Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

under: the Resource Management Act 1991

in the matter of: Notice of requirement for designation and resource consent applications by the NZ Transport Agency for the MacKays to Peka Peka Expressway Proposal

applicant: **NZ Transport Agency**
Requiring Authority

Statement of rebuttal evidence of **James Whitlock** (Vibration) for the NZ Transport Agency

Dated: 25 October 2012

REFERENCE: John Hassan (john.hassan@chapmantripp.com)
Suzanne Janissen (suzanne.janissen@chapmantripp.com)

Chapman Tripp
T: +64 4 499 5999
F: +64 4 472 7111

10 Customhouse Quay
PO Box 993, Wellington 6140
New Zealand

www.chapmantripp.com
Auckland, Wellington,
Christchurch

TABLE OF CONTENTS

STATEMENT OF REBUTTAL EVIDENCE OF JAMES WHITLOCK FOR THE NZ TRANSPORT AGENCY

1 My full name is James Andrew Travis Whitlock.

2 I have the qualifications and experience set out at paragraphs 2 and 3 of my evidence in chief, dated 3 September 2012 (*EIC*).

3 I note that since the date of my EIC, I have been voted in as President of the Acoustical Society of New Zealand (*ASNZ*), and will hold this position for at least two years.

4 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)

5 I confirm that I am authorised to give this evidence on behalf of the NZ Transport Agency (*NZTA)*.

6 In this statement of rebuttal evidence, I:

6.1 Respond to the late submission of **Arthur Wright** [submitter 743];

6.2 Respond to the evidence of:

(a) **Malcolm Hunt** on behalf of Kāpiti Coast District Council (*KCDC*) [submitter 682-2];

(b) **Emily Thomson** on behalf of KCDC [submitter 682-11];

(c) **Mary-Jane Rivers** on behalf of KCDC [submitter 682-10];

(d) **Marie O'Sullivan** on behalf of APSOC [submitter 677-1];

(e) **Christopher and Monica Dearden** [submitter 261-2];

(f) **Loretta Pomare** [submitter 309-1];

(g) **John Horne** on behalf of Loretta Pomare [submitter 309-3], and;

(h) **Philip Nordberg** on behalf of Ann Laing [submitter 337-1].

6.3 Summarise the results of additional vibration measurements of proposed construction machinery, obtained during a site

survey on 16 October 2012, in response to the KCDC submission (682).

7 The fact that my 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.[1] Rather, I rely on the technical reports[2] and management plan[3] which I have written/co-written, my EIC and this rebuttal statement to set out my opinion on what I consider to be the key vibration matters for this hearing.

8 Consistent with my EIC, I have referred to the MacKays to Peka Peka Expressway Project as "the Project" in this rebuttal evidence.

EXECUTIVE SUMMARY

9 I have read all of the statements of evidence provided by submitters relating to vibration and consider that I have addressed the majority of issues already in my EIC. Any remaining issues, I address in this rebuttal statement.

10 In response to submitters' evidence I have also made some changes to proposed Conditions DC.30 and DC.31, and added one new Condition, DC.49A (see **Annexure A**). These changes have been made to provide clarity around the contents of the CNVMP, vibration monitoring, communication with KCDC, and suitable criteria for operation vibration.

11 Since preparation of my EIC, further testing of machinery on peat soils has been undertaken (as sought by KCDC). As a result, I have identified, through measurement, that bulldozers are potentially a high-vibration source, and have recommended restrictions on their use.

LATE SUBMISSION

Arthur Wright (743)

12 Mr Wright (of 7 Leinster Ave, Raumati South) is concerned that he will be "greatly affected" by vibration during the construction phase of the Project, and notes that upon its completion there will be a "much higher" level of vibration than at present.[4] As he does not

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1 For example, Dianne Buchan for Save Kāpiti Inc. (505-7) and Beth Lindsay for Highway Occupants Group (542-2) both briefly raise general concerns about vibration in their evidence (at paragraphs 55/57 and 5.1 respectively). However neither specifies any particular vibration issues and I consider that I have adequately addressed their general concerns in my EIC.

2 Assessment of Vibration Effects (Technical Report 18) and Ambient Vibration Assessment Report (Technical Report 19).

3 Draft Construction Noise and Vibration Management Plan (*CNVMP*) (CEMP, Appendix F).

4 Wright submission, page 5.

specify any particular vibration issues, I consider that I have addressed his general concerns in my EIC.[5]

EVIDENCE OF SUBMITTERS

Malcolm Hunt (KCDC) (682-2)

13 Mr Hunt has provided expert evidence on noise and vibration issues on behalf of KCDC.

14 Overall, I note that Mr Hunt:

14.1 Agrees with the methodology used for the construction vibration assessment[6] and supports the management of construction vibration through a CNVMP[7];

14.2 Agrees that the assessment of operational vibration is adequately detailed, and that modern road construction techniques for even the poorest ground conditions are able to provide smooth roads;[8] and

14.3 Accepts that the new road will not be likely to give rise to significant levels of vibration received at typical receiver locations, and agrees that the new surface will be unlikely to induce significant ground vibration for roadside receivers so long as the surface remains smooth[9].

15 Mr Hunt also states that, having reviewed NZTA's evidence, he is satisfied that various issues raised in KCDC's submission on construction effects have been adequately dealt with via conditions.[10]

16 In his evidence, Mr Hunt proposes some changes and additions to the Project's designation conditions as they relate to vibration, and I will address each of these.

Construction vibration

17 Mr Hunt suggests that the scope and content of the CNVMP is not clearly defined, and that an additional condition is needed to assist KCDC in certifying the plan.[11]

18 In response, I note that proposed Conditions DC.7 to DC.10 set out requirements relating to timeframes, consultation and amendments

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5 Refer my EIC at paragraphs 63 – 65.

