IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF Lake Rotorua Nutrient Management – **PROPOSED PLAN CHANGE 10** to the Bay of Plenty Regional Water and Land Plan

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REBUTTAL EVIDENCE OF PROFESSOR GRAEME JOHN DOOLE

ON BEHALF OF THE BAY OF PLENTY REGIONAL COUNCIL

Evidence topic: Statement of rebuttal evidence of Graeme John Doole – Economic impacts of Plan Change 10 at the catchment level

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Qualifications and experience

1. My full name is **Graeme John DOOLE**. My qualifications, experience and commitment to the Environment Court's Code of Conduct for Expert Witnesses are as set out in paragraphs 1–6 of my evidence in chief filed 20 January 2017. I do not repeat them in this rebuttal.

Responses to evidence of Philip Mark Osborne

2. Since preparing my evidence in chief, I have reviewed the expert evidence of Philip Mark Osborne on behalf of the Rotorua Lakes Council. I should note that I do not intend to respond to every point raised in the evidence of Mr Osborne, but I have focused more directly on what I consider to be the points that relate most closely to my own field of expertise. Where I have not responded on other issues, that does not mean I necessarily agree with Mr Osborne's evidence on those issues. My rebuttal focuses primarily on the sufficiency of the use of natural capital to allocate entitlements to leach nitrogen. This is necessary given that Osborne suggests that insufficient consideration was given to the natural-capital approach in the evaluation of alternative allocation mechanisms for the Lake Rotorua catchment.

Natural capital allocation

3. The natural-capital allocation (NCA) approach to the allocation of leaching entitlements involves basing allocation on the inherent productivity of land; the combination of land, soil, and environmental factors that together determine its biophysical suitability for agricultural production. This was one of the scenarios (Scenario S4) that was considered in the Parsons et al. (2015) report that evaluated a number of diverse allocation schemes for nitrogen entitlements in the Lake Rotorua catchment.

4. The economic model applied in the Parsons et al. (2015) model represented the Lake Rotorua catchment through dividing it into many different partitions. Each partition was described in terms of its rainfall, its soil type, a representative farm system, and the size of that partition. A natural-capital allocation (Scenario S4 in the report) was simulated through allocating nitrogen to a given partition based on the estimated level of pasture production in that zone. The proportion of the total allocable load of nitrogen to agriculture that was allocated to a zone was drawn from the proportion of total pasture production that was produced therein.

5. Paragraph 36 of the Osborne evidence reports the benefits of the NCA approach, as outlined in a previous Environment Court decision. These benefits are principally:

    (a) No direct linkage with land use or intensity of operation.

    (b) Ability to disadvantage the placement of high-input farms where they are less suited (e.g. on free-draining soils).

    (c) Does not reward the biggest polluters.

    (d) Does not disadvantage owners of undeveloped land.

    (e) Does not penalise conservative behaviour.

    These factors are generally benefits of an NCA mechanism. However, I disagree with the inference that the broad suitability of this approach extends to the context of Proposed Plan Change 10 in the Lake Rotorua catchment, as this is not a one-size-fits-all situation, and there are other important factors that will determine the most suitable mechanism for allocation.

6. The economic classification of capital focuses on durable assets. However, it extends beyond natural capital; indeed, it also includes economic, human, and socio-cultural capital. These can be thought of enduring economic, human, and socio-cultural assets that add value in the production of goods and services. An example of economic capital is a dairy shed that allows multiple milking events to be carried out over a year. An example of human capital is a farmer's training and experience, while an example of socio-cultural capital includes the importance of existing social networks among producers that allow a faster dissemination of information pertaining to farm productivity.

