, I respond to:

4.1 The supplementary evidence of:

(a) Mr Handyside on behalf of the Director-General of Conservation (*DOC*); and

(b) Ms Kettles, on behalf of DOC; and

4.2 The section 42A report provided by Dr Hicks.

5 The fact that this rebuttal statement does not respond to every matter raised in the evidence of submitter witnesses within my area of expertise should not be taken as acceptance of the matters raised. Rather, I rely on my evidence including this rebuttal statement to set out my opinion on what I consider to be the key water quality matters for this hearing.

6 For the purposes of this evidence, I will refer to the NZ Transport Agency (*the NZTA*) Project and the Porirua City Council (*PCC*) Project collectively as the "Transmission Gully Project" (and hereafter, *the TGP* or *the Project*).

SUMMARY OF EVIDENCE

7 As a result of issues raised by Dr Hicks, Dr Basher and Ms Kettles, additional sediment generation estimates were calculated and a number of additional Harbour modelling scenarios have been assessed to address these issues.

8 **Dr Keesing** and **Dr De Luca** have not altered their opinions on the effects of the Project, as a result of this additional work. In the Harbour, the original scenario modelled to describe the 10 year ARI

event in the 'peak year' is still the modelled scenario that has the greatest ecological effects.

9 I conclude that the issues raised about the modelling methodology have only minor implications for the assessment of effects, and therefore I consider the modelling that has been undertaken provides a suitable basis for the assessment of effects.

10 While there is remaining uncertainty, much of this uncertainty is inherent to the calculation of sediment yield.

11 I consider the best way of managing this uncertainty is through the consent conditions.

EVIDENCE FOR SUBMITTERS

Brian Handyside

12 In paragraphs 16 – 18 of his supplementary evidence, Mr Handyside discusses conditions E1 and E2 and my recommendations that annual staging road lengths be added to this condition.

13 Mr Handyside then goes on to multiply the staging road lengths provided in my rebuttal evidence by an assumed 75m width, and concludes the areas he has calculated are substantial areas of bare earth. This is not quite correct.

14 In paragraph 103 of my rebuttal I make the point that the lengths I describe are not unstabilised areas, but are annual staging areas within which progressive stabilisation will occur. Accordingly, they are not "bare areas".

15 Regardless of this, I consider the important point is the figure(s) that go(es) into the conditions, and have discussed this further with **Ms Rickard**, along with considering debate between all attendees at conferencing on 8 February. I am confortable with, and understand the reasons for, **Ms Rickard's** recommendations that areas (in ha) are used in these conditions (rather than lengths). I circulated a memo at the 8 February session, and I understand that **Ms Rickard** is using the areas from that memo in the "track changes" version of conditions. However I note the area I used for revised estimate was 10ha for the Onepoto arm. I have requested that **Ms Rickard** alter this condition to reflect this area. I support using areas that are consistent with the modelling because my assessments of sediment generation use these areas, and then link to the assessment of effects on the marine and stream environments undertaken by the ecologists, and the recommendations on conditions that they have made.

16 In paragraphs 19- 26, My Handyside comments on the revised analysis I undertook following the conferencing on 8 December

2011, presented at conferencing on 20 January, and described in my rebuttal evidence. Paragraph 8 of the conferencing notes for 20 January 2012 records agreement between myself, **Dr Fisher**, Dr Basher and Dr Hicks that the revised estimate provides a better estimation and a reduced uncertainty in USLE parameters.

17 I understand there has been some confusion regarding an earlier version of the Revised Analysis report, circulated on 19 January and titled "Sensitivity Analysis". During the conferencing on 20 January I presented this report to the group. During the meeting, in response to comments made by the group some amendments were made to the report and the final version (dated 20 January 2012), was distributed at the end of the meeting and attached to the conferencing notes. The changes made to the document were:

17.1 I changed the title in response to a suggestion from Dr Basher that the work was not a sensitivity analysis, because the methodology was altered. I agreed and renamed the report, to reflect this. However, sensitivity analysis was undertaken on the Revised Estimates and this is discussed in Appendix A to my rebuttal evidence.

17.2 I reformatted table 18 in the Revised Analysis report, which compared the difference between the assessed estimate and revised estimate, to make comparison more straightforward for the reader.

17.3 I altered the description in table 18 of the difference between the assessed estimate and the revised estimate. In the report dated 19 January, I had described the difference between the two estimates as a proportion of the revised estimate. Dr Basher suggested he would prefer it was expressed as a proportion of the assessed estimate. I was happy to make this change, as both ways of expressing the difference are equally correct. For example: in the 19 January report the 2 year ARI estimate of sediment from the construction area in the Duck catchment is 59 (58.9) tonnes and 28 (28.4) tonnes for the revised estimate. The difference between the two numbers is 31 (30.5) tonnes. 31 tonnes is approximately 111% of the 28 tonnes and 52% of 59 tonnes.

18 In paragraphs 18 and 19 of his supplementary evidence, Mr Handyside gives the following reasons for undertaking an alternative USLE calculation to estimate appropriate 'open' areas:

18.1 Uncertainties associated with the modelling;

18.2 The sensitivity of the receiving environment; and

18.3 He suggests the "lengths/areas" in my evidence are far too large. In relation to this reason I note that I do not describe areas, and the lengths I describe are annual staging lengths, not 'open' areas.