6 Malcolm Hunt's Evidence, paragraph 13.1.

7 Malcolm Hunt's Evidence, paragraph 13.2.

8 Malcolm Hunt's Evidence, paragraph 14.1.

9 Malcolm Hunt's Evidence, paragraph 14.2.

10 Malcolm Hunt's Evidence, paragraphs 2.9 – 2.10.

11 Malcolm Hunt's Evidence, paragraph 2.13.

to management plans (including the CNVMP) in relation to certification by Council. I consider that these conditions adequately address Mr Hunt's concerns relating to scope and the certification process.

19 In terms of content of the CNVMP, I note that in her rebuttal evidence **Ms Siiri Wilkening** has addressed the same issue raised by Mr Hunt in relation to construction noise by amending and expanding proposed Condition DC.30 to include minimum content requirements for the CNVMP.[12] I support this amendment noting of course that the CNVMP also applies to construction vibration.

20 As a related amendment, the construction noise criteria have been moved (from DC.30) into a new Condition DC.30A.[13] The construction vibration criteria remain in proposed Condition DC.31.

21 Mr Hunt recommends that in proposed Condition DC.31, the reference to "NZTA's "State Highway Construction and Maintenance Noise and Vibration Guide SP/M/023 v.05 July 2012 or any subsequent revision of this document" should be removed, and considers this could be done without reducing its effectiveness.[14]

22 I agree that removing the reference to the NZTA Guide does not dilute the condition, as the Project criteria are clearly stated. I have amended Condition DC.31 accordingly (see **Annexure A**).

23 In relation to community liaison, Mr Hunt recommends that the minimum prior notification of construction works (especially night-time) be extended from two to five working days.[15] I agree with this recommendation and note that **Ms Siiri Wilkening** has addressed the same issue (for construction noise) by amending proposed Condition DC.35. I support this amendment.

24 Mr Hunt emphasises the need for NZTA to communicate with KCDC on locations in the community where construction vibration is significant, and to inform KCDC where the Project criteria are exceeded.[16]

25 I note that proposed Condition DC.32 requires that a SSCVMP[17] be prepared wherever the Category B vibration criteria[18] cannot practicably be met, and that each SSCVMP shall be submitted to the

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12 Refer rebuttal Evidence of **Ms Wilkening** at Annexure A, DC.30.

13 Refer rebuttal Evidence of **Ms Wilkening** at Annexure A, DC.30A.

14 Malcolm Hunt's Evidence, paragraph 2.16, 11.4(a), 11.5. Instead, he suggests that this document could be referenced in the condition listing the contents of the CNVMP (proposed Condition DC.30 discussed above).

15 Malcolm Hunt's Evidence, paragraph 2.17.

16 Malcolm Hunt's Evidence, paragraphs 14.8 – 14.9.

17 Site Specific Construction Vibration Management Plan.

18 Refer proposed Condition DC.31.

KCDC Regulatory Manager at least 5 working days prior to the relevant activity commencing. I consider this addresses Mr Hunt's concern relating to Project criteria exceedance.

26 However it would be reasonable for the KCDC Manager to also be notified of vibration issues of a lesser degree (i.e. where vibration exceeds Category A but not Category B). I have therefore proposed additional wording in Condition DC.31(b), as shown in **Annexure A**.

27 Finally, Mr Hunt commends efforts by NZTA and its contractors to investigate minimum setbacks in peaty soil sites to avoid high levels of vibration at close receiver sites. However, he considers that NZTA's study was not adequately completed and outlines the need for vibration measurements of other machinery (motor scrapers and off-road trucks) in peaty soils.[19] NZTA's original testing had included only a 21 tonne excavator, 28 tonne wheeled dozer and 14 tonne vibrating roller.

28 Since lodgement of my EIC, measurements of an off-road truck, loader and bulldozer have been undertaken, and the results are discussed later in my evidence.

Operational vibration

29 Mr Hunt has recommended that a new condition be added to clarify acceptable levels of traffic-induced vibration should complaints be received regarding operational vibration effects of the new Expressway. He proposes that Norwegian Standard NS 8176.E:2005 is a suitable Standard.[20]

30 I had originally elected not to include a condition on operational vibration monitoring because I am of the opinion that proposed Condition DC.49[21] will be sufficient to avoid complaints. However, upon review of Mr Hunt's evidence, I agree that in the event of a complaint, guidance in the form of an appropriate standard would be valuable. I also agree that the Norwegian Standard NS 8176.E:2005 Standard is appropriate for this.

31 I have therefore proposed a new Condition DC.49A, to read as follows:

> In the event of a reasonable complaint of traffic vibration from the completed Expressway, the Requiring Authority shall engage a suitably qualified expert to measure and assess traffic vibration levels for compliance with the Class C criteria of Norwegian Standard NS 8176.E:2005 *"Vibration and shock – Measurement of vibration in buildings from land-based transport and guidance to evaluation of its effect on human beings"*. A

[19] Malcolm Hunt's Evidence, paragraphs 2.9(c), 13.3 – 13.6.

[20] Malcolm Hunt's Evidence, paragraphs 2.6, 2.11, 14.3 – 14.7.

[21] DC.49 reads: *"The NZTA system for monitoring and maintaining the condition of State Highway pavements and road surfaces shall be applied in order to minimise the risk of operation vibration issues."*

report describing the findings shall be provided to the Manager within one month of the assessment being completed.

This is now shown in **Annexure A**.