7. One issue with use of the NCA approach is that natural capital is not the only determinant of farm profit; the other forms of durable capital also play a key role. Indeed, extensive empirical work has now highlighted that it is not natural capital that drives farm profit, but the combination of many factors (Jiang, 2011; Doole, 2012; Doole and Pannell, 2012; Darku et al., 2013). Thus, while the NCA approach recognises the inherent contribution that natural capital plays to nitrogen loss, production and profit, it does not recognise the accumulated stock of other forms of capital that contribute to them. Thus, it fails to recognise existing investment (e.g. including infrastructure, land value, cash investment etc.), in conflict with the principles for allocation-system design that were followed by the Stakeholder Advisory Group (StAG), and the guiding principles for allocation set out in the Regional Policy Statement. The implication is that the NCA approach therefore promotes an allocation of nitrogen entitlements that is perverse from an economic perspective. This is reflected in the Parsons et al. (2015) report, where the NCA scenario (S4) is shown to affect capital values more than the proposed Range 2 approach (S8), in some circumstances. Indeed, its narrow definition of capital serves to impair its capacity to consider a broad range of factors that determine the contribution that the agriculture sector makes to the Lake Rotorua catchment.

8. Another issue with use of the NCA approach is that natural capital is not a good determinant of nitrogen leaching (Lilburne et al., 2016); the other forms of capital also play a key role in determining rates of nutrient loss. This has been shown in an extensive literature highlighting that nitrogen-leaching rates can vary greatly, even on the same soil type (Doole et al., 2011; Doole, 2012; Doole and Pannell, 2012; Doole and Romera, 2014a; Doole, 2015a; Doole and Kingwell, 2015). This efficiency is related to inherent soil attributes (e.g. texture, structure, profile) and location (e.g. rainfall, attenuation, distance from waterway) that vary within different instances of a

soil with the same level of natural capital, as assessed using standard methods. In line with this assertion, Lilburne et al. (2016, p. 9) states that there is "considerable variability in the proneness of soils to leach" within parcels of land deemed to have equivalent levels of natural capital. Indeed, this is clearly evident in field results reported by Hewitt et al. (2015). The implication is that the NCA approach promotes an allocation of nitrogen entitlements that does not align with the natural capacity of a certain soil in a given location to efficiently utilise nitrogen. This weakens the assertion that the NCA approach is a suitable strategy to disadvantage the placement of high-polluting farms on high-risk soil types, as raised in paragraph 36 of the Osborne evidence. Indeed, farmers (and other landowners of land not in production) receive a windfall allocation of entitlements based solely on the inherent productivity of their soil, and not the inherent suitability of the soil to support intensive agriculture through efficient nutrient attenuation.

9. The use of Land Use Capability (LUC) to measure natural capital is outlined in Paragraph 36 of the Osborne evidence. This approach has recently been criticised by Lilburne et al. (2016), whom highlight a number of key flaws:

   (a) "The LUC classification is subjective, heavily biased towards meeting the needs of soil conservation…" (p. 6)

   (b) "Land assigned to LUC classes 1–4 must be suitable for arable use, where arable use is interpreted as being suitable for tillage for cropping, and the land is capable of growing at least one of the common annual field crops (e.g. wheat, barley, maize) with average yields under good management without any permanent adverse soil effects… The land's suitability for arable use does not necessarily equate with its potential pastoral productivity." (p. 6)

   (c) "… [V]ariability contained in an LUC Class, and even at the LUC Subclass level, makes attainable stock-carrying capacity 'aggregated by LUC Class' a poor proxy for soil 'natural capital'." (p. 9)

10. Trading of nutrient-loss entitlements has the potential to overcome the distortion provided by a NCA approach in the long term. However, the NCA approach requires a much higher volume of trade than most other scenarios, if the most-efficient outcome for the catchment is to be attained when land-use is unconstrained and there are no frictions in the market for nutrient entitlements. Parsons et al. (2016) highlight that the dairy sector must purchase 42 kg N ha^{-1}, on average, to continue operation. This is

around 40% of their total leaching load and 75% more than in any other scenario, excluding equal allocation. The sheep-and-beef sector are required to trade more than two-thirds of their allocation, while forestry are required to trade more than 85% of theirs, if the efficient outcome is to be reached. This demonstrates how the greater level of distortion between leaching in the current state and when allocated according to natural capital places great pressure on the efficiency of the trading mechanism to attain least-cost outcomes for society. In effect, this is a practical impact of the poor link between measures of natural capital and the level of nitrogen loss experienced from a given soil (Lilburne et al., 2016). Furthermore, the significant rights to leach allocated to land uses with low leaching promote windfall gains to be experienced within these sectors (Parsons et al., 2015), in conflict with the principles for allocation-system design that were followed by the Stakeholder Advisory Group (StAG) and as guided by the Regional Policy Statement principles.

