

BEFORE THE PALMERSTON NORTH CITY COUNCIL, (PNCC) THE MANAWATŪ  
DISTRICT COUNCIL (MDC) AND THE TARARUA DISTRICT COUNCIL (TDC)

IN THE MATTER OF           the Resource Management Act 1991 ('the RMA')

AND

IN THE MATTER OF           NOTICES OF REQUIREMENT by the New Zealand  
Transport Agency ('the Agency') under section 168 of the  
RMA for the construction, operation, maintenance and  
improvement of approximately 11.5 km of new State  
Highway between Ashhurst and Woodville to replace the  
closed section of state Highway 3 through the Manawatū  
Gorge and associated works, known as the Te Ahu a  
Turanga; ManawatūTararua Highway Project ('The  
Highway')

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STATEMENT OF EVIDENCE OF **CORY MATTHEW**

EFFECTS ON THE AGRESEARCH BALLANTRAE LONG TERM HILL COUNTRY  
PERFORMANCE TRIAL ('The Trial')

Submitted from a sense of public interest as a private individual with relevant expertise

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## **INTRODUCTION:**

1. My full name is Cory Matthew. I am 68 years of age.
2. I grew up on a hill country sheep and beef farm, was employed by Massey University as a Junior Lecturer in Agronomy in 1984 and retired as Professor in Agronomy in December 2018. My employment with Massey University was continuous over that period. I am now retired.
3. I completed my Massey University Diploma in Sheep Farming (with distinction) in 1970, My B Agr Sci (1<sup>st</sup> Class Hons & Leading student) in 1983, and my PhD in ryegrass ecophysiology in 1993. I have supervised some 15 PhD students as chief supervisor and authored or co-authored over 70 international journal articles and 40 conference papers in the New Zealand Grassland Association and the Agronomy Society of New Zealand annual proceedings, with over 160 total publications. My life's work has been focussed on the science of grassland productivity, management, and systems optimisation with professional contributions in UK, France, Germany, China, USA, Brazil, Argentina, and Malaysia in addition to those in New Zealand.
4. This portfolio of professional experience equips me to understand both the research practice and trial integrity issues around the impact of The Highway on The Trial, and the importance of The Trial to the New Zealand sheep and beef farming industry.
5. My impetus to make a submission to the hearing arose when I attended a briefing meeting conducted by Dr Alec Mackay of AgResearch in the office of Professor Peter Kemp, Head of the School of Agriculture and Environment, Massey University. This meeting was convened to inform Massey staff as potentially interested parties, who had used the Trial in undergraduate teaching and various research projects, that the planned route for the Highway passed through The Trial. To that point in time, I was unaware of this fact, despite having followed media releases quite closely as a Woodville resident with a strong interest in seeing The Highway completed as soon as possible.
6. No specific request for support was issued at that meeting (Paragraph 5) that I recall, but I was left with a strong personal conviction that my particular set of career experiences was uniquely relevant (Paragraphs 3, 4 above) and that I should engage the hearing process, as a matter of public and industry advocacy duty, in my role as a Massey University staff member.

7. There followed a period of email exchanges between me and Dr Mackay in which I asked various questions and pieces of information, to ascertain in my own mind that the trial had a present value and potential future contribution worth defending. I did not assume as a starting point, that the trial necessarily had a future value, or that I would make a submission in favour of its retention, as I am now doing.
8. My approach whenever I engage professionally, is to aim to see all sides of a problem and seek workable solutions that all parties would be able to subscribe to. Based on the aerial photographs of the planned Highway route and my knowledge of The Trial location I noted that there appeared to be a potential variation to the proposed Highway route whereby a bridge across a gully to carry The Highway between two adjacent ridges would allow The Highway to bypass The Trial to the south. I recognised it would be outside of my expertise to assess this.
9. In preparing my evidence I have:
  - a. Obtained information from AgResearch, performed some literature searching in the research database *Web of Science* which covers nearly 90 million publications, and collated information from my own professional experience in order to provide an opinion on the points listed in Paragraph 12a – d (see below).
  - b. Engaged with Mr Greg Lee of NZTA, and attended a site meeting at The Trial and later briefing and discussion at NZTA Palmerston North Office organised by Mr Lee, for interested parties to hear the NZTA perspective on the planning process to date and to discuss the draft report of NZTA-commissioned experts Drs Jeffrey Morton and David Horne (Paragraph 5a in his evidence refers).
  - c. Read selected hearing documents, including the 4 hearing minutes, the evidence of Horne, Morton, Dalzell, and some others.