Emily Thomson (KCDC) (682-11)

32 Ms Thomson has provided expert evidence on planning issues on behalf of KCDC and incorporated some of the changes to the proposed designation conditions recommended in Mr Hunt's evidence.

33 Ms Thomson proposes considerable amendments to the proposed Condition DC.30,[22] quoting Mr Hunt's evidence in support of these changes. However, Ms Thomson's evidence and proposed amendments are confusing. Amongst other things:

33.1 While Condition DC.30 originally addressed construction noise criteria only, Ms Thomson proposes to add vibration content to it;

33.2 Ms Thomson's changes appear to contain typographical errors, such that part of DC.31 (construction vibration conditions) has been transplanted mid-sentence into DC.30;

33.3 Mr Hunt did not recommend all of the changes that Ms Thomson attributes to him in her evidence, so the rationale for some is not clear.

34 I disagree with Ms Thomson's proposal to combine noise and vibration criteria in one condition as it would be unnecessarily lengthy and potentially confusing to the reader.

35 As explained earlier, Ms Wilkening and I recommend that the proposed conditions be amended so that:

35.1 DC.30 – relates to the content of the CNVMP;

35.2 DC.30A – relates to construction noise criteria;

35.3 DC.31 – relates to construction vibration criteria.

36 I consider that these proposed changes to the conditions satisfy Ms Thomson's issues and are preferable to her suggested changes.

[22] Emily Thomson's Evidence, paragraphs 9.5 – 9.8.

37 Ms Thomson suggests that two new items relating to vibration be added to the list of items which the CNVMP must address in proposed Condition DC.30, [23] as follows:

> 5) Measurements of vibration of the first instance of each high-vibration machine is be obtained with the results employed within calculations to re-assess, as appropriate, compliance with the Proposal criteria, and build up a site-specific profile of risk contours for each type of construction operation.
>
> 6) Improved management of vibration risks by completing the work completed to date on defining minimum set-back distances to dwellings based on field measurement of vibration levels taken on peaty soils found in the area. The setback distances to include motorscraper machines and dump trucks.

38 I agree with the intention of item (5). As explained in my EIC, the requirement to measure high-vibration machinery at its first use was originally omitted from the draft CNVMP, but I have since recommended an amendment to include this[24]. I propose using the wording from this amendment as it also covers high-noise machinery, and have included this in the revised DC.30 in (**Annexure A**) to read as follows:

> 5) Monitoring requirements, including relevant times (i.e. critical phases of construction, e.g. at the first use of high-noise or high-vibration machinery), when possible exceedance of the Project criteria is anticipated (e.g. night works etc.), or in response to any reasonable complaint.

39 I do not agree with item (6) suggested by Ms Thomson because the issues of completing the work to date and defining minimum set-back distances are already addressed in items (1) – (3) of DC.30. I also consider that the term "improved management" is vague, unquantifiable and unsuitable for use in a condition (i.e. improved compared to what?).

40 Ms Thomson recommends an additional condition following DC.37 requiring any vibration complaints "during construction or operation" to be assessed against the Norwegian NS 8176.E:2005 Standard, and reported to council and mitigated within 30 days[25].

41 I strongly disagree with this suggestion and note that Mr Hunt did not recommend it either. The Norwegian Standard is designed for measurement and assessment of transportation vibration only (as indicated in its title). Suggesting it be applied to the construction phase of the Project is completely inappropriate.

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[23] Emily Thomson's Evidence, paragraph 9.7.

[24] My EIC, paragraph 40.1.

[25] Emily Thomson's Evidence, paragraph 9.11.

42 As discussed earlier in my evidence, the essence of Mr Hunt's recommendation, which was aimed at addressing complaints (if any) from operational vibration, is addressed in my new proposed Condition DC.49A (see **Annexure A**).

43 I do not agree with Ms Thomson's recommended amendment to Condition DC.49[26], nor is it supported by Mr Hunt's evidence. Mr Hunt recommended that a new condition be added after DC.49 (which I have done) that referenced the Norwegian Standard in terms of how complaints about traffic induced vibration were to be handled (which I have also done). (Refer paragraph 31 above).

Mary-Jane Rivers (KCDC) (682-10)

44 Ms Rivers has provided evidence on social effects on behalf of KCDC. She raises several general concerns about vibration[27] which I consider I have addressed in my EIC. However, she specifically raises the issue of potential psychological effects of vibration at night[28].

45 The only proposed night-time construction works involve lifting bridge beams into place. This activity produces very little vibration, so I consider there will be no vibration effects at night.

Marie O'Sullivan (APSOC) (677-1)

46 Dr O'Sullivan has provided evidence on public health issues on behalf of "Action to Protect & Sustain our Communities" (*APSOC*), and raises a number of points regarding vibration. The majority of these points[29] relate to potential health impacts of vibration. I am not a health specialist and such matters are addressed in the EIC and rebuttal evidence of **Dr David Black**.

47 I note, however, that Dr O'Sullivan makes various comments relating to vibration propagation and mitigation,[30] which are generally incorrect and without references. She also confuses the

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[26] Emily Thomson's Evidence, paragraph 9.13.

[27] Mary-Jane Rivers' Evidence, paragraphs 5.6(c), 6.5, 6.12(a), 6.15 and 6.19.

[28] Mary-Jane Rivers' Evidence, paragraph 6.15.

[29] Dr O'Sullivan's Evidence, paragraphs E.24, 7, 64, 127, 128, 129, 199, 200, 201, 202 and 203.