19 I have a number of concerns with the approach Mr Handyside adopts for his alternative USLE calculation. My concerns are:

19.1 In paragraph 17, My Handyside suggests that the 3000 tonnes of additional sediment estimated using the scaled USLE method and long term simulation should be used to set the open area condition, because "it is not identified as having any particular environmental effect". The logic of this argument is flawed. The advice I have received from **Dr De Luca** is that it is the acute effects associated with large events which are of primary ecological concern. Therefore, it is not appropriate to base the open area limits on the long term average annual sediment inputs. To account for events, the average annual yield needs to be disaggregated. In the assessed scaled USLE approach and the Revised Analysis, this has been undertaken using a sediment rating curve applied to estimates of daily peak flow to generate estimates of event loads;

19.2 The USLE method applied by Mr Handyside selects median or mid range values for USLE factors from the tables of factors provided in the Revised Analysis report dated 20 January. His method then combines these to calculate an average annual sediment yield for a 14.3ha area in the Duck catchment. By comparison, the Revised Estimate calculations I undertook were calculated at 10m intervals. I developed 190 calculations for 1.9km of annual staging length accounting for the cross section, geology and rainfall at each section. The USLE yields were then weighted on area. I consider the approach I used to be more mathematically precise, because it accounts for variability in conditions along the length of the proposed construction. The weighted mean of the factors to generate a one line USLE for this total road area used by Mr Handyside will not generate the same yield as the method I used because the sum of the products does not equal the product of the sums;

19.3 I do not believe that Mr Handyside has interpreted the staging graphs provided in Attachment B of his evidence correctly. These graphs describe annual staging areas, not coincident bare earth areas. In the revised analysis I undertook, I made assumptions (described in tables 11, 12 and 13 of the Revised Analysis report) about what proportion of these annual staging areas would be stabilised, protected

with erosion control measure and in active earthworks. These assumptions were based on advice from **Mr Edwards**;

19.4 As noted above, Mr Handyside has calculated the 'open areas' from the annual staging plans, assuming a 75m width. In footnote 21 of my rebuttal evidence, I state that the average width of the road is 55m, based on advice from **Mr Edwards**. The 75m assumption was used in the assessed Scaled USLE as a conservative assumption. In the Revised Analysis, I have provided design areas for these annual staging lengths, and these are described in Table 1 of the 20 January 2012 report;

19.5 In paragraph 23, My Handyside assumes the geology of the Duck catchment is representative of the whole route and then scales down his estimate of sediment yield from the Duck catchment for the other catchments based on rainfall and length slopes. This method is overly simplified and does not account for spatial variability. A greater level of spatial variability was captured in the scaled USLE and a much finer spatial resolution was calculated for the revised estimate;

19.6 My Handyside suggests that a single 'open area' limit be set for the whole of the Porirua Harbour watershed (i.e. both the Pauatahanui and Onepoto arms). **Mr Roberts** has advised me that within an event there will be minimal exchange of terrestrial sediment input from the streams between the harbour arms. Therefore, from an effects perspective, I consider it more appropriate that these arms of the harbour be managed separately, as is proposed under Conditions E1 and E2;

19.7 The conclusion of My Handyside's calculations is that conditions E1 and E2 be modified to restrict the allowable amount of bare earth over two catchments at any one time to no more than 9ha per annum. I consider it more appropriate that these non-stabilised areas be informed by the more detailed Revised Analysis described in the 20 January report.

Helen Kettles

20 In paragraphs 20 and 21 of Helen Kettles' evidence she describes the non-stabilised area conditions E1 and E2. Ms Kettles concludes that she prefers Mr Handyside's open area limits because he suggests that the open area limit be spread over at least two catchments, and Ms Kettles concludes this is likely to minimise the risk from a heavy rainfall event in one catchment delivering a large plug of sediment to the Inlet.

21 I note that Mr Handyside's method was based on average annual sediment yields, and therefore does not account for the effects of

large rainfall events that could have the acute effects Ms Kettles is concerned about. This re-confirms my disagreement with his approach.

22 The memo that I circulated at the conferencing on 8 February summarises the stabilised and non-stabilised areas assumed in the Revised analysis and has been used as the basis for the revisions to conditions E1 and E2. These areas assume that the combined open area limit of each arm of the Harbour is spread over more than one stream catchment.

23 The scaled USLE used for the assessment and the Revised Estimate were both disaggregated using a sediment rating curve to provide estimates of sediment event loads. It is these event loads that were used by **Dr De Luca** for the assessment of ecological effects. It is my opinion that the assessment of effects should inform the limitation on non-stabilised areas.

DR HICKS' SECTION 42A REPORT

24 Dr Hicks' section 42A report was prepared in early January before I had developed the Revised Estimates, submitted my rebuttal evidence, and attended conferencing with Dr Hicks.

25 In this section of my evidence I summarise the conclusions of the additional analysis that has been undertaken and provide responses to issues raised in the Section 42A report, that have not previously been addressed.

26 In bullet point 1 of his executive summary, Dr Hicks discusses the use of the same SDR[1] to scale the USLE factors to the SSYE, in the baseline and construction scenario. I confirmed in paragraph 110 of my EIC that I understood that the SDR was likely to differ between the construction and baseline scenario, but that I considered this simplification acceptable. I agreed at conferencing on 8 December to test the effect of altering the SDR. The Revised Analysis included consideration of all the USLE factors and revision of those that were likely to change under the construction scenario. More detailed factors for soil erosivity and length slope and the standard Auckland Regional Council SDR values of 0.5 and 0.7, were used as well as more refined erosion and sediment control assumptions. In conferencing on 7 and 8 December Dr Basher and I agree the USLE is the best method for estimating the effects of road construction on sediment yield from the road corridor (see paragraph 14). Dr Hicks, Dr Basher, Dr Fisher and I agreed at conferencing on 13 February that the revised sediment estimate is an improvement on the assessed estimate in Technical report 15, with more appropriate

[1] Sediment Delivery Ration.

implementation of the USLE model and no further improvement can be expected using this modelling method (see paragraph 6).

27 The Assessed Estimates were higher or similar to the Revised Estimates in most catchments. This confirms that for these catchments the conservative assumptions in the Assessed Estimates were sufficient to compensate for not accounting for the alteration of the SDR between the 'with' and 'without' road scenarios in the Assessed Estimate. For the Kenepuru, the Revised Estimate was higher. Further harbour modelling has been undertaken to test the effect of increased sediment yield from the Kenepuru. While the increase in sediment at the discharge point from the construction area in the Kenepuru was approximately 50%, at the mouth of the Kenepuru the increase in sediment was less than 10%, and less when considered in the context of the Porirua stream that discharges at the same location. **Dr De Luca** has confirmed that this increase did not alter her assessment of effects, as described in paragraph 38 of her rebuttal evidence.