## **CODE OF CONDUCT:**

10. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. My evidence has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this evidence is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.
11. I wish to declare for the record that Dr Mackay was one of my PhD supervisors between 1986 and 1993 and that we have jointly authored scientific papers as recently as 2016. However, I don't believe this potential conflict of interest has affected my behaviour or opinion in the preparation of my evidence.

## **PURPOSE & SCOPE OF EVIDENCE**

12. I have focussed my evidence on:
  - a. The structure of The Trial from a perspective of scientific credibility and usefulness of the data generated;
  - b. The questions at play;
  - c. The present and future value of The Trial;
  - d. The impact of The Highway on The Trial.
13. It has become apparent during the preparation of my evidence (Paragraph 9 above) that my opinions differ substantively in some points from those advanced by NZTA, including among others project manager Dalzell and experts Horne, and Morton (and Gillingham's support for Morton in Morton's Appendix 1). I would like to note at the outset that I have very high professional respect for each of those individuals, such that my own evidence is presented with much reflection and some trepidation. However, I need to be true to the information and implications, as I perceive them. Where opinions differ, I have tried to separate out the questions at play (which are at times tangled) as a basis for clarity, and to present data-based insight, as distinct from intuitive deductions.

## **EXECUTIVE SUMMARY**

14. The Trial is still scientifically viable, and continues to produce publications, though currently limited by lack of funding.
15. The Trial is uniquely valuable to the New Zealand sheep and beef farming industry because of a continuous treatment history stretching back to 1972, which is irreplaceable.

16. In my opinion constructing the proposed highway through the trial will scientifically compromise the trial to the point that The Trial will have a limited life post construction.
17. Reduced outputs in the last 20 years from The Trial do not reduce the present value of The Trial as treatments continue to be applied and the treatment effects continue to be available for measurement. As a result, The Trial is currently positioned to answer questions on future sustainability of hill farming in New Zealand.
18. NZTA has advised that moving the relevant section of the proposed route a few hundred metres southward in order to avoid the trial would be technically feasible, though with significant collateral impact.

### **QUESTIONS AT PLAY**

19. To me it makes sense to 'decompose' the discussion about The Trial into a series of more focussed questions (my opinion on the answer to each question will follow below);
  - a. Is the historic trial still operationally viable; i.e. would measurements made on The Trial site in 2019 be regarded by pasture scientists as credible and valid for publication? (See Paragraph 19)
  - b. What makes The Trial valuable to the New Zealand pastoral industry, in 2019, and going forwards? (See paragraph 20)
  - c. What will be the impact on The Trial of The Highway being built through it? (See Paragraph 21)
  - d. Is reduced trial usage in the last 20 years a relevant consideration? (See paragraph 22)

### **Design and context elements of The Ballantrae Trial important to discussion of Paragraph 19 questions**

20. When we as scientists lay down a trial, we need to be clear about the research questions we want to answer, and set up treatments that will facilitate collection of data to answer those research questions, with all other influences on the data kept to a minimum. In this respect the statistician Hugh Gauch at Cornell University speaks of 'signal-to-noise ratio' (Gauch, 1993). We can never design a perfect trial in field conditions but we can maximise the 'signal' from imposed treatments and minimise the 'noise' from other sources. Hill country land is uniquely difficult to design trials on because hill country pastures are a mosaic of different microsites with widely contrasting water supply and soil fertility from slope effects on rainfall runoff and on where animals prefer to urinate and defecate. The original (1972) research questions for The Trial related to the yield increase from phosphate fertiliser at high and low rates, with the

question of the longevity (in a time frame of years) of the phosphate fertiliser effect being introduced about 8 years after the start of The Trial. Some historic sheep versus cattle comparison is now gone and the site that remains has a logically tight comparison of high and low initial fertiliser rates (HF or LF, respectively), either continued to the present or stopped (NF) after 8 years, giving 4 combinations: HF-HF, HF-NF, LF-LF, LF-NF. The concept was that each fertiliser treatment was applied to a sufficiently large area to average out the mosaic of microsite effects, so that at the farmlet scale of several ha, the 4 farmlets were essentially homogeneous. Additional control of data variability from microsite effects was achieved by designating some 72 fixed sampling sites within farmlets (Appendix 1), so that revisiting of the same sites at successive samplings conferred a degree of data stability. Normally trials are 'replicated', so that the 'proof' of the treatment effect, is its consistent occurrence in all the replications. Critically, The Ballantrae Fertiliser Trial is unreplicated, because of logistical constraints. Traditionally, manuscript reviewers are reluctant to pass results from unreplicated trials for publication. Where such results are to be published, the article discussion needs to traverse and address any extraneous effects that logically might have affected the responses to the treatments as reflected in the data.