11. In applied research, it is often found that the majority of farmers are risk averse (Pannell et al., 2006). Risk aversion can motivate hoarding of entitlements, as these make farms more resilient in the face of market, environmental, and political variation (Robb et al., 2001; Marsh et al., 2014). Frictions in the market for nutrient entitlements have a significant impact on the capacity for trade in nutrient entitlements to allow the catchment to reach an efficient outcome, following the use of a NCA. The price for nitrogen in the catchment increases from around $118 and $60 kg N^{-1} in the 5000 ha and unlimited land-use change scenarios, to around $444 kg N^{-1} when half of the entitlements. However, the optimal price in the NCA scenario in the Parsons et al. (2015) report is the highest at $551 kg N^{-1}, as limited trading impairs the ability for the significant distortion introduced by the allocation method to be overcome. In turn, this impacts the ability of the incentives fund to purchase significant amounts of nitrogen because the price of leaching entitlements is inflated.

12. Experimental evidence confirms that the performance of markets for nutrient entitlements can realistically compromise their ability to attain fully-efficient outcomes. Marsh et al. (2014) studied the performance of simulated entitlements markets, for grandfathering and equal-allocation methods, using human subjects in an experimental-economics setting. The equal-allocation method produces a substantial distortion in rights to leach nitrogen, relative to grandparenting, but is somewhat similar in this regard to what is found under NCA (Parsons et al., 2015). Marsh et al. (2014) find that both systems fail to achieve the gains predicted by theory given the reluctance of people to trade entitlements. This reinforces the detrimental impact that

market frictions may have on the performance of allocation patterns that are broadly different from the status quo, such as NCA.

13. There may also be additional frictions present in the market. One example is a potential reluctance for owners of multiple-owned Maori land to trade, particularly due to high levels of risk aversion concerning future flexibility of the farm operation. Another example is the potential reluctance of the Rotorua Lakes Council to trade, so as to insure the scope of effective waste-water treatment against population growth. The effect of these frictions would manifest themselves in a similar way to those identified for the hoarding of entitlements among agricultural enterprises in the Parsons et al. (2015) report. Nevertheless, they were not explicitly quantified and considered in this analysis.

14. Paragraph 37 of the Osborne evidence provides a quote from the OECD. This quote reads, “Green growth means fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities.” Osborne suggests that this is international ‘evidence’ of policy makers taking interest in natural capital. I believe that this statement is erroneous in the context of the Osborne evidence, in that this quote does not provide any indication that the NCA approach is any better than the Range 2 scenario with regards to “fostering green growth” and ensuring natural assets are protected.

15. Paragraph 47 of the Osborne evidence highlights that the economic assessment undertaken for Plan Change 10 highlights the gap between the current land use and that which would be sustainable under a natural capital scenario. I disagree with this statement for several reasons:

    (a) The economic assessment undertaken for Plan Change 10 in Parsons et al. (2015) highlights the gap between current land use and the land use that would be present if cost of transitioning to the desired state from an environmental viewpoint were minimised. This land-use pattern is, of course, directly conditional on the data inputs used in the modelling exercise.

    (b) Even if it did indicate the size of this gap, the Parsons et al. (2015) report—nor any other economic analysis of environmental improvement in the Lake Rotorua catchment for that matter—has not established the sustainability of a

natural-capital scenario. Indeed, as raised in paragraphs 6–12 above, it is likely that the natural-capital scenario does not actually achieve economic, environmental, social, and cultural sustainability, due to its narrow focus on land-use suitability that is not strongly correlated to these outcomes.