28 This modelling is significant because it illustrates that uncertainty in estimates of sediment yield at the construction site discharge point, does not necessarily translate to changes in environmental effects. This is because the construction areas make up a very small proportion, in this case less than 0.2%, of the Onepoto watershed. The ecological assessment is based on a threshold analysis so changes in the sediment loads do not necessarily translate into changes in ecological effects.

29 In bullet point 2, Dr Hicks suggests that temporary works and stream works were not accounted for in the sediment yield estimates. I have been advised by **Mr Edwards** that earthworks during the enabling phase of this Project will be relatively minor. The analysis I have undertaken (included in paragraphs 12-14 of appendix A of my rebuttal evidence), estimated sediment yields from this phase of works that are far below the estimates for the peak year (that were used as the basis of the assessment of effects). Therefore, I consider the effects from this stage of the Project have been accounted for. Earthworks near stream channels were accounted for in the Revised Analysis. However, USLE only accounts for sediment generated from rain on these areas. In paragraphs 15 – 16 of appendix A of my rebuttal I summarised advice from **Mr Gough** that the majority of stream works can be undertaken in the dry, with streams diverted around the areas being worked, and the new channel being armoured where necessary prior to the re-introduction of stream flow. I am advised by **Mr Gough** that he considers much of the stream works would be undertaken prior to the main earthworks in that stage as a preliminary phase. Therefore there is likely to be less open area in these catchments during the stage when stream works are being undertaken, compared to the peak earthworks scenario that I used for the

assessment of effects. **Mr Martell** has advised me that the major diversions are out of the flood way in the case of the Horokiri and the Te Puka, and in the Pauatahanui there are opportunities to stage works to reduce risk.

30 Based on this advice, I do not consider that temporary works or stream works are likely to be a significant contributor of sediment. I consider the approach of using the peak construction year for the assessment of effects is sufficiently conservative to account for the sediment discharged from these areas, given that **Mr Gough** has advised that the majority of stream works are likely to occur ahead of the peak earthworks in each catchment.

31 In bullet point 3 Dr Hicks expresses concern that the rating function may underestimate events spanning more than one day. I am advised by **Mr Martell** that the majority of events in the catchments affected by the Project last for less than 24 hours, and on this basis I consider the 24 hour storm a representative event for the assessment of effects.

32 In bullet point 3 Dr Hicks identifies that the method does not adequately deal with the risk that the sediment yield associated with a given return period rainfall may be several times greater than predicted by the rating function. This has been addressed in Appendix B of my rebuttal evidence by describing the uncertainty around the average annual estimate and quantifying the uncertainty around the slope of the rating curve. The average annual sediment yield has been used as the basis of the assessment and a conservative slope of 1.9 was selected. If a larger or smaller average annual baseline estimate was to be used, this would apply to both the with and without project scenarios, and therefore would not significantly affect relative change.

33 Following conferencing on 13 February, Dr Hicks expressed the view that there is greater uncertainty in event sediment yields than has been addressed (this is noted as an unresolved area in paragraph 15 of the statement). It is my view that the 50 year ARI and 2 year ARI modelling provides sensitivity analysis that can be interpreted to understand the effects of uncertainty in sediment yields.

34 In bullet point 4 Dr Hicks discusses the data validation process. I understand that the second statement of rebuttal evidence of **Mr Martell** responds to this comment with reference to the calibration of the hydrological models.

35 In bullet point 6 Dr Hicks suggests that an existing time-series driven integrated catchment scale model such as GLEAMS or WEPP could have been used. I note that he also acknowledges that these models have their limitations, in particular GLEAMS and WEPP can only model sheet and rill erosion. The catchments affected by the

Transmission Gully Project are subject to other erosion processes including gully erosion and landslides. The method I used to overcome this issue was to scale USLE factors. The USLE also only estimates sheet and rill, but nevertheless describes the factors driving erosion, that is R[2] and L/S[3] and factors controlling the supply that is: K[4], C[5] and P[6] and in this way is comparable to the SSYE, which classifies the driving and supply factors and accounts for all erosion processes. Therefore, the estimate of the baseline used for this Project does account for all erosion processes in these catchments. At conferencing on 8 December, Dr Basher and I agreed that the SSYE was the best method for estimating the baseline in these catchments (see paragraph 10).

36 In section 3.4 of his report, Dr Hicks explains that he understands that GLEAMS determines a spatially-varying sediment delivery ratio. As discussed in paragraph 118 of my EIC, given the stage of the design for this Project, I am doubtful that either GLEAMS or WEPP would have been able to estimate an accurate spatially-varying sediment delivery ratio for the construction areas. However, I do agree that an advantage of GLEAMS and WEPP is the integrated runoff, sediment generation and routing.

37 In bullet point 7, Dr Hicks discusses the collection, processing and analysis of the field data on stream sediment loads during storm events. This work was undertaken while I was on maternity leave, and so was technically reviewed by Dr Bonnie Bonneville of SKM[7]. She has advised me that:

37.1 The turbidity data editing is provided in Appendix 15.A of Technical Report 15. It was edited to remove only obviously erroneous data, when loggers were moved and loggers with higher turbidity limits installed. In her view, the resulting data set looks good with no valid reasons to edit it or remove data points;

37.2 The streams are very shallow, but also fast-flowing. While the shallowness of the sites may expose the loggers and give false low readings, the fast flowing nature of the streams means that biofouling of the logger is less likely;

37.3 The loggers were calibrated by NIWA prior to installation. There is little detectable drift in the calibration of the probes

[2] R: Rainfall erosion index

[3] L/s Length slope

[4] K soil erodibility

[5] C Cover

[6] P Erosion control practice

[7] Email From Dr Bonneville to Michelle Malcolm 14/2/12 attached **Appendix A**

in the data. The increase in the baseline is more likely due to the winter/spring;

37.4 Both TSS and turbidity were measured in first flush and composite samples during storm events by autosamplers and event-based grab samples, plus in the wet and dry weather grab samples. This data was used to derive the relationship, which was then applied to the turbidity loggers. The relationship can be irrespective of flow or may differ in low versus high flow conditions. The aim is to determine a conversion factor based on catchment turbidity sources. This is never going to be 100% accurate, but efforts were made to characterise the relationship in high versus low flow conditions and strong relationships were found. TSS is common practice. Hills laboratory have provided their methodology:

(a) Shake the sample bottle vigorously to produce a homogeneous sample.