## **OPINION ON QUESTIONS AT PLAY**

21. Is the historic trial still operationally viable; i.e. would measurements made on The Trial site in 2019 be regarded by pasture scientists as credible and valid for publication?

In my opinion, the answer to this question is "yes". This is evidenced by: (i) the publication earlier this year in NZ Journal of Agricultural Research, of a paper comparing 1979 and 2014 data on earthworm abundance of the 4 farmlets (Schon et al., 2019); (ii) the publication in 2018 in Journal of NZ Grasslands of a paper comparing 2003 and 2014 data on soil Carbon levels in the four farmlets (Mackay et al., 2018); (iii) the submission in 2016 of a report to the Fertiliser Association of New Zealand comparing 2015-16 pasture production data from HF-HF, LF-LF, and LF-NF farmlets with 1982-1988 mean production on the same farmlets (Mackay et al., 2016).

22. What makes The Trial valuable to the New Zealand pastoral industry, in 2019, and going forwards?

The value of the trial is the site history, which is irreplaceable. To be clear, the original questions posed in 1972 about the yield response to phosphate fertiliser are now well answered, and the site now represents the long term equilibrium reached after continuous (almost 40 years) HF, LF or NF treatments. With this history, the site is now uniquely placed to

answer research questions around sustainability of New Zealand central and southern North Island hill country farming practices. The future profitability of sheep and beef farming in New Zealand is a burning question now, not only for the farmers, but for New Zealand as a whole, planning our future. However, in my opinion, maintenance of the 4 current treatments is integral to use of the trial site to answer questions around farming sustainability. From a lay perspective, comparison of the results from the four treatments provides a mutual cross check which intuitively compensates for lack of replication. From a statistical perspective, some formal analysis (not possible for 4 unreplicated treatments) may now be possible using regression techniques which look for data trends across the fertility gradient from low to high. It is not hard to think of industry-important research questions that could be addressed by The Trial with immediate effect if funding were available. Examples that quickly come to mind include: (i) How does pasture productivity now and in the coming 1 – 2 decades compare to that in the second half of last century, given the warming climate? (As covered in Mackay et al., 2016); (ii) There is an emerging global interest in soil carbon status as a measure of health of terrestrial ecosystems. Research questions in that space could now be addressed, as in Mackay et al., 2018; (iii) Farming introduces trace pollutants, examples being cadmium and fluoride in fertilisers. Research ascertaining if there are emergent issues arising (including potential synergies between trace pollutants (Li et al., 2016), could be carried out.

23. What will be the impact on The Trial of The Highway being built through it?

Apart from the obvious issue of (a) loss of area, this is a hard question to answer, because the question of highway impacts on adjacent pastures is seldom researched. As a minimum, I believe, in addition to loss of area, (b) the evolution over time of soil fertility gradients parallel with highways needs to be considered in this case, and (c) the potential impact on neighbouring pastures of gaseous and fine-particulate vehicle emissions, especially with numbers of heavy vehicles travelling uphill under load.

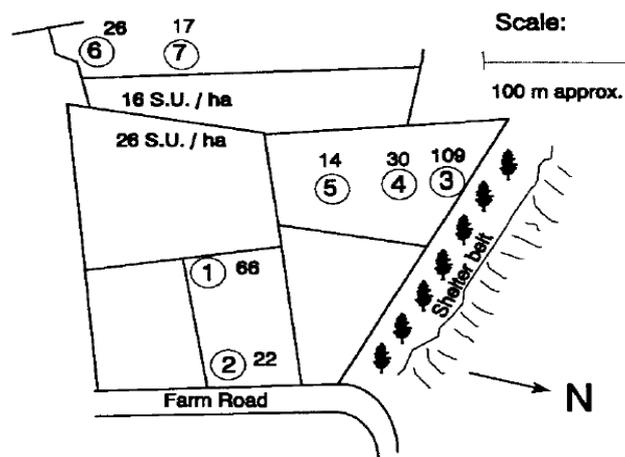
a) Loss of area.

(i) Paragraph 9 in the evidence of Horne submitted by the NZ Transport agency is of critical relevance, especially the comment “I note that my analysis was based on the indicative construction footprint, and not the full designation corridor.” From a trial management perspective, in my opinion, any land acquired by NZTA as part of the designation corridor, MUST be considered as lost to the trial. This substantively impacts on the estimated area loss for the HF-HF farmlet in Table 2 of Horne’s evidence. In that case, reading from “Trial sites impacted by proposed road location” (Supplied by AgResearch, Attached here as Appendix 1), loss of land to The Highway construction from the HF-HF farmlet will be more like triple

the 0.65 ha declared in Horne's Table 2, and there will be a further 0.8 ha or so isolated as a long finger (c.f. Paragraph 16 of Horne's evidence), which as a result of edge effects and isolation from the remaining HF-HF area, could not be considered as viable for future inclusion in The Trial, making an actual usable-trial-area loss from HF-HF of nearer 35% (based on visual estimate from the plan).