(c) Furthermore, the Parsons et al. (2015) report—nor any other economic analysis of environmental improvement in the Lake Rotorua catchment for that matter—has not established the suitability of the natural-capital approach to allocation. Rather, it is highlighted that this mechanism can have a perverse effect on economic and environmental outcomes. An example of a perverse economic outcome is that farm profits will fall on dairy farms as producers must pay higher prices for nitrogen, when frictions exist in the market for nutrient entitlements and these are allocated using a natural-capital approach. An example of a perverse environmental outcome is that the Lake Rotorua Incentives Scheme will be unable to purchase adequate levels of nitrogen over time because less entitlements will be available in the market and the price of entitlements will be higher, when frictions exist in the market for nutrient entitlements and these are allocated using a natural-capital approach. Further concerns with the natural-capital approach are raised in paragraphs 6–12 above.

Moratorium on trading

16. Paragraphs 58–61 of the Osborne evidence highlights that the decision to prevent the trading of nutrient entitlements between farmers until 2022 has not been assessed and could introduce much inefficiency. There are several reasons to suggest that the cost of limiting the purchase of leaching entitlements by farmers in the initial years of the scheme will be low:

(a) The first action of farmers will likely be to optimise management within their allocated level of leaching entitlements, rather than purchase additional rights. This has been shown in simulated trading markets for nutrient entitlements, using experimental-economics methods (Marsh et al., 2014).

(b) The willingness to trade may be slightly reduced, given that the catchment only must move 70% of the way towards its target level of nitrogen loss by 2022. This would promote the thinness of the market for nutrient entitlements,

serving to dampen any distortion brought about by the exclusive purchase of leaching rights by the Lake Rotorua Incentives Scheme.

(c) A catchment intermediate target for the managed reduction of nitrogen loss is to be set to achieve 70% of the required reduction from 746 t/yr to 435 t/yr by 2022.

(d) The Lake Taupo Protection Trust has dominated the market for nutrient entitlements in the Lake Taupo catchment, even though other farmers have been able to purchase rights as well (Duhon et al., 2011). This may be due to uncertainty being present in the early years of the scheme (Duhon et al., 2011). These factors provide evidence from reality that the Lake Rotorua Incentives Scheme is likely to dominate the market, even if competition from other buyers was present in the market for leaching entitlements.

(e) Producers could more cost-effectively exploit opportunities for intensification outside, rather than inside, the Lake Rotorua catchment if Plan Change 10 went forward as proposed. Intensifying outside the catchment would be less expensive, given that there is no need to purchase leaching entitlements. The likelihood of this happening is higher if farmers were competing with the Lake Rotorua Incentives Scheme, given that the cost of purchasing these rights in the Lake Rotorua catchment would be inflated in these circumstances.

(f) It seems possible that holders of leaching entitlements could reach early contractual agreements, which involve them transferring allocations at a future date when such trades are permissible. This could counteract the current strategy to prevent sales to agents other than those representing the Lake Rotorua Incentives Scheme. However, the attractiveness of this option is dampened by temporal uncertainty around climate, scheme management, input prices, output prices, and the price for leaching entitlements. The effects of this could be particularly marked given the level of risk aversion commonly found among farmer populations (Pannell et al., 2006).

17. Paragraph 59 of the Osborne evidence states that the moratorium on trading between farmers will restrict any rural land use change for up to 5 years. I disagree with this statement because even though trading between farmers cannot take place, the Lake Rotorua Incentives Scheme can still purchase leaching entitlements. This will allow

land use change to occur over the 5-year period. Indeed, this will likely play a key role in mitigating nitrogen within the catchment over this period.

Direct economic impacts from trade

18. Paragraph 70 of the Osborne evidence states that if greater trading occurs under the NCA approach then the direct economic impacts are likely to be lower, relative to the grandparenting approach. I disagree with this logic. There are several reasons that greater trading under the NCA approach would not necessarily lead to greater benefits:

    (a) Trading activity imposes a transactions cost on farmers (Duhon et al., 2011).

    (b) Frictions are likely in the market for nutrient entitlements. More trade is required under a NCA approach to attain the most-efficient outcome; thus, this mechanism is much more prone to inefficiency being introduced by way of market frictions (Parsons et al., 2015).

    (c) The greater distortion presented by the initial allocation within a NCA scheme makes it harder to identify valuable opportunities for trade that are available across the catchment. This increases the risk that efficient outcomes are not fully exploited.