(b) Quickly pour off into a measuring cylinder a sub-sample of 20-500mL, depending on the amount of suspended solids present in the sample.

(c) If the sample is very sandy, use a magnetic stirrer and take 20mL for analysis whilst stirring continues.

37.5 The samples were analysed in a IANZ approved laboratory following APHA 2540 D 21st ed. 2005. The replicates were all within approved limits, which would not be the case if there was a problem with too much sand in the samples. For Suspended Sediment Concentration (*SCC*) the entire sample is filtered. SSC is not a common laboratory test.

38 In response to Dr Hicks' comments regarding the collection and analysis of water quality data, I would add that the data was collected over 1 year, and that at the time the harbour modelling was developed less than 6 months of data was available. I consider this is the most significant limitation of this data-set. I consider that the way the data has been used, which was to inform the slope of the rating curve and to check order of magnitude, was appropriate for this data-set, and I note that there is generally good agreement between the rating curves and the measured data.

39 In bullet point 8, Dr Hicks discusses the sediment transport modelling. I agree that the stream modelling is limited and it was used in a limited manner. My assessment of water quality effects was primarily focused on the change in TSS, and the TSS estimates I used did not account for modelled sediment deposition. My

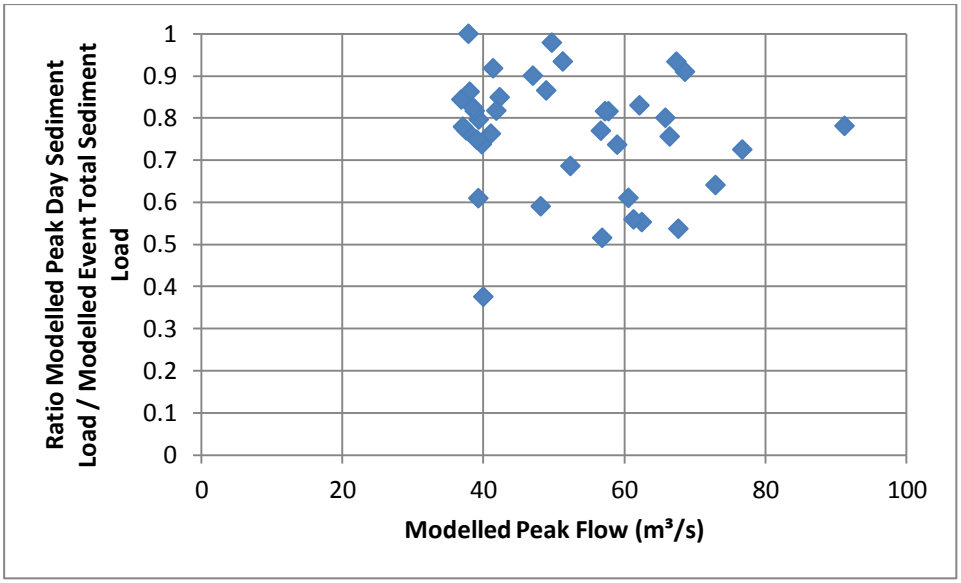
understanding is that **Dr Keesing's** assessment was also primarily focused on change in TSS.

40 In bullet point 9 Dr Hicks suggests that extreme events have not been fully assessed. The Q50 event has now been modelled and is discussed by **Dr De Luca** in paragraph 24 of her rebuttal evidence. This event provides some context to the effect of a larger baseline that can be expected with extreme events. **Dr De Luca** has advised that she considers that the effects of the 50 year ARI event are less than those of the 10 year ARI event, because in the 50 year ARI the larger baseline dominates.

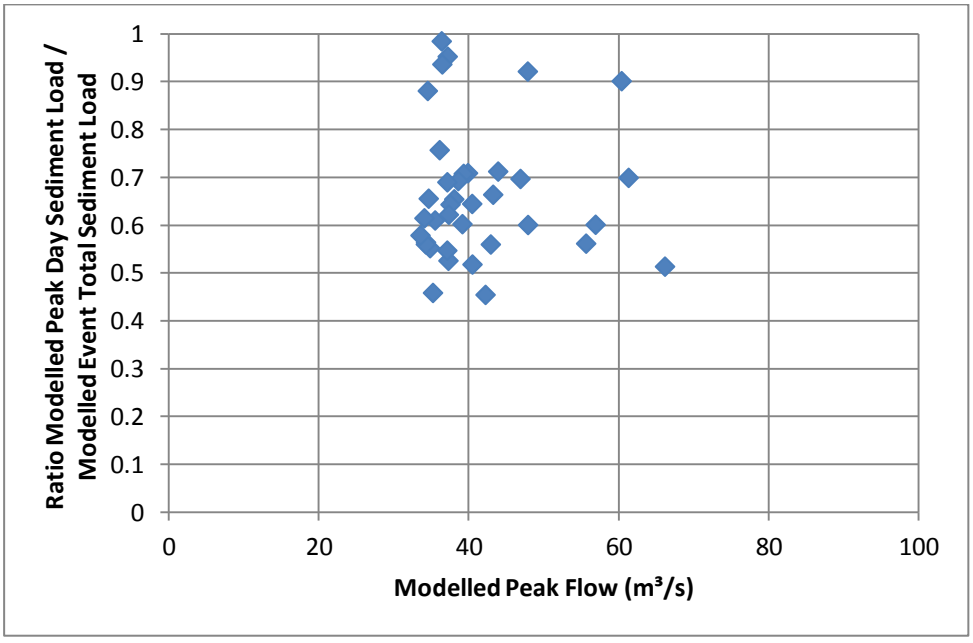
41 This modelling is significant in understanding the implications of uncertainty in the estimation of the baseline. The relationship between the sediment yield and effects in the Harbour is complex, the modelling undertaken of the 2 year, 10 year and 50 year ARI events identifies that there is a threshold for effects that is associated with the sediment identified as having a 10 year ARI return period.