[30] For example, Dr O'Sullivan's Evidence, paragraph 203:
"Low frequency noise is not amenable to mitigation. Construction of noise bunds does not reduce the frequency of this noise, which travels through the ground. Construction of water trenches and other structures to attempt to break the traveling vibration have been of limited success. There is no known mechanism for insulating homes or properties from exposure to low frequency noise. Individual rooms can be vibration proofed by insulation with specialized material, however it is not feasible to install this in an entire household. As such, this impact of the proposed expressway represents a significant health risk which cannot be addressed adequately."

use of basic acoustic concepts, such as sound insulation vs vibration isolation[31].

48 That said, I agree with her comment that "Vibrations from road traffic are mainly caused by road unevenness, irregularities that are intrinsic features of the road landscape". [32]

49 I disagree with Dr O'Sullivan's statement that construction of "*water trenches and other structures to attempt to break the traveling* (sic) *vibration have been of limited success"*.[33] When installed correctly, vibration barriers in various forms are well accepted and implemented world-wide to reduce groundborne vibration.

50 Similarly, the following claim from Dr O'Sullivan is incorrect: *"there is no known mechanism for insulating homes or properties from exposure to low frequency noise. Individual rooms can be vibration proofed by insulation with specialized material, however it is not feasible to install this in an entire household"*.[34] Vibration isolation methods for whole buildings do exist (the earthquake mounts in the NZ Parliament Building are an example of this), and systems such as resilient hangers and floating floors can be used to isolate single rooms.

51 Notwithstanding that these isolation methods exist, they are not required for this Project because the predicted vibration levels from traffic on the completed Expressway readily comply with the Project criteria, as outlined in my EIC[35].

52 In relation to vibration, I consider Dr O'Sullivan's conclusion that the proposed Expressway represents a significant health risk that cannot be addressed adequately, to be unfounded.

Christopher and Monica Dearden (261-2)

53 Mr and Mrs Dearden have provided evidence on their concerns about vibration impact on their dwelling at 39 Puriri Rd, Waikanae, as well as vibration aspects of the Project in general.

54 The two primary criticisms of the vibration assessment are that it is tentative (particularly around the effects of houses on sand and

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31 Dr O'Sullivan's Evidence, (paragraph 203) states that "Individual rooms can be vibration proofed by insulation…". The term 'insulation' is most commonly used to describe sound absorbing materials (e.g. Pink Batts® etc). These materials are not used for vibration isolation purposes.

32 Dr O'Sullivan's Evidence, paragraphs E.24, 129 and 202: *(Lak, Degrande & Lombaert 2011).* And that *"the unstable nature of the geology of the Kapiti area will make it more likely that road unevenness will occur, resulting in traffic-induced vibrations from road traffic"*.

33 Dr O'Sullivan's Evidence, paragraph 203.

34 Dr O'Sullivan's Evidence, paragraph 203.

35 Refer my EIC at paragraph 55.

peat)[36] and that there is no proposal to inspect buildings for damage before or after the construction period[37].

55 While I have approached the vibration assessment for this Project in a conservative and careful manner, this should not be misinterpreted as tentativeness. Compared with noise, the prediction of construction vibration is less precise because of the large variables involved[38] so it is prudent to take a conservative approach and I feel this is in the best interests of affected receivers (such as the Deardens).

56 Furthermore, the proposed conditions[39] and methodologies in the draft CNVMP[40] reasonably constrain high-vibration activities until they are deemed 'safe' in terms of the vibration risk they pose. I feel this offers a pragmatic solution so that both the NZTA and affected receivers can be reassured that vibration damage will be avoided as far as practicable.

57 Mr and Mrs Dearden state that there is no requirement for NZTA to undertake building condition surveys before or after construction, but this is incorrect. Proposed Condition DC.34 requires *"a detailed pre-construction building survey of at-risk buildings, services and structures (as identified in the certified CNVMP)"*. I note that Mr and Mrs Dearden's dwelling is not currently identified as being at risk as it is slightly outside the risk contour in that area[41]. I would, however, support the inclusion of their dwelling in the pre-construction building condition survey regime to address the specific concerns they have expressed.

58 I note that Section 10.4 of the draft CNVMP sets out in more detail the requirement to carry out pre-construction building surveys, the nature of such surveys, the need to resurvey (if vibrat*ion criteria have been exceeded and there is potential for damage to have occurred), and the requirement for post-construction sur*veys. I consider that this adequately addresses Mr and Mrs Dearden's concerns.

Loretta Pomare (309-1*)*

59 Ms Pomare has expressed her concern about the vibration impact on her dwelling at 55 Puriri Rd, Waikanae. She also expresses concern about trucks on local streets causing damage[42], although she does

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36 Christopher and Monica Dearden's Evidence, paragraphs 2.30 – 2.32 and 3.16.

37 Christopher and Monica Dearden's Evidence, paragraphs 2.31 and 2.40.

38 Refer Assessment of Vibration Effects: Technical Report 18, at Section 5.8.

39 For example, proposed condition DC.30, point 5 in **Annexure A**.

40 Refer draft CNVMP at Sections 9 and 10.

41 Refer draft CNVMP at Section 11.2.3.

42 Loretta Pomare's Evidence, paragraph 58.

not specify whether she is referring to damage to the roads, or to dwellings along the route.

60 I have addressed the vibration effects of construction traffic on local roads in my EIC (at paragraph 76), and vibration effects on infrastructure assets in the draft CNVMP at Section 10.12. I consider these address Ms Pomare's concerns.

61 Ms Pomare raises the issue of vibration in peat, and the associated risk of damage to her dwelling[43], stating that *"the acoustics of vibration on this type of terrain has not been investigated"*[44]. This is incorrect.