Maintenance of productive land uses

19. Paragraph 79 of the Osborne evidence states that no assessment appears to have been undertaken that considers the maintenance of land uses that are most productive. This includes estimating the costs of “continuing to encourage a market where the most efficient land use is not maintained”. This evidence is incorrect on several accounts:

    (a) The economic assessment described in Parsons et al. (2015) provides a detailed economic evaluation of diverse allocation mechanisms, under different assumptions concerning land-use change and market frictions. Restricting land-use change and/or market efficiency both reflect instances in this report where the “most efficient land use is not maintained”. Indeed, an overall conclusion of the report was that these barriers to efficiency can significantly impact the relative performance of alternative allocation mechanisms.

(b) The objective of maintaining land uses that are most productive is a general misconception. Individual farmers require income to service debt and living expenses. Also, regional economies are better served by farming systems that provide for better economic outcomes. Thus, production levels should never take precedence over economic efficiency as a goal for environmental policy (Doole, 2015). This aligns with the common proverb espoused by dairy farmers nationwide, “production is vanity, profit is sanity”.

(c) Seeking to maximise production also is likely to have a direct detrimental impact on the environment. Extensive empirical evidence shows that high production levels are generally associated with higher nitrogen-leaching losses, especially in dairy systems. Greater energy ingestion through higher levels of feed eaten promotes milk production. However, protein is ingested simultaneously, thus increasing the output of nitrogen in urine. Around 95% of nitrogen leaching in pasture-based dairy systems in NZ arises from the urine patches of grazing animals, due to the high protein content of pastures and its low retention rate in dairy cattle (10–30%) (De Klein et al., 2010). This direct relationship between leaching and milk production means that nutrient outflows often directly increase with milk production (Doole, 2015; Doole and Romera, 2015).

(d) Osborne outlines that it is important to consider the identification and encouragement of land that is also most productive on a per-kilogram leached basis. Previous points attest to the insufficiency of focusing on production metrics. Further error is introduced when this is considered on a per-kilogram leached basis. Productive-efficiency ratios are commonplace in biophysical sciences. However, they should not be used to determine appropriate land use or land management within a given environmental policy. This is because they do nothing to restrict environmental outputs themselves (Doole and Romera, 2014b). Indeed, it is entirely possible within such schemes for farms to leach a high amount of nitrogen, provided they do so efficiently.

Responses to evidence of James Britton Fuller

20. Since preparing my evidence in chief, I have reviewed the expert evidence of James Britton Fuller on behalf of the Rotorua Lakes Council. I should note that I do not intend to respond to every point raised in the evidence of Mr Fuller, but I have focused more directly on what I consider to be the points that relate most closely to my own field of expertise. Where I have not responded on other issues, that does not mean I necessarily agree with Mr Fuller's evidence on those issues. My rebuttal focuses primarily on the economic impacts of a natural-capital allocation (NCA) system.

Economic impacts of a NCA approach

21. Paragraph 17 of the Fuller evidence highlights how previous work performed by the Bay of Plenty Regional Council (BOPRC) concludes that the NCA approach does not recognise existing investment. I agree with this conclusion made by the BOPRC, given that the economic modelling performed by Parsons et al. (2015) considered existing levels of investment. As set out above, an issue with the NCA approach is that natural capital is not the only determinant of farm profit; the other forms of durable capital also play a key role. Indeed, extensive empirical work has now highlighted that it is not natural capital that drives farm profit, but the combination of many factors (Jiang, 2011; Doole, 2012; Doole and Pannell, 2012; Darku et al., 2013). Thus, while the NCA approach recognises the inherent contribution that natural capital plays to nitrogen loss, production and profit, it does not recognise the accumulated stock of other forms of capital that contribute to them. Thus, it fails to recognise existing investment (e.g. including infrastructure, land value, cash investment etc.), in conflict with the principles for allocation-system design that were followed by the Stakeholder Advisory Group (StAG). The implication is that the NCA approach promotes an allocation of nitrogen entitlements that is perverse from an economic perspective. This is reflected in the Parsons et al. (2015) report, where the NCA scenario (S4) is shown to affect capital values more than the proposed Range 2 approach (S8), in some circumstances. Indeed, its narrow definition of capital serves to impair its capacity to consider a broad range of factors that determine the contribution that the agriculture sector makes to the Lake Rotorua catchment.