42 In bullet point 9 Dr Hicks discusses the daily time step used to develop the rating curves. I agree this method of developing the rating curve is likely to lead to an underestimation of sediment yield, because even though most of the events in the catchments are less than 24 hours, many are spread over longer than one calendar day. Graphs 1, 2 and 3 below illustrate for the Pauatahanui, Porirua and Horokiri catchments that, for days of consecutive rain, approximately 70% of the load is modelled in the peak day, with the remaining sediment load spread over the preceding and following days. This would lead to up to a 30% underestimation of event loads.

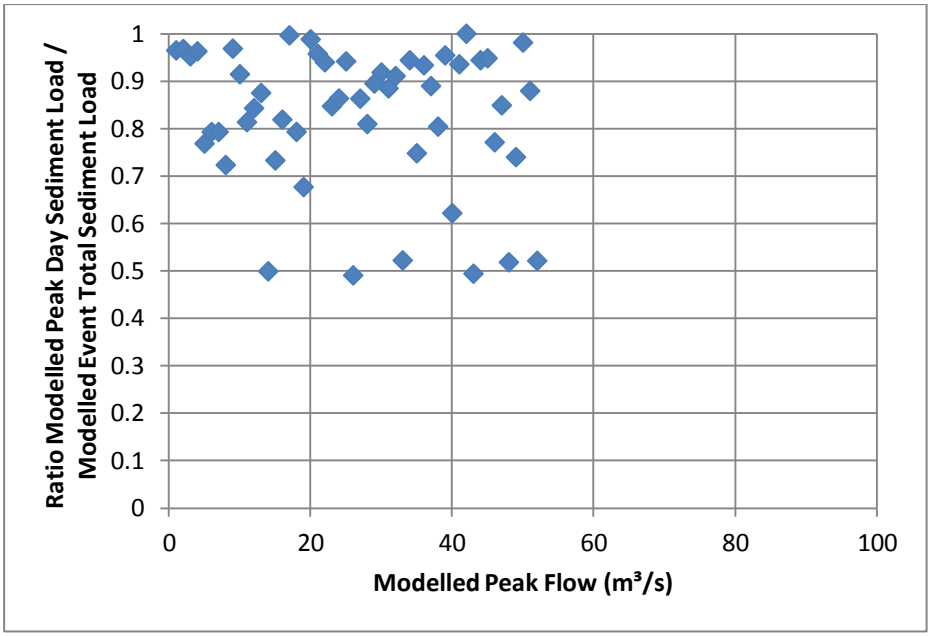
Graph 1 Pauatahanui Stream



Graph 2 Porirua Stream



Graph 3 Horokiri stream



43 This underestimation of event sediment yield applies to both the 'with' and 'without' Project scenarios. Further harbour modelling has been undertaken to test the effect of this.

44 The scenario that was modelled was:

44.1 Q10 in the Duck and Pauatahanui, Q2 elsewhere. Northerly 90th percentile wind, Peak construction scenario, described in **Table 1**, and 30 % more sediment that was previously assessed for both the baseline and "with Project" scenarios.

Table 1 Peak Construction Scenario

Sub-catchment	Road length km
Horokiri	3
Pauatahanui	0.2
Duck	1.9
Kenepuru	2,1
Porirua	0.2

45 The results are presented in **Appendix B**. **Dr De Luca** has reviewed these results and advised that the baseline deposition patterns appear relatively similar to that previously assessed (**Dr De Luca's** Figures 21 and 35, Appendix B). However, the "with Project" scenario shows a different pattern of sediment deposition

above ecological effects thresholds (**Dr De Luca's** Figures 10 and 33, Appendix B).

46 In the 30% more sediment "with Project" scenario significantly less intertidal benthic habitat receives sediment above threshold depths (0.2 ha compared to 3.9ha) and similar areas of subtidal benthic habitat affected (2.0 ha compared to 2.4 ha) (see Table 2 below). I understand that **Dr De Luca** concludes that the +30% sediment scenario has less ecological effects (negligible) than that previously modelled and assessed. **Mr Roberts** has advised me that this result is likely to be due to the "with Project" sediment depositing on areas already affected by the higher baseline sediment deposition.

Table 2: Modelled deposition of Project-related Sediment in Intertidal and Subtidal Marine Habitats in the Pauatahanui Inlet relating to an increase in sediment of 30% in the Q10 Duck/Pauatahanui with northerly wind.

Scenario modelled	Intertidal		Subtidal	
	5-10mm	>10mm	5-10mm	>10mm
Q10 Duck/Pauatahanui Northerly	3.9	0.0	-1.0	3.4
+30% sediment	0.1	0.1	1.3	0.7

47 The results of this modelling are significant, because it aids in understanding the sensitivity of the ecological assessment to increases in sediment, when these increases apply to both the baseline and the construction estimate. Of the scenarios that have been assessed for the peak earthworks in the Duck catchment with a northerly wind, the 10 year ARI has more ecological effects than the 2 year ARI, 10 year ARI +30% and the 50 year ARI. This provides greater confidence that the assessment of effects is based on a scenario that is conservative.

Michelle Kathleen Malcolm
16 February 2012

APPENDIX A - DR BONNIE BONNEVILLE EMAIL 14 FEBRUARY 2012

From: Bonneville, Bonnie (SKM) [BBonneville@globalskm.com]
Sent: Tuesday, 14 February 2012 11:42 p.m.
To: Malcolm, Michelle (SKM)
Subject: Transmission Gully

Hi Michelle,
See below my responses to Dr Hicks comments on the transmission gully report.