62 As explained in my EIC, I have undertaken measurements of proposed high-vibration machinery in sand and peat and have used these to establish risk contours[45]. I note that Ms Pomare's dwelling is not identified as being at risk as it is slightly outside the risk contour in that area[46]. However, as with the Deardens, I would support the inclusion of her dwelling in the pre-construction building condition survey regime to address her specific concerns.

63 I have also measured vibration from heavy vehicles on dwellings adjacent to the existing SH1, Raumati South and found that this complies with the Project's operational vibration criteria[47]. I consider these address Ms Pomare's concerns.

64 Ms Pomare requires that *"any change to road surface i.e. sinking and damage, thus becoming uneven, to be addressed and repaired within 7 days"*. This is addressed by proposed Condition DC.49 which requires that the NZTA system for monitoring and maintaining the condition of State Highway pavements and road surfaces shall be applied.

John Horne (for Loretta Pomare) (309-3)

65 Mr Horne has provided evidence, on behalf of Loretta Pomare, on the recreational use of the land adjacent to the proposed Expressway by trampers, walkers and runners. Mr Horne mentions vibration several times in his evidence,[48] but in a general manner only, along with visual, noise and air pollution effects. He raises no specific concerns about vibration.

66 In my experience, people on the move (i.e. walking or running) are much less likely to perceive ground vibration because their feet

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43 Loretta Pomare's Evidence, paragraphs 112, 113, 117, 134 and 139.

44 Loretta Pomare's Evidence, paragraph 112.

45 Refer my EIC at paragraph 39, and Technical Report 18 at Sections 5.5.1 and 5.7.

46 Refer draft CNVMP at Section 11.2.3.

47 Refer Technical Report 18 at Section 6.3, and Technical Report 19 at Section 5.4.

48 John Horne's Evidence, paragraphs 18, 22, 23, 34 and 25.

(through which they receive the vibration) are in contact with the ground for much shorter time periods than someone who is stationary (particularly sitting or lying down).

67 On a smooth, well maintained road, vibration levels close to the road are below the human perception[49] for a stationary receiver. I expect there would be no vibration effects on people walking or running on walkways adjacent to the Expressway.

Phillip Nordberg (for Ann Laing) (337-1)

68 Mr Nordberg has provided evidence, on behalf of Ann Laing, on vibration induced settlement. The issues raised by Mr Nordberg relate to geotechnical vibration, which I have addressed in my EIC at paragraph 43.

ADDITIONAL VIBRATION MEASUREMENTS

69 As noted earlier in my evidence, additional vibration measurements of construction machinery working in peat have recently been undertaken. This work was undertaken on 16 October 2012 in Poplar Ave by Mr Bill Wood of Marshall Day Acoustics.[50]

70 The main purpose of the measurement was to obtain vibration data in peat for other construction machinery (off-road truck and motor scraper), as requested by Malcolm Hunt in his evidence.[51]

71 As a result, on 16 October, a Moxy HA-270 off-road truck, a CAT 924 loader and an Allis Chalmers HD16 bulldozer were measured.

72 I understand from Mr Stan Goodman (Project construction contractor) that the measured off-road truck is a similar weight and has similar wheel type to a motor-scraper, and that in terms of vibration, one is entirely representative of the other. While I personally cannot confirm this, I consider that the measured data is sufficient for vibration prediction purposes.

73 I also note that high-vibration sources (including the motor scraper and any not yet identified) will be measured the first time they are used, as required pursuant to proposed Condition DC.30 (**Annexure A**).

74 The measured data has been processed, collated and regression curves[52] have been developed. These curves are attached as

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[49] Refer the SH20 measurement described in Technical Report 18 at paragraph 6.3.

[50] Mr Wood is an acoustical consultant with over 20 years' experience on the environmental effects of transport.

[51] Malcolm Hunt's Evidence, paragraphs 2.9(c), 13.3 – 13.6.

[52] A regression curve is a collected set of vibration measurements of a particular machine, made at varying distances. Regression analysis of this dataset is undertaken (using an inverse-power relationship) to smoothly interpolate between the data points so that a vibration value (for that machine) can be read off the curve at any distance.

Annexure B to my rebuttal evidence. These curves indicate that both the off-road truck and loader have risk contours of approximately 3 metres (i.e. the vibration level at or further than 3 metres from these machines is predicted to comply with the Project criteria).

75 This finding validates the 8 metre contour adopted for both machines in my initial risk assessment[53], and shows that assessment to be conservative.

76 By comparison, the measured data for the bulldozer, indicates it has a risk contour of approximately 20 metres. This is higher than the 16 metres risk contour for a vibratory roller, being the highest-vibration item of mobile plant (i.e. not including piling) contained in my initial risk assessment.[54]

77 I have discussed this with **Mr Andrew Goldie** (Project construction engineer) and I understand that a bulldozer would not typically be used within 20 metres of dwellings: an excavator would be used instead. To reinforce this, I suggest that this requirement be added in Section 10 *General management procedures and mitigation measures* of the CNVMP.

78 Finally, I note that the risk contours are based on the DIN 4150-3:1999 Standard[55], which is a conservative Standard whose criteria are designed to prevent *any* damage to structures. As a result, breaching the criteria does not necessarily imply that damage will occur.

CONCLUSION

79 I have reviewed all relevant statements of evidence that relate to vibration, and have addressed the issues raised. I have made some additions and amendments to the proposed designation conditions to address particular issues. I remain of the opinion that the effects of vibration from the construction and operation phases of this Project can be appropriately and adequately managed.

James Whitlock
25 October 2012

[53] Refer Technical Report 18 at Section 5.7.

[54] Refer Technical Report 18 at Section 5.7.