(ii) Additionally, in my opinion the impact of land loss on The Trial, is better defined by the loss of sampling sites (25 of 72 sites, according to the AgResearch analysis, or 34.7% of the total, and 36% if HF-HF Site 72 is also counted as lost). Simple land area loss, is a less useful measure.

- b) It has been my career experience that pastures adjacent to roads develop soil fertility gradients with low fertility nearest the road and higher fertility at distance from the road. My interpretation of this is that animals will eat grass right up to a road fence, but rest, urinate, and defecate at a distance from the road. Since I have seen this effect even on a farm access road with lower traffic density (Figure 1, below, Matthew et al., 1995), it logically seems to be a response to a disturbance gradient, rather than a disturbance threshold; that is animals choose a quieter area of any paddock for resting. Another possible explanation for these effects may be that animals tend to wait by gates, which tend to be away from roads. In the example below taken from my published research, the soil phosphorus test was 3x higher, and pasture production was 70% higher away from a farm access road than close to it (Sites 1 and 2 in Figure 1).



**Fig. 1** Plan of seven microsites sampled by Matthew et al. (1988). Numbers within circles indicate location of the seven microsites. Numbers adjacent to each microsite are Olsen P soil test values for that site. Microsites 1-5 were stocked at 26 stock units/ha, and Microsites 6 and 7 at 16 stock units/ha.

We saw a very similar fertility gradient of 0.13 Olsen P units per meter distance from State Highway 57 (Hendriks et al., 2016; soil Olsen Phosphorus 18 mg/kg near SH57 and 37 mg/kg at the opposite end of Massey No. 4 Dairy farm Paddock 17 (150 m distance). Lastly we anecdotally see a similar effect every year in Massey University student grazing management experiments located in paddocks adjacent to Tennent drive between Palmerston North and Linton.

I am concerned that a soil fertility gradient is likely to develop in paddocks adjacent to the highway post construction. If this happens it would create 'data noise' in the sense defined by Gauch (1993) (Paragraph 20 above) that would make it hard to compare pre- and post-Highway-construction data from sampling sites in the HF-HF farmlet

- c) I have no experience with effects of vehicle emissions on pastures near roads. However, it is clear such effects are complex and can be substantive (Spellerberg, 1998; Nikolaeva et al., 2019).

Overall, in my opinion, the loss of the trial integrity from (a) area and sampling site loss and spatial separation of HF-HF from other farmlets; (b) likely build up of soil fertility gradients for over 100 m distance from The Highway, and (c) the unknown effects of various vehicle emissions would cumulatively cause me, if I were Trial manager, or a manuscript reviewer of data coming forward for publication, to lose confidence in the credibility of the trial data. In short, my opinion is that construction of The Highway as proposed, would result in The Trial being concluded.

24. Is reduced trial usage in the last 20 years a relevant consideration?

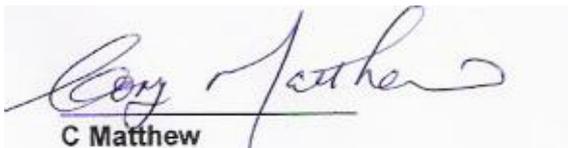
I think it is important to ring fence this question from consideration of the intrinsic value of The Trial, as discussed in paragraphs 21 and 22 above. I would not personally have taken the time to prepare my evidence if I believed the trial had no future (Paragraph 7 above). Evidence of Dalzell (Paragraph 70, pages 14,15) notes the site was in 2012 listed in an AgResearch document as 'surplus capacity' proposed for sale, but the sale did not proceed. My understanding from contact with AgResearch staff at the time was that the sale proposal generated internal discussion among AgResearch scientists and management, which led to the sale decision being changed to a leasing arrangement with ongoing application of The Trial fertiliser treatments and associated stocking rate differentials. Some publications from The Trial have followed. If this trend can be continued, there is case for keeping the trial.

25. Mr Greg Lee of NZTA has advised that the route variation to avoid The Trial (Paragraph 8 above) would be technically feasible, but with high collateral costs.

## REFERENCES CITED

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- Spellerberg, I.F. 1998. Ecological effects of roads and traffic: a literature review. *Global Ecology and Biogeography Letters* 7, 317 – 333.

## SIGNED:



C Matthew

Cory Matthew

15<sup>th</sup> March 2019

Appendix 1

Map extracted from document supplied to me by AgResearch and entitled "Trial sites impacted by proposed road location."