Response to Transmission Gully Project Peer Review of Sediment Generation and Yield Aspects. Prepared for Environmental Protection Authority January 2012. Murray Hicks

- The turbidity data editing is provided in Appendix 15.A of Technical Report 15. It was edited to remove only obviously erroneous data, when loggers were moved and loggers with higher turbidity limits installed. The resulting data set looks good with no valid reasons to edit it or remove data points;

- The streams are very shallow, but also fast-flowing. While the shallowness of the sites may expose the loggers and give false low readings, the fast flowing nature of the streams means that biofouling of the logger is less likely;

- The loggers were calibrated by NIWA prior to installation. There is little detectable drift in the calibration of the probes in the data. The increase in the baseline is more likely due to the winter/spring;

- Both TSS and turbidity were measured in first flush and composite samples during storm events by autosamplers and event-based grab samples, plus in the wet and dry weather grab samples. This data was used to derive the relationship, which was then applied to the turbidity loggers. The relationship can be irrespective of flow or may differ in low versus high flow conditions. The aim is to determine a conversion factor based on catchment turbidity sources. This is never going to be 100% accurate, but efforts were made to characterise the relationship in high versus low flow conditions and strong relationships were found;

- TSS is common practice. The samples were analysed in a IANZ approved laboratory following APHA 2540 D 21st ed. 2005. The replicates were all within approved limits, which would not be the case if there was a problem with too much sand in the samples. For Suspended Sediment Concentration (SCC) the entire sample is filtered. SSC, is not a common laboratory test.

  Hills laboratory have provided their TSS methodology:

  (a) Shake the sample bottle vigorously to produce a homogeneous sample.

  (b) Quickly pour off into a measuring cylinder a sub-sample of 20-500mL, depending on the amount of suspended solids present in the sample.

  (c) If the sample is very sandy, use a magnetic stirrer and take 20mL for analysis whilst stirring continues.

Regards,

Dr Bonnie Bonneville (née Atkinson)
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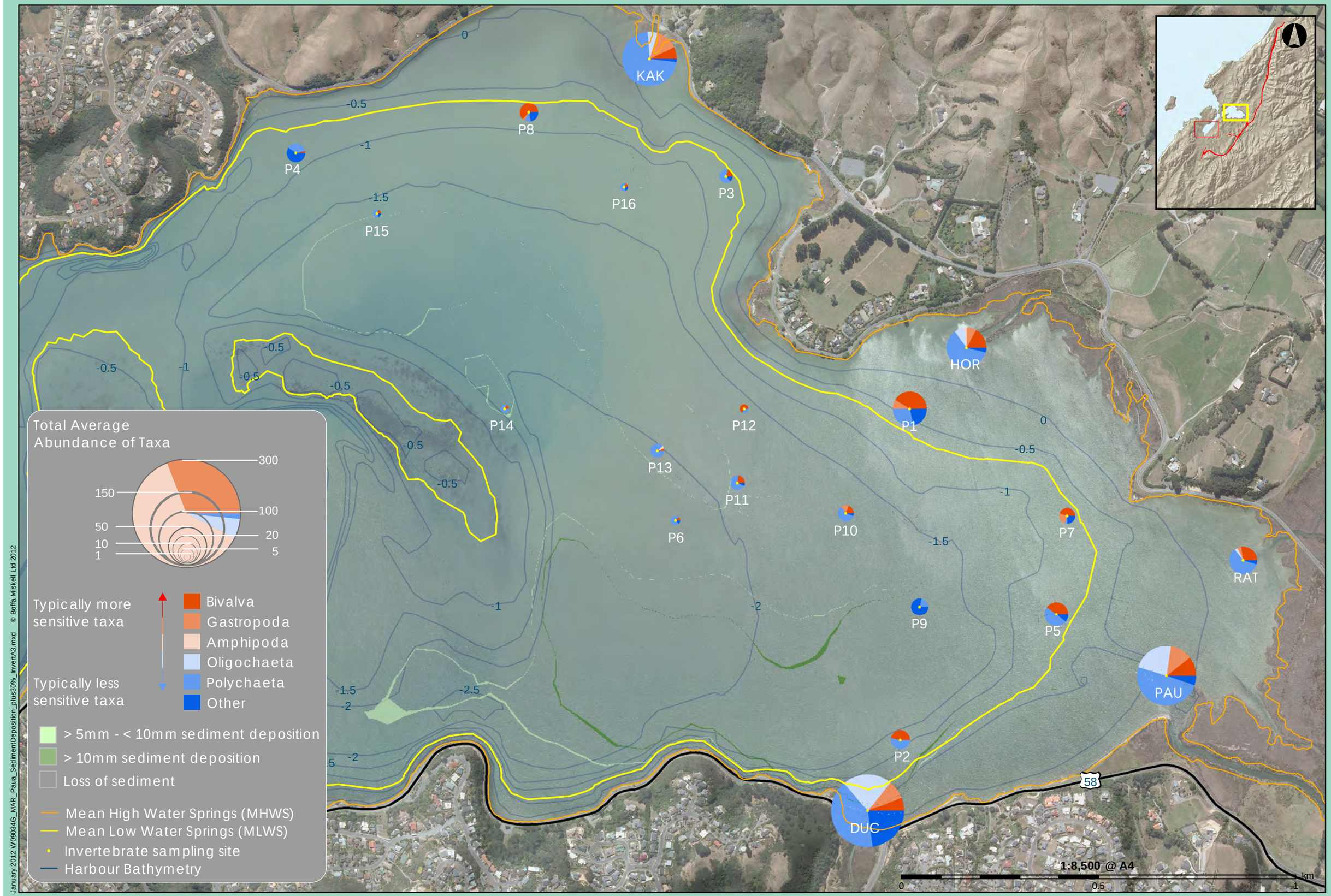
APPENDIX B - 10 YEAR ARI+30%