[55] German Standard DIN 4150-3:1999 *"Structural vibration – Part 3: Effects of vibration on structures".*

ANNEXURE A – PROPOSED DESIGNATION CONDITIONS REFERRED TO IN THIS REBUTTAL STATEMENT[56]

DC.30

The Requiring Authority shall implement ~~the noise management and mitigation measures identified in~~ the certified CVNMP throughout the entire construction period of the Project.

The CNVMP shall, as a minimum, address the following:

1. Description of the works, anticipated equipment/processes and their scheduled durations;
2. Hours of operation, including times and days when construction activities causing noise and/or vibration would occur;
3. The construction noise and vibration criteria for the project;
4. Identification of affected houses and other sensitive locations where noise and vibration criteria apply.
5. Monitoring requirements, including relevant times (i.e. critical phases of construction, e.g. at the first use of high-noise or high-vibration machinery,) when possible exceedance of the Project criteria is anticipated (e.g. night works etc.), or in response to any reasonable complaint.

DC.30A

Construction noise shall, as far as practicable, be made to comply with the following criteria in accordance with NZS6803:1999:

Residential receivers

Time of week	Time period	dB $L_{Aeq(T)}$	dB L_{Amax}
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and public holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

Industrial and commercial receivers

[56] Proposed changes to condition wording are shown by underlining (for additions) and strikethrough (for deletions). The changes to conditions DC.30 and DC.30A are discussed in **Ms Wilkening's** rebuttal Evidence (construction noise).

	Time period / dB $L_{Aeq(T)}$ 0730-1800 — 70 1800-0730 — 75 (T) means a duration between 15 minutes and 60 minutes, in accordance with NZS6803:1999. Where the criteria set out above cannot be met, the process of Condition DC.32 shall be followed.
DC.31	The Requiring Authority shall implement the vibration management and mitigation measures identified in the certified CVNMP. Construction vibration shall, as far as practicable, be made to comply with the following criteria ~~in accordance with the draft NZTA *State highway construction and maintenance noise and vibration guide,* July 2012 / version 0.5 DRAFT (or any subsequent revision of this document)~~:

Receiver	Details	Category A	Category B
Occupied dwellings	Night-time 2000h – 0630h	0.3 mm/s PPV	1 mm/s PPV
	Daytime 0630h – 2000h	1 mm/s PPV	5 mm/s PPV
Other occupied buildings*	Daytime 0630h – 2000h	2 mm/s PPV	5 mm/s PPV
All other buildings	Vibration – continuous**	5 mm/s PPV	50% of Line 2 values in Table B.2 of BS 5228-2:2009

* 'Other occupied buildings' is intended to include daytime workplaces such as offices, community centres etc., and not industrial buildings. Schools, hospitals, rest homes etc. would fall under the occupied dwellings category.

** This line addresses 'continuous' or 'long-term' vibration as there are no construction machinery proposed which produces transient vibration.

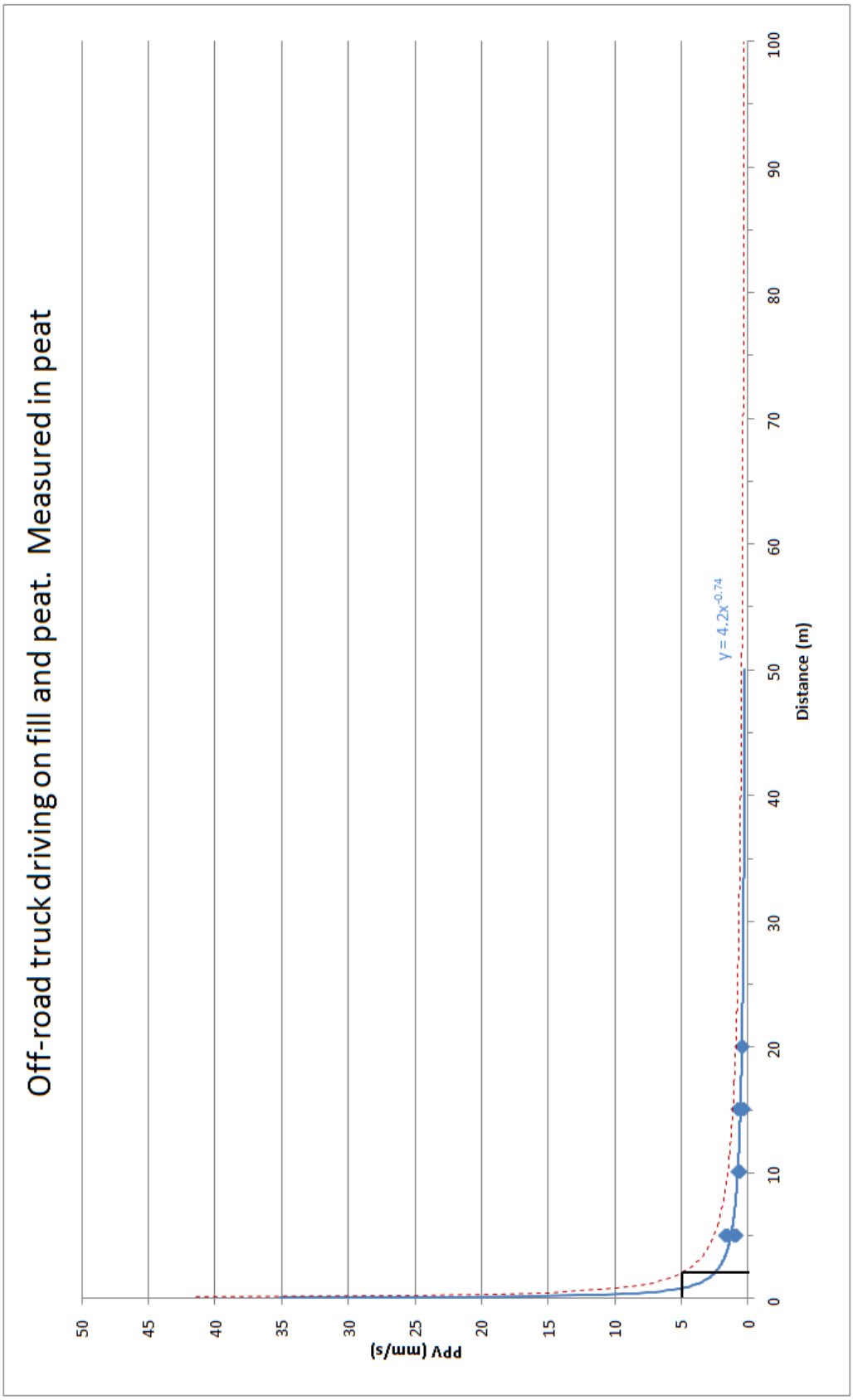
a) Measurements of construction vibration shall be undertaken in accordance with German Standard DIN 4150-3:1999 "Structural Vibration Part 3: Effects of vibration on structures".