22. Paragraph 17 of the Fuller evidence highlights how previous work by BOPRC concludes that the NCA approach impacts those with high nutrient discharges. This conclusion by the BOPRC is correct in that some farms with high nutrient discharges will be given less entitlements but, on the other hand, farms with low nutrient discharges will also typically be allocated much more. This is evident in the Parsons

et al. (2015) report where the dairy sector must purchase 42 kg N ha^{-1}, on average, to continue operation. This is two-thirds of the mean leaching observed across the sector. Moreover, the sheep-and-beef sector are required to trade more than two-thirds of their allocation, while forestry are required to trade more than 85% of theirs, on average. These data reinforce the failure of a NCA approach to recognise existing investment, while also highlighting the significant impact this can have on farm. Indeed, the NCA approach promotes windfall gains to farms of low intensity, while retarding the capacity of farms of higher intensity to maintain their income position or recognise investment.

23. Paragraph 18 of the Fuller evidence states that the evidence of Philip Mark Osborne establishes the economic case for natural-capital allocation. Indeed, it states that "Mr Osborne's economic evidence notes… the natural capital approach is likely to have greater economic benefits in the longer term and promotes the most efficient land use". I disagree with this statement. As I have explained above, the Osborne evidence provides no economic analysis that establishes the case for the use of natural-capital allocation, relative to the Range 2 scenario. Additionally, the Osborne evidence does not establish how natural-capital allocation will promote the most-efficient land use. I believe that a natural-capital allocation approach will fail on both accounts (ability to promote long-term economic benefits and the most-efficient land use configuration), relative to the preferred position of the Range 2 mechanism. Indeed, this is a key finding of the Parsons et al. (2015) report. Additional evidence that questions the general suitability of the NCA approach, from both an economic and environmental perspective, is provided in my responses to the Osborne evidence.

Responses to evidence of Carla Frances Muller

24. Since preparing my evidence in chief, I have reviewed the expert evidence of Carla Frances Muller on behalf of DairyNZ Ltd and Fonterra Co-operative Group Ltd. I should note that I do not intend to respond to every point raised in the evidence of Ms Muller, but I have focused more directly on what I consider to be the points that relate most closely to my own field of expertise. Where I have not responded on other issues, that does not mean I necessarily agree with Ms Muller's evidence on those issues. My rebuttal focuses primarily on the consideration of productivity increases to overcome the costs associated with the mitigation of nitrogen leaching on dairy farms in the Lake Rotorua catchment.

25. Paragraph 5.12 of the evidence of Ms Muller outlines that increases in productivity were used to minimise the cost of imposing restrictions placed on nitrogen leaching. The evidence states that this was done by Lee Matheson in the formulation of the input data for the catchment-level model. Subsequently, Ms Muller attributes this feature of the input data to reducing the cost estimated for the dairy sector at the catchment-level.

26. For each representative farm defined in the catchment model, Lee Matheson determined the profit and nitrogen-loss levels for different management strategies. These strategies were outlined in modelling protocols developed for each sector—see Parsons et al. (2015) for more detail. The modelling protocol applied for the dairy sector in this assessment did not incorporate productivity gains as an explicit choice of the producer. The input data for dairy farms in the catchment model is presented in Appendix 1 of the Parsons et al. (2015) report. This data shows that the use of some mitigation strategies do lead to productivity increases, relative to occasions where the farm lost more nitrogen. However, this occurs in only 65 of the 300 simulated scenarios (i.e. in around 22% of the cases) performed for dairy farms by Lee Matheson. Additionally, the production gains observed in these 65 cases average only 1.3%, with a maximum of 2.4%. For these reasons, I disagree with the assertion that productivity increases mask the cost of nitrogen loss in the input data used in the catchment model and, therefore, within the catchment model itself.

27. This conservative approach to representing increases in productivity is justified for several reasons. The primary reasons are actually outlined in Paragraphs 5.3 and 5.4 of the evidence of Ms Muller.

Professor Graeme John Doole

3 March 2017

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