January 2012 W09034G_MAR_Paua_SedimentDeposition_plus30%_InvertA3.mxd

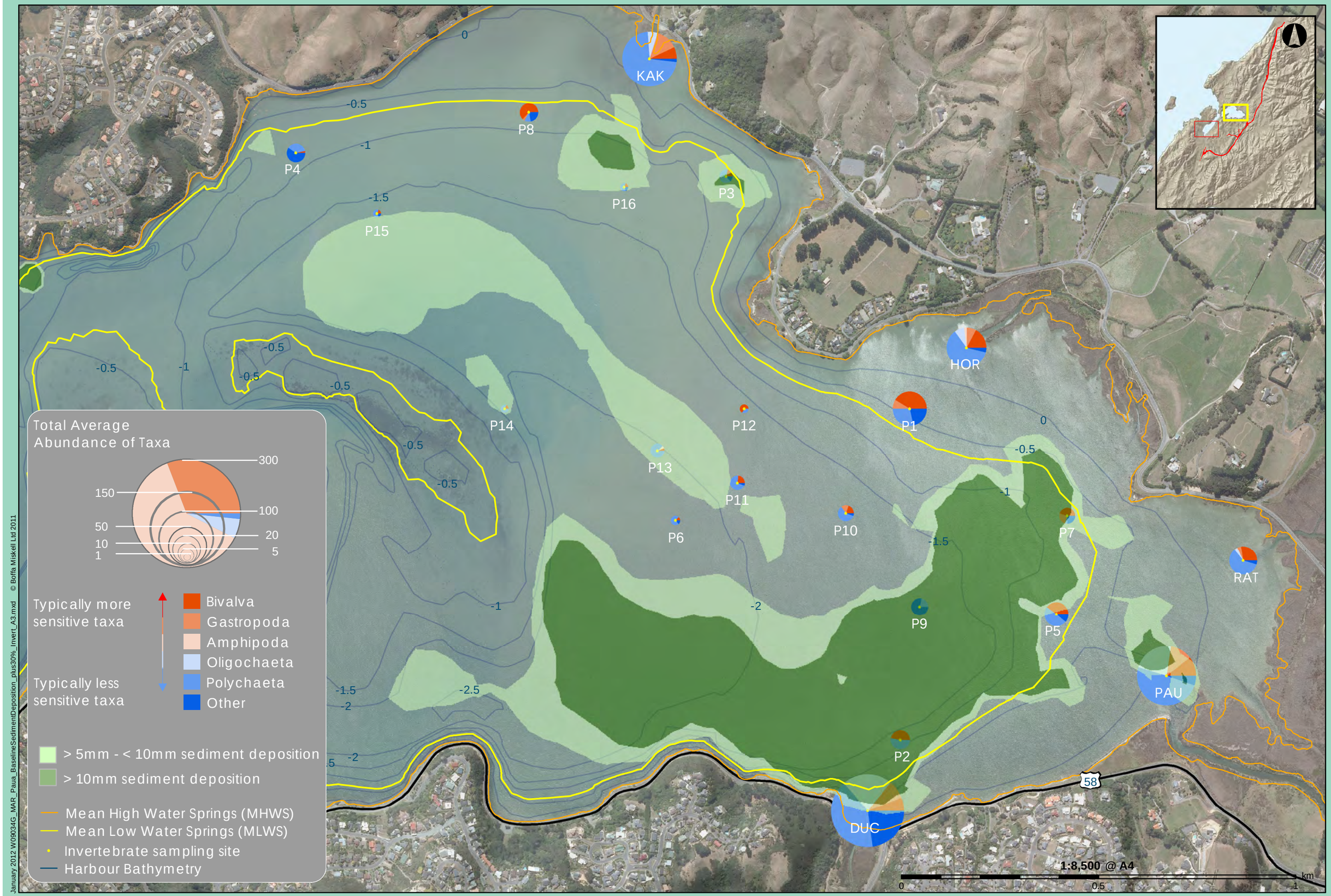
Boffa Miskell

NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY - PAUATAHANUI INLET

INVERTEBRATE ABUNDANCE AND THRESHOLD SEDIMENT DEPOSITION

10 year event in Duck/Pauatahanui, (+30% sediment) northerly wind, 3 days post peak of storm