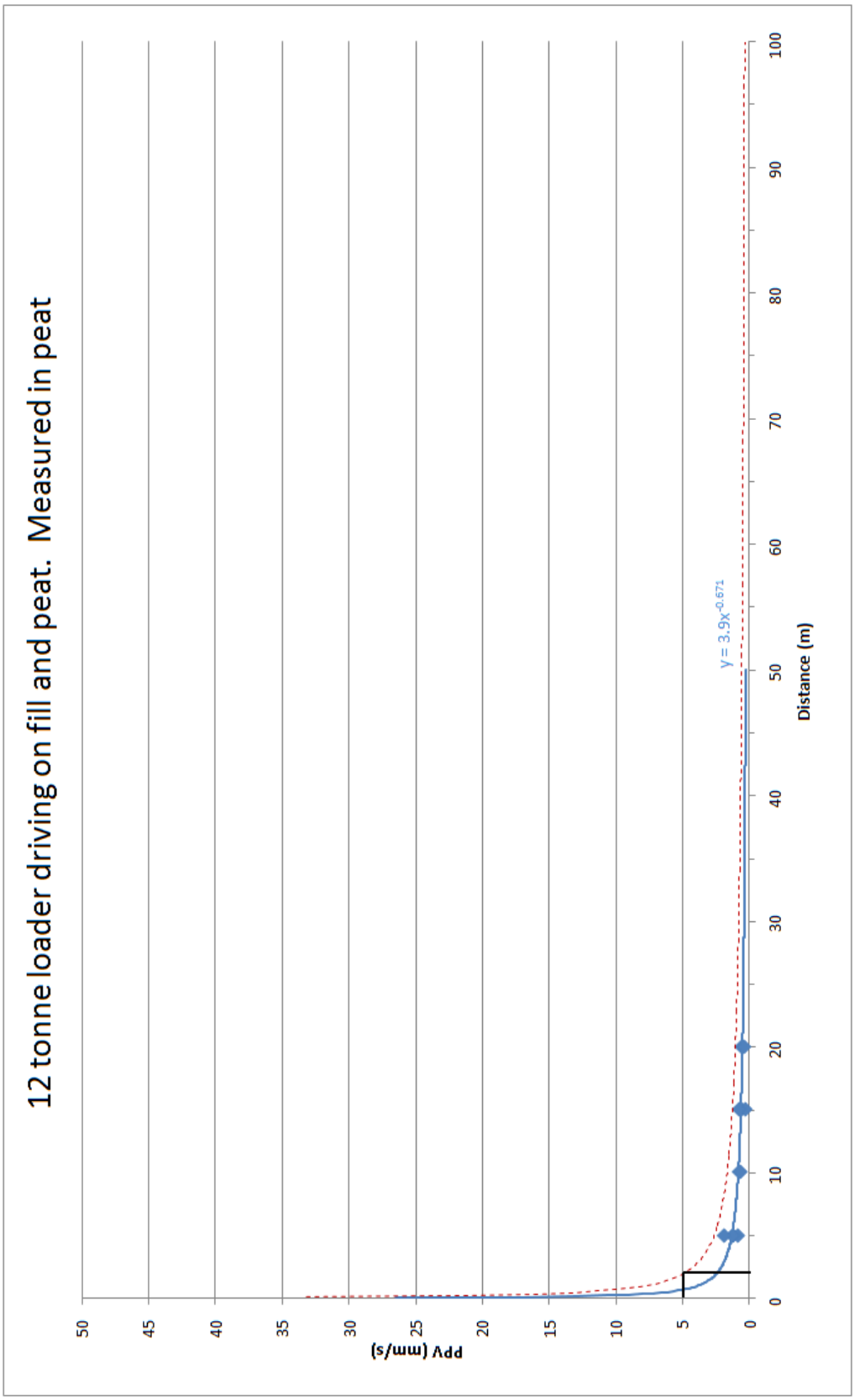
b) If measured or predicted vibration levels exceed the Category A criteria then a suitably qualified expert shall be engaged to assess and manage construction vibration and to comply with the Category A criteria~~.~~, and the Manager shall be notified. If the Category A criteria cannot be practicably achieved, the Category B criteria shall be applied.