January 2012 W09034G_MAR_Paua_BaselineSedimentDeposition_plus30%_Invert_A3.mxd

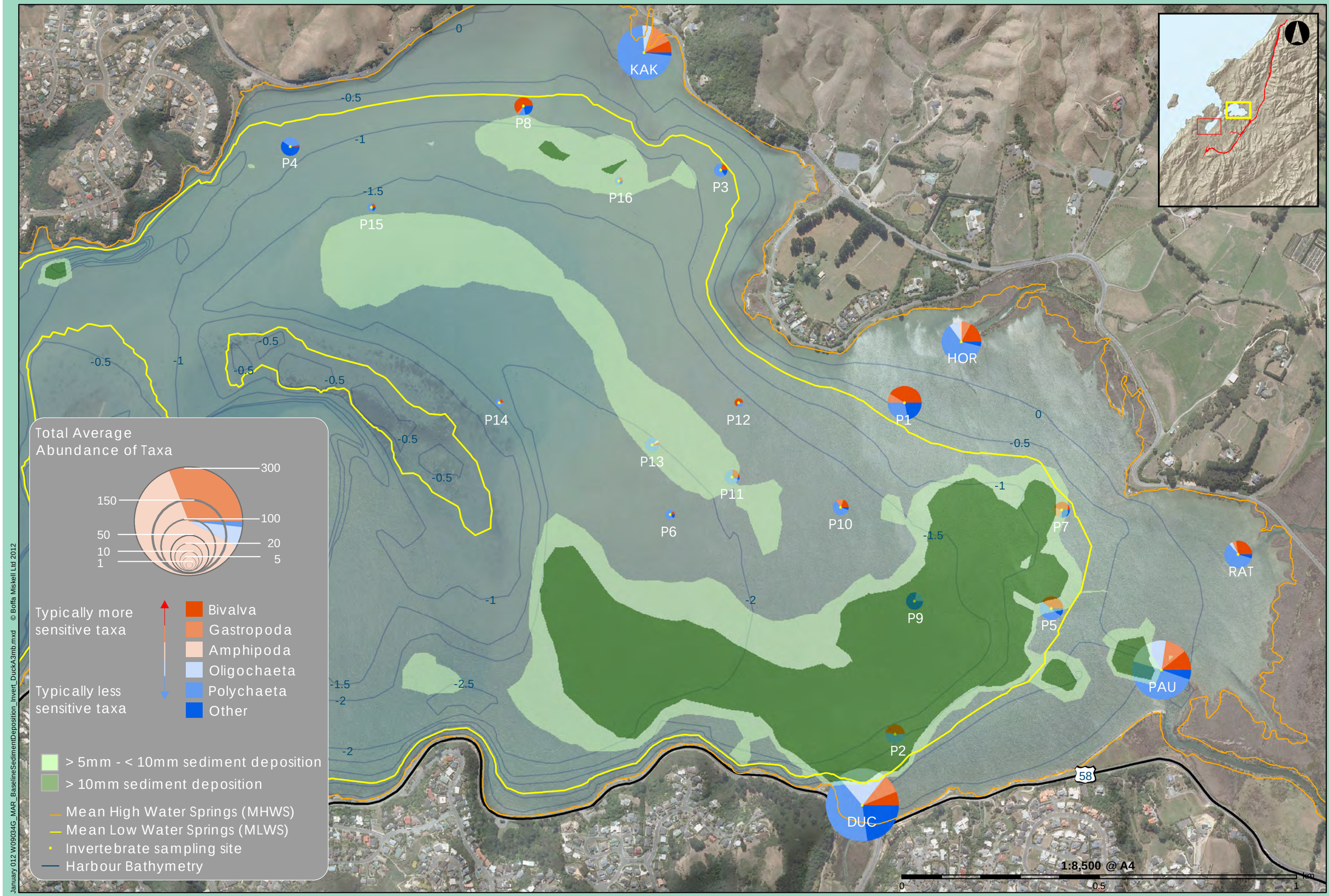
Boffa Miskell

NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY - PAUATAHANUI INLET

INVERTEBRATE ABUNDANCE AND BASELINE THRESHOLD SEDIMENT DEPOSITION

10 year event in Duck/Pauatahanui, northerly wind, (+30% sediment), 3 days post peak of storm



Boffa Miskell

NZ TRANSPORT AGENCY WAKA KOTAHI

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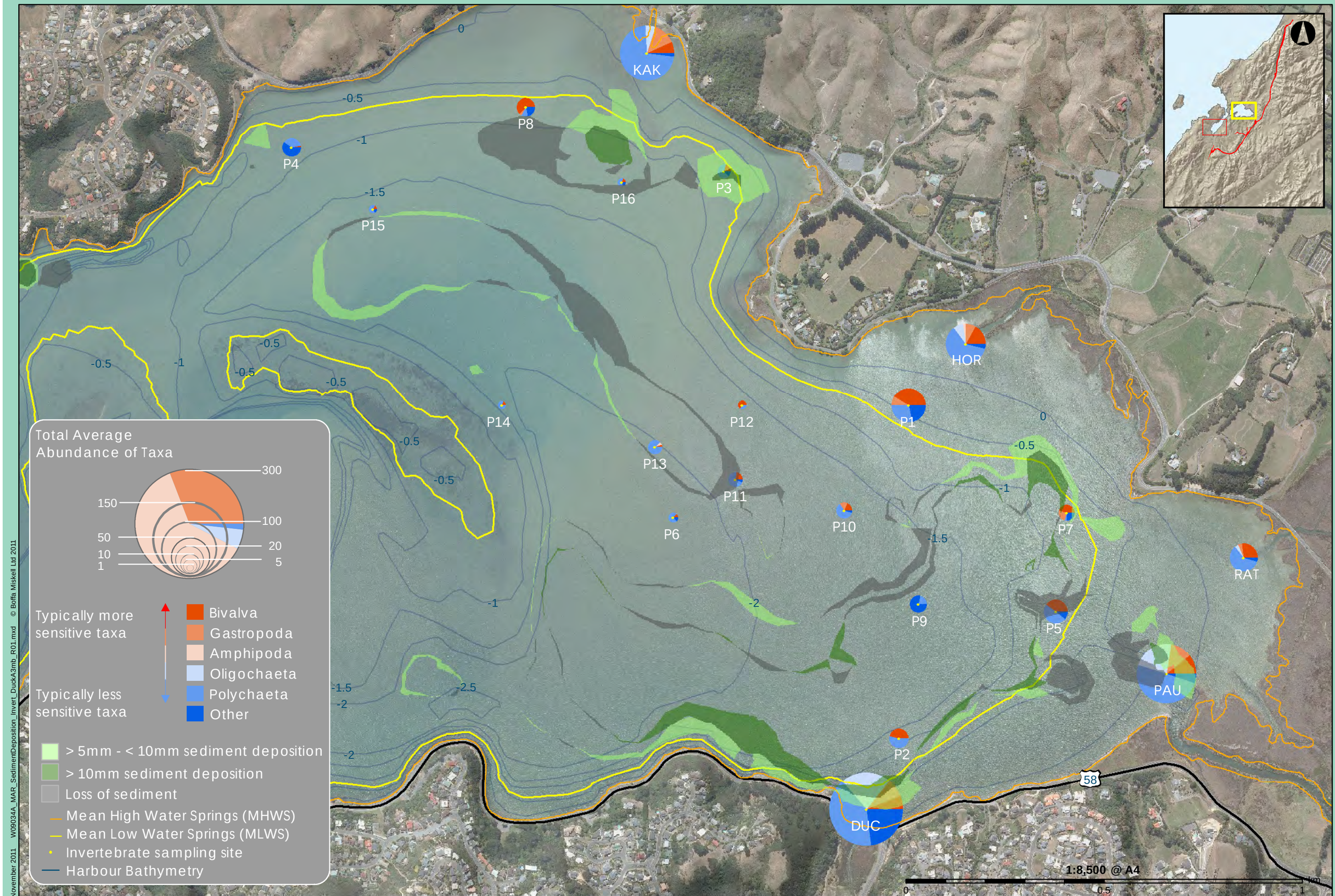

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