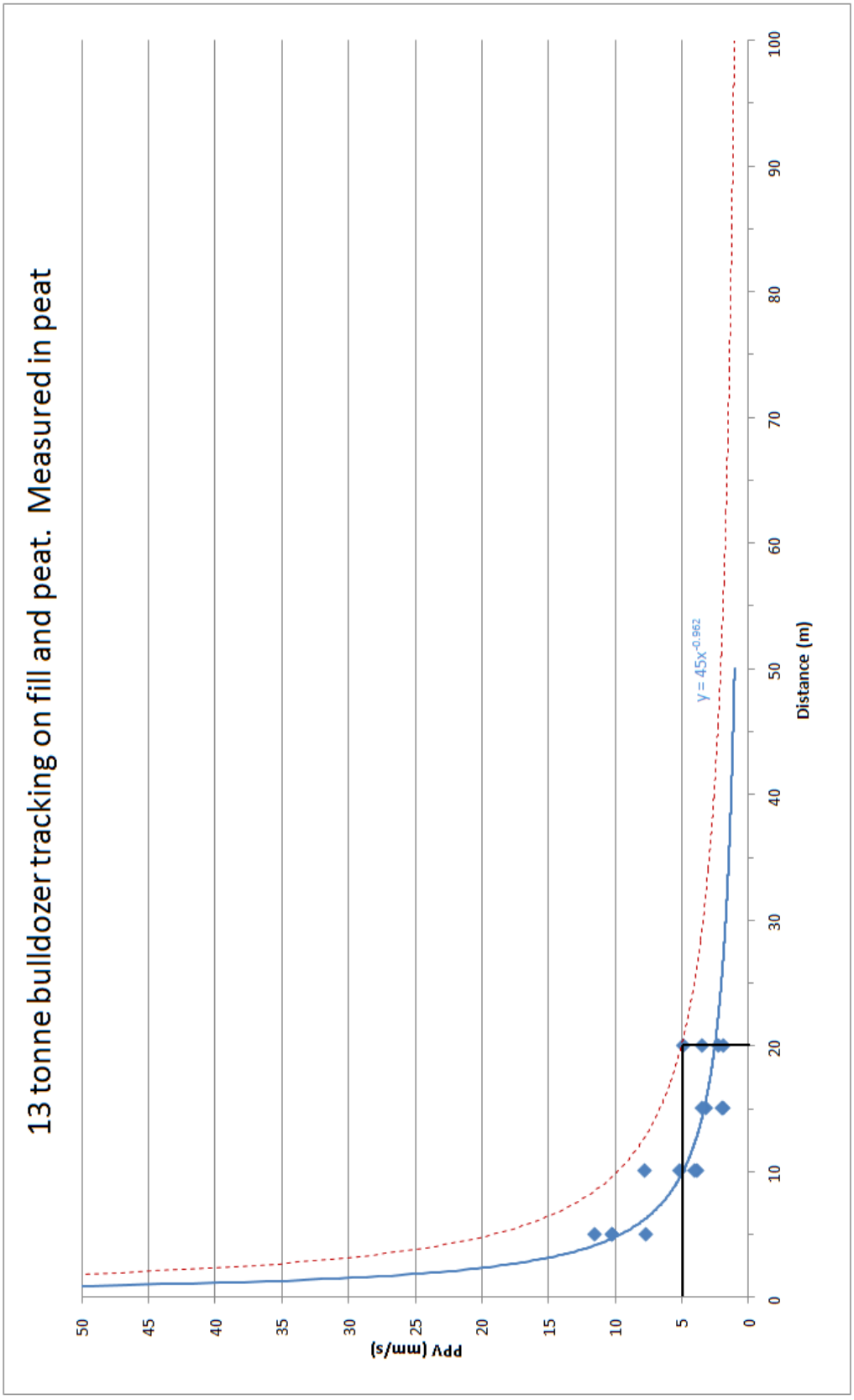
c) If measured or predicted vibration levels exceed Category B criteria, then construction activity shall only proceed if there is continuous

	monitoring of vibration levels and effects on buildings at risk of exceeding the Category B criteria, by suitably qualified experts. d) Where the Category B criteria set out above cannot be met, the process of Condition DC.33 shall be followed.
DC.33	a) Where the Category B criteria of Condition DC.31 cannot practicably be met, the Requiring Authority shall prepare Site Specific Construction Vibration Management Plans (SSCVMPs) in accordance with the certified CNVMP. The SSCVMP shall describe site specific vibration risks and mitigation measures required, which shall be in addition to the general mitigation measures notes in the certified CVNMP. b) Each SSCVMP shall be submitted to the Manager for certification at least 5 working days prior to the relevant construction activity commencing.
DC.34	Prior to the commencement of Project construction operations, a detailed pre-construction building condition survey of at-risk buildings, services and structures (as identified in the certified CNVMP) shall be conducted by a suitably qualified engineer. A report of each survey shall be forwarded to the Manager within one week of the assessment.
DC.49A	In the event of a reasonable complaint of traffic vibration from the completed Expressway, the Requiring Authority shall engage a suitably qualified expert to measure and assess traffic vibration levels for compliance with the Class C criteria of Norwegian Standard NS 8176.E:2005 *"Vibration and shock – Measurement of vibration in buildings from land-based transport and guidance to evaluation of its effect on human beings"*. A report describing the findings shall be provided to the Manager within one month of the assessment being completed.

ANNEXURE B – REGRESSION CURVES OF ADDITIONAL MACHINERY MEASURED IN PEAT ON 16 OCTOBER 2012




12 tonne loader driving on fill and peat. Measured in peat
PPV (mm/s)
Distance (m)
y = 3.9x^-0.671
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90
100


13 tonne bulldozer tracking on fill and peat. Measured in peat
PPV (mm/s)
Distance (m)
y = 45x^-0.962
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90
100